TECHNICAL REPORT ON THE WAFI-GOLPU PROPERTY

IN

MOROBE PROVINCE
PAPUA NEW GUINEA

Prepared in accordance with the requirements of National Instrument 43-101, Standards for Disclosure of Mineral Projects, of the Canadian Securities Administrators.

Qualified Person:

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Effective Date of Report: 29 August 2012

CONTENTS

TABLES

FIGURES

1 SUMMARY

The Wafi-Golpu Property (Property) is located in the Morobe Province of Papua New Guinea (PNG), approximately 65 km southwest of Lae. The deposit was initially discovered in 1977 with the discovery of the Wafi epithermal gold mineralization leading to the discovery of the copper-gold porphyry mineralization at Golpu in 1990.

The Wafi-Golpu project lying within the Property is owned by the Wafi-Golpu unincorporated joint venture (WGJV), one of three unincorporated joint ventures in the Morobe Province of Papua New Guinea between subsidiaries of Newcrest Mining Limited (Newcrest, 50%) and Harmony Gold Mining Company Limited (Harmony, 50%) referred to collectively as the Morobe Mining Joint Ventures (MMJV).

A Pre-Feasibility Study (PFS) has recently been completed for the Golpu deposit. As part of the PFS, revised Mineral Resource estimates for the Wafi and Golpu deposits and a revised Mineral Reserve estimate for the Golpu deposit were reported in August 2012.

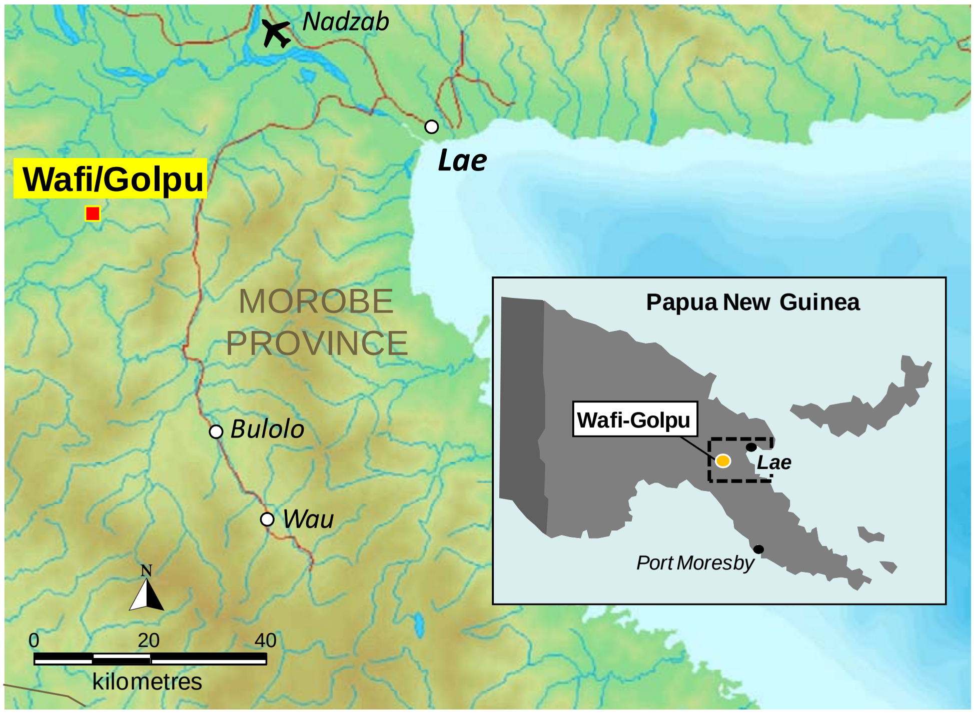
There has not been any mining at Wafi-Golpu.

For the purpose of this report, Mineral Resources and Mineral Reserves are reported in 100% terms, however Newcrest has a beneficial interest of 50% in the assets.

1.1 Geology

The Wafi-Golpu project, which is located within EL440, comprises multiple porphyry and epithermal gold-copper-silver deposits located on the western flanks of the Timini Range. The location of the Wafi-Golpu project is shown in Figure 1.1.

Figure 1.1 Wafi-Golpu Project Location



The Wafi-Golpu project area is hosted within the Wafi Transfer Zone which can be traced for some 25km. The Wafi-Golpu project is based around gold and copper-gold deposits associated with a dacite porphyry diatreme and associated breccia and altered metasediments.

Mineral Resources have been reported for:

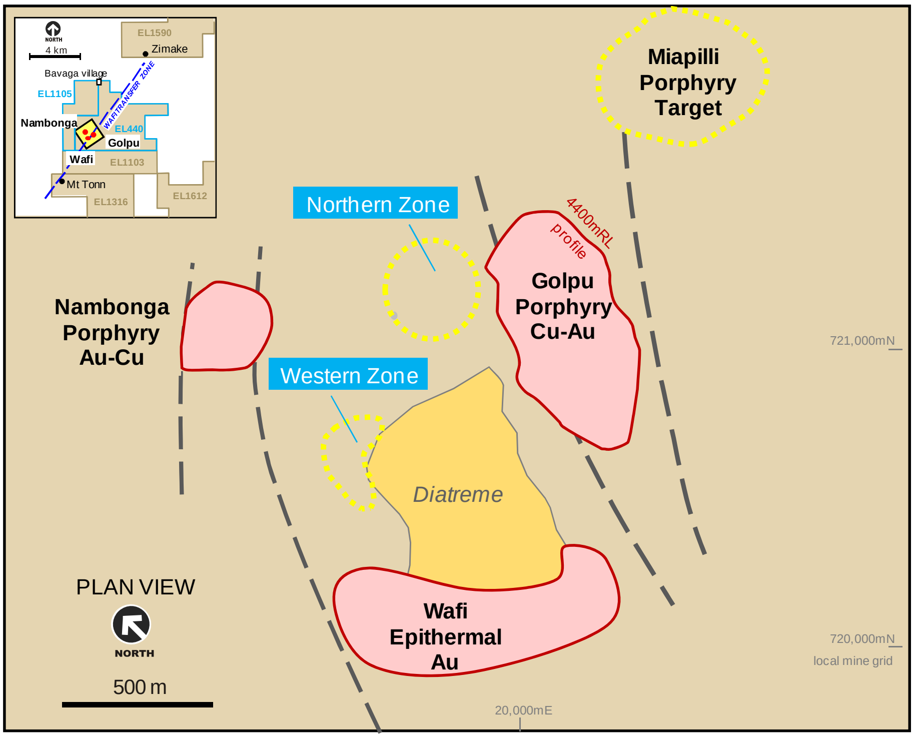
- Golpu (porphyry-related copper and gold) deposit – this comprises stockwork vein arrays and disseminated sulphides hosted in altered diorite porphyry intrusions and surrounding metasedimentary rocks. Copper and gold mineralization is both disseminated and fracture controlled with and without quartz fill. The highest grades are associated with abundant biotite and potassium feldspar alteration, typically rich in chalcopyrite, bornite and gold. The epithermal overprint that caps the porphyry system hosts mineralization that is disseminated and contains abundant pyrite with lesser covellite, enargite and electrum.

- Wafi (gold-silver epithermal) deposit – this comprises disseminated sulphides and quartz vein stockworks in advanced argillic to intermediate argillic altered conglomerate, siltstone and sandstone units. Alteration and mineralization is hosted in and around diatreme breccia.

- Nambonga (porphyry-related copper and gold) deposit – this comprises stockwork vein arrays and dissemination hosted in altered diorite porphyry intrusions and surrounding metasedimentary rocks. Structurally-controlled quartz-carbonate veins also occur in the Nambonga deposit.

The approximate relative locations of Wafi, Golpu and Nambonga are shown in Figure 1.2.

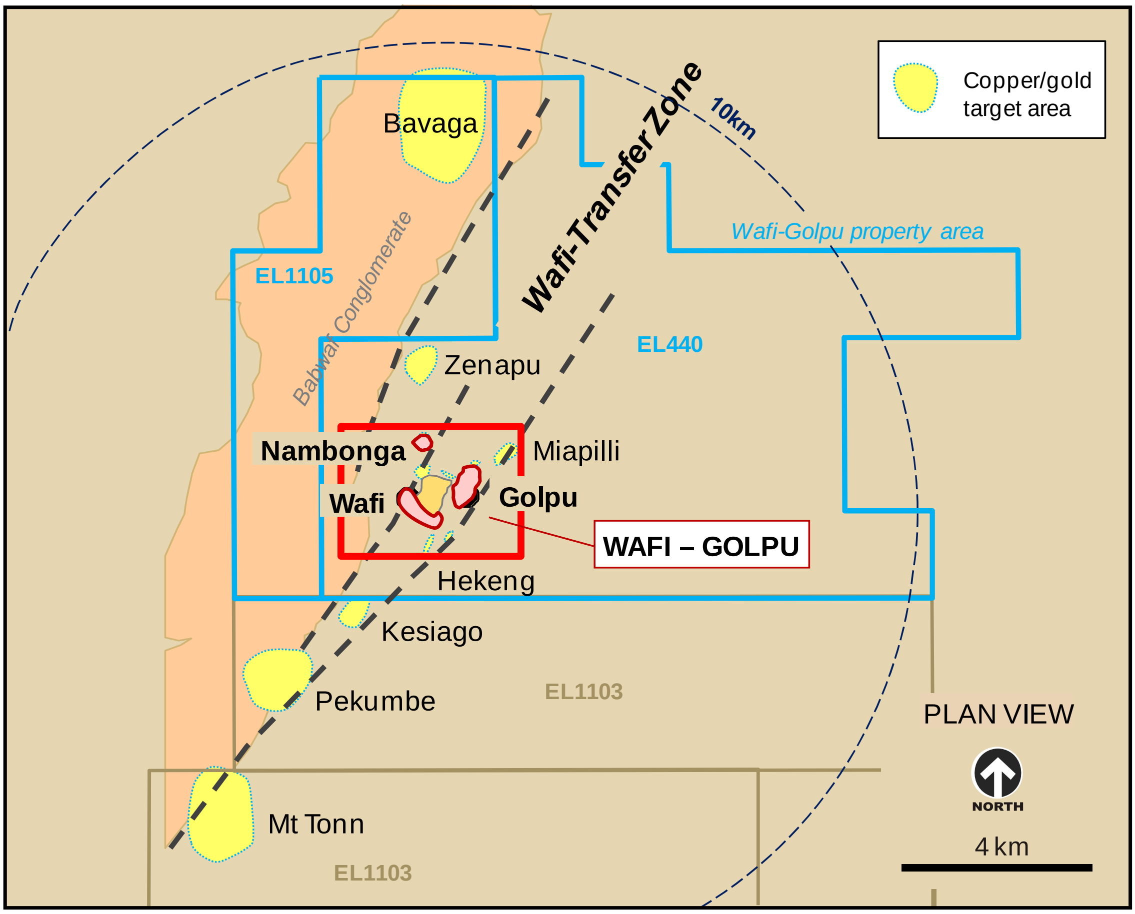
Figure 1.2 Plan View of Wafi-Golpu Project Area



In addition, there are a number of early stage exploration porphyry targets located along the entire length of the Wafi Transfer Zone, including Mt Tonn, Pekumbe, Kesiago and Miapilli. Limited drilling conducted to date has confirmed the presence of porphyry related mineralization. In the years ahead, exploration will continue in the Wafi Transfer Zone on these and other targets.

A plan view of the Wafi Transfer Zone showing the location of the Wafi-Golpu project and principal deposits and targets is shown in Figure 1.3.

Figure 1.3 Plan View of Wafi-Golpu Property Showing the Wafi Transfer Zone



1.2 Licences

The WGJV holds two exploration licences, covering a total area of approximately 129 km^2, registered in the name of the WGJV participants – Newcrest PNG2 Limited (50%) (a wholly owned Newcrest subsidiary) and Wafi Mining Limited (50%) (a wholly owned Harmony subsidiary). The Wafi-Golpu project is located in Exploration Licence EL440.

Under the terms of the Wafi-Golpu exploration licences, the PNG Government has also reserved the right to acquire up to a 30% equity interest in any mineral discovery at Wafi-Golpu. In January 2011, the PNG Government nominated a subsidiary of State-owned Petromin PNG Holdings Limited (Petromin) as the entity that would purchase the interest and indicated that it would be likely to exercise that option. The option is able to be exercised at any time up to the commencement of mining but has not been exercised to date.

Subject to the project being developed, a royalty of 2% of net smelter revenue would be payable to the PNG Government.

1.3 Mineral Resources

Mineral Resources estimated for the deposits which comprise the Wafi-Golpu Property as at 30 June 2012 (and as reported in August 2012) are summarized in Table 1.1. Revised resource estimates are reported for the Golpu deposit and the Wafi deposit.

Table 1.1 Mineral Resources Estimated for the Wafi, Golpu and Nambonga Deposits

	Tonnes (Mt)	Gold (g/t)	Copper (%)	Silver (g/t)	Contained Gold (Moz)	Contained Copper (Mt)	Contained Silver (Moz)
Indicated Resource							
Golpu (Porphyry Au/Cu)	810	0.64	0.92	1.1	16.6	7.46	29.4
Wafi (Epithermal Au/Ag)	110	1.7	-	3.6	6.3	-	13.0
Nambonga (Porphyry Au/Cu)	-	-	-	-	-	-	-
Total Indicated Resource	**920**				**22.9**	**7.46**	**42.4**
Inferred Resource							
Golpu (Porphyry Au/Cu)	190	0.61	0.80	1.0	3.7	1.52	6.3
Wafi (Epithermal Au/Ag)	23	1.3	-	2.5	0.9	-	1.8
Nambonga (Porphyry Au/Cu)	40	0.79	0.22	-	1.0	0.09	-
Total Inferred Resource[1]	**250**				**5.7**	**1.60**	**8.1**

Rounding may cause some computational discrepancies in totals.

The Golpu Mineral Resource is reported within a 0.2% Cu shell which reflects the proposed bulk underground mining method of block caving with ore processing by sulphide flotation as proposed by the Golpu PFS. The Wafi Mineral Resource is reported at a cut-off grade of 0.4g/t Au for non-refractory, predominantly oxide material and a cut-off grade of 0.9g/t Au for low recovery, refractory sulphide material. The Mineral Resource estimates were developed using prices of US$1,400/oz gold and US$3.50/lb copper respectively.

[1] *Newcrest reports its resource and reserve estimates in compliance with the 2004 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code).*

1.4 Mineral Reserves

The Mineral Reserve estimate for Golpu as at 29 August 2012 is summarized in Table 1.2.

Table 1.2 Mineral Reserve Estimate for the Golpu Deposit

	Tonnes (Mt)	Gold (g/t)	Copper (%)	Silver (g/t)	Contained Gold (Moz)	Contained Copper (Mt)	Contained Silver (Moz)
Probable Reserve[2]	450	0.86	1.2	1.4	12.4	5.44	19.7

The Golpu Mineral Reserve estimate was developed using prices of US$1,250/oz gold and US$3.10/lb copper. Mineral Reserves have been classified using a net value, rather than a cut-off grade, to take into account the contributions of both gold and copper. The cut-off value used in this estimate is US$18/t.

The Qualified Person (QP) commissioned AMC Consultants Pty Ltd (AMC) to conduct a review of the drilling, sampling and analytical processes and associated Quality Assurance / Quality Control procedures that were relied upon to support the new estimates. The Golpu Mineral Resource and Mineral Reserve estimates have also been the subject of independent external review by AMC. No material issues have been identified in these reviews and AMC concluded that the estimates have been prepared using accepted industry practice and have been classified and reported in accordance with the JORC Code and have been restated in accordance with the requirements of National Instrument 43-101 (NI43-101).

1.5 Mining Method

The PFS has proposed the block caving mining method for the Golpu deposit with initial production commencing from Lift 1 whilst ramp development continues down to Lift 2. The Golpu deposit comprises a vertical porphyry intrusion with a thrust fault slightly displacing the upper and lower sections of the deposit. The fault is an important structural feature that influences the location of the boundary between Lifts 1 and 2. Lift 1 has a planned extraction horizon located at 4850mRL[3] (approximately 700m below surface) and a 250m column height. The extraction horizon for Lift 2 is located at 4100mRL (approximately 1.45km below surface) with a 750m column height. In the PFS, production from Lift 1 is scheduled to ramp up to 15Mtpa over a four year period commencing in 2019 with development of Lift 2 undercut and initial production scheduled to commence in 2024. Production from Lift 2 would progressively ramp up to reach 22Mtpa in 2029. Mining from Lift 1 would be suspended in 2028 with remaining ore from Lift 1 recovered through overdraw of Lift 2. The mineralization continues below Lift 2, indicating good potential for a third mining lift (Lift 3). Figure 1.4 is a Schematic Cross Section of the Golpu Porphyry Deposit.

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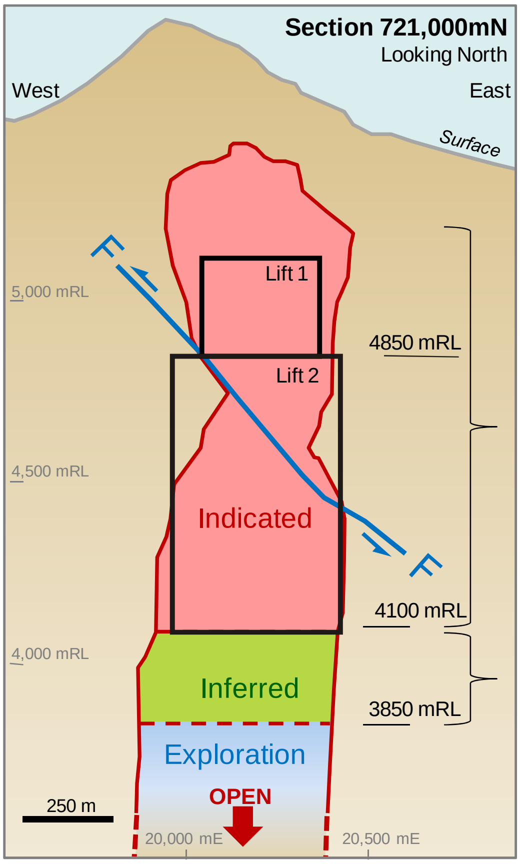
[2] *The Golpu Indicated Mineral Resource estimate, as set out above, is inclusive of the Golpu Probable Mineral Reserve estimate as set out above. For the purpose of this report, Mineral Resources and Mineral Reserves are reported in 100% terms. Newcrest has a beneficial interest of 50% in these resources and reserves.*
[3] *5,000m has been added to the national height datum to establish the local height datum.*

Figure 1.4 Schematic Cross Section of the Golpu Porphyry Deposit

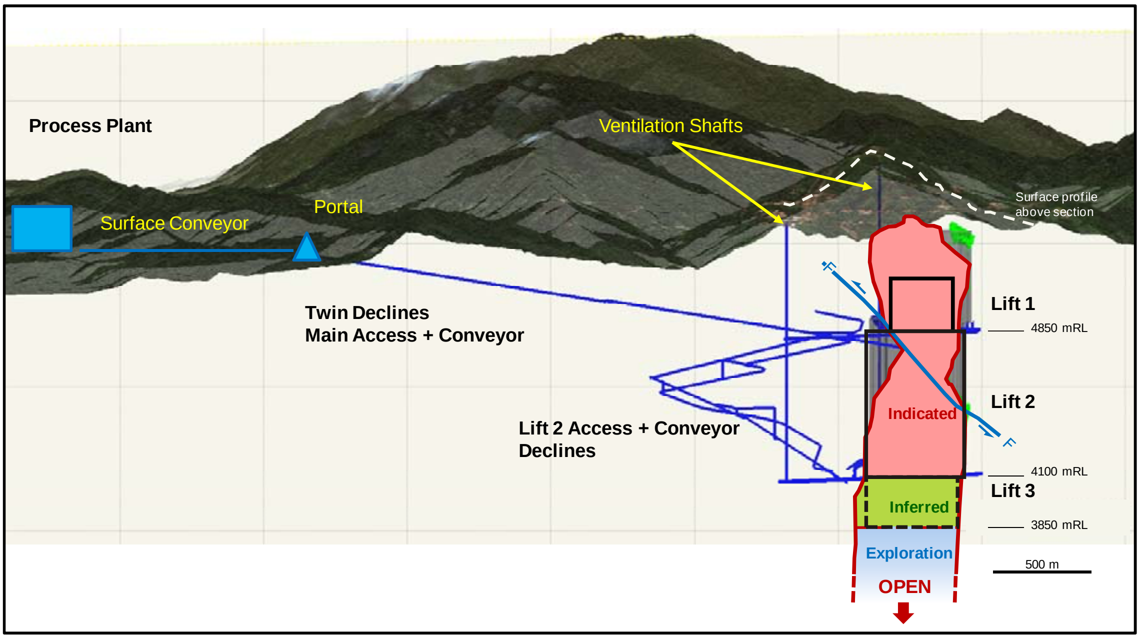


Indicated Resource	Probable Reserve	Conversion
16.6 Moz Au	12.4 Moz Au	75%
7.46 Mt Cu	5.44 Mt Cu	73%

Inferred Resource
3.7 Moz Au
1.52 Mt Cu

The mine development for Golpu Lifts 1 and 2 (and potentially Lift 3) is depicted in Figure 1.5.

Figure 1.5 Golpu Mine Development



Underground infrastructure is planned to comprise twin declines for access of mobile equipment and ore handling via an inclined conveyor system. Other significant underground infrastructure would include a dewatering system, electrical reticulation and ventilation systems, crushers and conveyor transfer stations.

Preconditioning has been included in the mine plan to reduce the impact of the coarse fragmentation on cave propagation and production rate.

1.6 Metallurgical Testing and Mineral Processing

Metallurgical test work was conducted as part of the Golpu PFS.

The Golpu deposit consists predominantly of two major mineralization types, porphyry and metasediments.

- Within the porphyry, the majority of gold (in excess of 80%) is typically hosted in copper mineralization and pyrite. Gold associated with copper mineralization is recoverable however the proportion associated with pyrite is not recovered.
- Metasediments are characterised by finer grain sizes and clay alteration that deleteriously affects flotation performance and gold recovery.

PFS laboratory test work indicates copper recovery from porphyry ores is typically +95%.

Metallurgical test work completed during the PFS indicates process recoveries for gold in the range 51% to 66%. Based on this data, metallurgical recoveries were separately estimated for Lift 1 and Lift 2. The PFS assumes an average gold recovery of 61% and an average copper recovery of 93%.

Metallurgical recoveries are yet to be optimised and future test work programs are planned to be conducted during the Feasibility Study phase of the project. The purpose of this work will be to assess alternative flow sheets and reagent options with the objective of improving gold recovery.

In the PFS, mine start-up and development is based on a gradual ramp-up in production. The process plant would be constructed in two stages: initially a 15Mtpa module would be constructed with a second 7Mtpa module added to match the mine ramp-up to achieve a total treatment rate of 22Mtpa of ore.

The flow sheet for each concentrator module would comprise:

- a primary crusher, SAG mill, ball mill and pebble crushing circuit;
- bulk rougher flotation followed by regrinding and three stages of concentrate cleaning; and
- concentrate thickening and storage facilities.

It is proposed that concentrate would be transferred by slurry pipeline to dewatering, storage and ship loading facilities near Lae.

1.7 Capital Cost and Operating Cost Estimates

The estimated initial capital cost to first production for the Golpu development as per the PFS is presented in Table 1.3.

Table 1.3 Capital Cost Estimate

Area	PFS Estimate (US$M)
Direct Costs	
Mine	967
Process Plant	652
Infrastructure	557
Power Supply	472
Total Direct Costs	**2,649**
Indirect Costs	
Project Management	679
Owners' Costs	635
Drilling and Studies	444
Total Indirect Costs	**1,759**
Contingency	437
Total Capital Cost	**4,845**

Capital cost estimates have been developed over a period of time in which economic conditions, particularly as they related to resource projects, were higher than is currently the case. These capital cost estimates do not reflect recent changes and therefore represent a significant opportunity during the Feasibility Study to optimise.

No major contracts are being committed until this review has been completed.

After first production, there will be ongoing capital expenditure for the remainder of the mine life, including ongoing mine development to deliver the projected production. The PFS estimates total capital expenditure (including the US$4.845 billion referred to above) for the life of the project to be US$9.767 billion over 32 years.

The operating costs per tonne of ore processed for Lift 1 and Lift 2 estimated in the PFS are presented in Table 1.4:

Table 1.4 Operating Cost Estimate

Area	PFS Estimate (US$/t processed) (Life-of-Project)
Mining	8.64
Processing	7.39
Infrastructure	1.61
G&A (US$100m p.a.)	5.01
Total Operating Cost	**22.65**

The operating cost estimates have been developed over a period of time in which economic conditions, particularly as they related to resource projects, were higher than is currently the case. These operating cost estimates do not reflect recent changes and therefore represent an opportunity during the Feasibility Study to optimise.

1.8 Recommendations

The Golpu PFS was completed in August 2012 and it is expected that a Feasibility Study will follow. The Golpu project is not yet in the Feasibility Study phase. Newcrest and Harmony are engaging with key stakeholders (including the PNG and provincial governments, landholders and community representatives) to ensure clear alignment on the objectives and requirements for the project development and key elements of the next phase of work. It is anticipated that, subject to satisfactory resolution on these outstanding matters, Newcrest and Harmony will progress the Golpu project into the Feasibility Study phase during the first half of calendar 2013.

It is recommended that capital and operating costs which have been estimated to PFS level are closely evaluated to assess what opportunities exist to further refine them, particularly given the continuing weaker global economic conditions.

It is recommended that opportunities with the potential to impact production, grade and metal recoveries for a Golpu development beyond that assumed and modelled for the PFS Reserve Case be fully investigated during Feasibility Study phase. These include higher grade and recovery in Lift 1, optimised metallurgical recovery for gold, production ramp up and production rate enhancements and opportunity for an additional mining lift immediately below Lift 2.

It is recommended that exploration activities within the Wafi-Golpu Property continue whilst the Golpu deposit progresses through the Feasibility Study phase and the Wafi deposit progresses to the PFS phase.

The Feasibility Study is estimated to take two years to complete. Pre-Execution Phase expenditure for the period 1 July 2012 to 31 December 2014 is estimated at approximately US$800 million (100% terms). The majority of this spend comprises resource definition drilling and studies (approximately US$250 million), access decline and advanced exploration works (approximately US$200 million) and EPCM and owners' costs (approximately US$250 million).

2 INTRODUCTION

2.1 General and Terms of Reference

This Technical Report (the Report) on the Wafi-Golpu Property in the Morobe Province, Papua New Guinea has been prepared by Newcrest Mining Limited following release of the results of a PFS on the Golpu deposit which forms part of the Wafi-Golpu Property.

It has been prepared in accordance with the requirements of NI 43-101, 'Standards of Disclosure for Mineral Projects', of the Canadian Securities Administrators (CSA) for lodgement on the CSA's 'System for Electronic Document Analysis and Retrieval' (SEDAR).

2.2 Report Authors

A listing of the authors of this Report, together with the sections for which they are responsible, is given in Table 2.1.

Table 2.1 Persons Who Prepared or Contributed to the Technical Report

Qualified Person	Position	Employer	Independent of Newcrest	Date of Site Visit	Professional Designation	Sections of Report
Qualified Person responsible for the preparation and signing of this Technical Report						
C Moorhead	Executive General Manager Minerals	Newcrest Mining Limited	No	May 2012	FAusIMM	All sections
Other Experts who assisted the Qualified Person						
Expert	**Position**	**Employer**	**Independent of Newcrest**	**Date of Site Visit**	**Professional Designation**	**Sections of Report**
D Corp	General Manager ExCo Coordination and Projects	Newcrest Mining Limited	No	No visit	MAusIMM	1-3, 5, 6, 23-27
L Bowyer	Manager Land Tenure	Newcrest Mining Limited	No	No visit	N/A	4
F MacCorquodale	General Manager Minerals Development	Newcrest Mining Limited	No	May 2012	MAIG	7-9
P Dunham	Principal Geologist, Golpu Studies	Newcrest Mining Limited	No	April 2012	MAusIMM	10-12, 14
J Watt	Processing Lead - Wafi Golpu Project	Harmony Gold (PNG Services) Pty Ltd	Yes	No visit	MAusIMM	13, 17
G Flores	Head of Development	Newcrest Mining Limited	No	May 2008, June 2009, February 2010	MAusIMM, Member SME	15

Expert	Position	Employer	Independent of Newcrest	Date of Site Visit	Professional Designation	Sections of Report
M Smith	Principal Mining Engineer, Golpu Study	Newcrest Mining Limited	No	No Visit	MAusIMM	16
Charles Lamb	Study Manager Golpu Study	Newcrest Mining Limited	No	Multiple Jan – Jul 2012	N/A	18, 19
M Hawkins	Environment Manager Wafi-Golpu Project	Newcrest Mining Limited	No	Multiple Jan - July 2012	N/A	20
Rod Cochrane	Estimating Manager Wafi-Golpu Project	Axiom Project Services Pty Ltd	Yes	June 2012	N/A	21
N Hill	Senior Business Analyst	Newcrest Mining Limited	No	No visit	N/A	22

There are no mining or mineral processing operations at the Wafi-Golpu site and it was concluded that a site visit by James Watt was not necessary for preparation of the Report.

The Report is based on information available to Newcrest from the WGJV, a list of which is contained in Section 27, on site visits undertaken by the Qualified Person and on discussions with the WGJV project team.

This report is effective 29 August 2012.

2.3 Units of Measure and Currency

Throughout this Report, measurements are in metric units and currency in United States dollars unless otherwise stated. Table 2.2 includes key terms used and their abbreviations.

Table 2.2 Key Terms

Abbreviation	Unit/Term	Abbreviation	Unit/Term
pH	Acidity or basicity	MLs	Mining Leases
AA	Atomic Absorption	NPV	Net Present Value
AAS	Atomic Absorption Spectrometry	NSR	Net Smelter Return
BWI	Bond Ball Work Index	µm	One millionth of a meter
m^3	Cubic metres	%	Percent
km^3/a	Cubic kilometres per annum	pa	Per annum
m^3/hr	Cubic metres per hour	$/m^3$	Per cubic metre
dia	Diameter	/kWh	Per kilowatt hour
EA	Environmental Assessment	/oz	Per ounce (Troy)
ELs	Exploration Licenses	/lb	Per pound
FA	Fire Assay	/t	Per tonne
Au	Gold	ICP-OES	Plasma-optical Emission Spectrometry
g/t	Grams per tonne	lb	Pound (avdp)
g/t Au	Grams per tonne of gold	PFS	Prefeasibility study
HW	Hanging wall	QA/QC	Quality Assurance/Quality Control
ICP	Inductively-Coupled Plasma	RC	Refining Charge
kg	Kilogram(s)	RPD	Relative Paired Difference
kg/m^3	Kilograms per cubic metre	RC	Reverse Circulation
km	Kilometre(s)	RWi	Rod Mill Work Index
ktpa	Kilotonne per annum	SAG	Semi-autogenous grinding
kW	Kilowatt	km^2	Square kilometres
kWh	Kilowatt-hours	m^2	Square metres
l	Litre	TSF	Tailings Storage Facility
m	Metre(s)	t	Tonne(s)
Mt	Million tonnes	t/m^3	Tonnes per cubic metre
Mtpa	Million tonnes per annum	tpd	Tonnes per day
MW	Megawatts	tph	Tonnes per hour
mm	Millimetres	V	Volt(s)
Moz	Million ounces (Troy)		

3 RELIANCE ON OTHER EXPERTS

The Qualified Person has relied, in respect of legal and environmental aspects, upon the work of certain Experts listed below. To the extent permitted under NI 43-101, the Qualified Person disclaims responsibility for these sections of the Report.

The following disclosure is made in respect of each of these Experts:

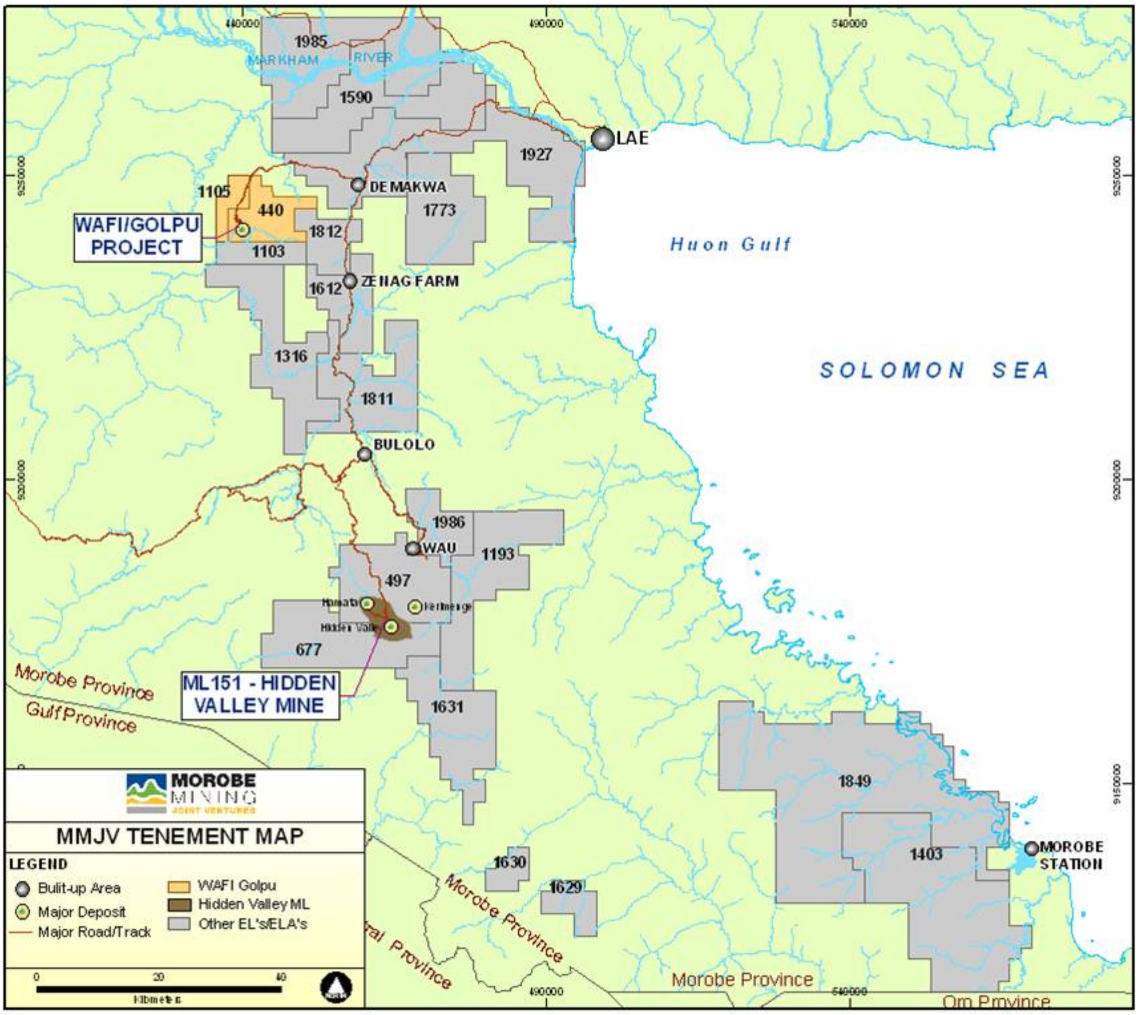
- Ms L Bowyer, Manager Land Tenure, Newcrest Mining Limited:
  - Report, opinion or statement relied upon: Information on mineral tenure and status, title issues, royalty obligations.
  - Extent of reliance: full reliance following a review by the Qualified Person(s).
  - Portion of Technical Report to which disclaimer applies: Section 4.
- Mr M Hawkins, Environment Manager Wafi-Golpu Project:
  - Report, opinion or statement relied upon: Information on environmental, permitting, and social/community matters.
  - Extent of reliance: full reliance following a review by the Qualified Person.
  - Portion of Technical Report to which disclaimer applies: Section 20.

4 PROPERTY DESCRIPTION AND LOCATION

4.1 Property Location

The Wafi-Golpu project is located in Exploration License (EL440) within the Morobe Province of Papua New Guinea, approximately 65 km southwest of Lae, the nearest commercial centre within the region with a population of about 90,000. The Property is located at approximately 6º52'S latitude, 146º27'E longitude. The location is shown in Figure 4.1.

Figure 4.1 Property Location



The Wafi-Golpu project is an advanced exploration project that has been subject to extensive exploration and study by previous project owners and most recently by the current owners.

4.2 Land Tenure

The Property is owned by the WGJV, one of three unincorporated joint ventures in the Morobe Province of Papua New Guinea between subsidiaries of Newcrest (50%) and Harmony (50%) referred to collectively as the MMJV. The WGJV holds two exploration licences covering a total area of approximately 129 km^2 (Table 4.1), registered in the name of the WGJV participants, Newcrest PNG2 Limited (50%) (a wholly owned

Newcrest subsidiary) and Wafi Mining Limited (50%) (a wholly owned Harmony subsidiary).

Table 4.1 Details of Tenements

Lease	Lease Type	Lease Status	Grant Date	Expiry Date	Area km^2
EL1105	Exploration License	Granted	26 January 1995	25 January 2013	33
EL440	Exploration License	Granted	11 March 1980	10 March 2014 (pending renewal)	95.2

The minimum statutory annual expenditure commitment for the project is approximately $34,300; however the WGJV has committed to annual expenditure of $14 million.

4.3 Relevant Agreements

The joint venture is between Newcrest and Harmony with equal 50% participating interests.

Subject to the project being developed, a royalty of 2% of net smelter revenue is payable to the Government of Papua New Guinea.

A compensation agreement with local landowners is in place whereby specified payments are made due to impacts of exploration activities including loss of trees, impact on water resources, access restrictions, and disturbance to sacred sites.

Consistent with the current administrative practice of the Government of Papua New Guinea and under the terms of the Wafi-Golpu exploration licenses, the Government of Papua New Guinea has reserved the right to acquire up to a 30% equity interest in the project. In the event that the Government of Papua New Guinea exercises its option in full, Newcrest's interest in the WGJV would be reduced to 35%. In January 2011, the PNG Government indicated an intention to exercise the option, nominating the State-owned Petromin to take up the interest. The option is exercisable at any time up to the commencement of mining. Under the terms of the PNG Government option set out in the Wafi-Golpu exploration licences, the price payable for the interest is the proportionate share of exploration sunk costs at the point of exercise. Post-exercise, the PNG Government holding entity will be responsible for its proportionate share of continuing development and project costs.

4.4 Environmental Liabilities

The Mineral Resource Authority in Papua New Guinea holds a total of PGK12,000 provided by the WGJV participants as security deposits.

5 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 Topography Elevation and Vegetation

Wafi-Golpu is located in the Morobe Province at an elevation of approximately 400m above sea level and is located near the Watut River, where subsistence agriculture is the dominant activity. The Morobe Province is generally mountainous and rugged, divided by large upland valleys containing fast flowing rivers which descend to the plains.

The mountains in the Wafi-Golpu area are covered by lowland and mid-mountain tropical forests with some areas of tropical grassland in upper areas. Some forest areas are partly cleared as part of subsistence agricultural practices.

5.2 Access

The Wafi-Golpu project is located in a greenfields location in a mountainous area of Papua New Guinea. The exploration activities are serviced by an exploration camp in steep, heavily forested, mountainous terrain. A combination of roads and access tracks exist between Lae and the project site. However, the track components are suitable for four wheel drive vehicles and small trucks only. During major rainfall events this access route is closed to vehicular traffic.

Access to the project is via sealed road from Lae to Timini and gravel road from Timini (Demakwa) to Wafi, with the trip taking about four hours depending on the weather.

Commercial airlines operate flights between the national capital, Port Moresby, and Nadzab, which is approximately 40 minutes drive by road from Lae. The Nadzab airstrip is sealed. Helicopter access is available, with a suitable area at the site cleared for landing.

5.3 Infrastructure

There is no effective local infrastructure with respect to power, water and roads trafficable by vehicles larger than small trucks. Water supply for drilling is sourced from rivers and power at the exploration camp is locally generated. Any significant infrastructure required for project operation will need to be included in the development plan.

The MMJV has arrangements to use existing port infrastructure in Lae to support other mining operations. However, these facilities may need to be modified for expanded port operations that may be required for development of the Wafi-Golpu project.

5.4 Climate

Papua New Guinea has a hot, tropical climate at sea level, cooling towards the highlands. In most parts of Papua New Guinea rain falls mainly between December and March due to the northwest monsoon, although Port Moresby is dry at that time of year. There are occasional snowfalls on the highest mountain peaks as well as frost in places during the cooler months.

Lae is the nearest regional town to the Wafi-Golpu project. Lae has an average annual rainfall in the range 4,500 mm to 5,500 mm with each month having, on average, 19 days where some rain falls. Maximum temperatures average 30ºC and minimum temperatures average 20ºC with little variability across the year. The Wafi-Golpu project area experiences an average annual rainfall of around 2,500 mm. Maximum and minimum temperatures could be more variable at the Wafi-Golpu project site due to its 400m elevation.

6 HISTORY

Prior to the formation of the WGJV in 2008, there had been a long history of exploration in the Wafi-Golpu area which was commenced by CRA Exploration Pty Ltd (CRAE) in 1977. From 1977 to 2007, five different companies carried out exploration over the area culminating in approximately 103,000m of drill core and five Mineral Resource estimates. Since 2007, two further resource estimates were completed by WGJV, in 2010 and in 2011.

A number of mapping programs have been also been carried out over the Wafi-Golpu project area since discovery. Mapping and subsequent geological interpretations were used along with drill hole data to model the deposit geology and structure.

The project history of Wafi-Golpu is as follows:

In 1977 CRAE identified mineralized float in a regional geochemical sampling program. Two years later in 1979, mineralization was discovered outcropping near Mount Golpu. In 1980 the Mt Wanion Exploration License (EL440) was granted with ridge and spur sampling completed by 1982. In 1983 drilling commenced targeting the Wafi prospect followed by geophysical surveys which were completed in 1985.

An initial Mineral Resource was estimated for the Wafi deposit in 1986. In 1987, metallurgical test work was carried out which identified that the primary mineralization was highly refractory with low cyanide leach recoveries.

CRAE entered into a joint venture in 1988 with Elders Resources Limited and had success with drill hole WR095 intersecting the Golpu copper-gold porphyry deposit in 1990. In 1991 CRAE reacquired EL440 from Elders Resources Limited. A PFS of the Golpu deposit was completed at that time.

In 1997 the high grade Link Zone near the Wafi gold deposit was discovered. Australian Gold Fields Limited briefly acquired the project from CRAE in 1998, and from 1999 to 2001 the project was placed on care and maintenance with the downturn in commodity prices. In 2001 Aurora Gold Limited acquired project ownership, before being subsequently merging with Abelle Limited in 2003. Abelle was acquired by Harmony in 2004 resulting in Harmony gaining ownership of Wafi-Golpu.

A PFS for Golpu commenced in 2005, including drilling of the deposit which was completed in 2006. Prefeasibility drilling commenced on the Link Zone/NRG1 in 2006 and concluded in 2007. The Nambonga porphyry was discovered in July 2007. The Nambonga prospect is part of the Wafi-Golpu project and represents a moderate tonnage, low grade gold-copper porphyry system similar to Golpu.

In 2008 the WGJV was formed. In 2009, extensions of Golpu porphyry to the west and down dip were identified and a Concept Study on the expanded Wafi-Golpu Mineral Resource commenced. In 2010 a PFS based on the expanded Wafi-Golpu Mineral Resource started and the WGJV reported a revised Mineral Resource.

Further drilling and re-evaluation of the Mineral Resource estimate led to reporting of an updated Mineral Resource estimate in July 2011.

In August 2012, a new PFS was completed for the Golpu deposit. This incorporated the results of drilling and assessments completed subsequent to the 2005 Golpu PFS and resulted in the reporting of updated Mineral Resource and Mineral Reserve estimates in August 2012.

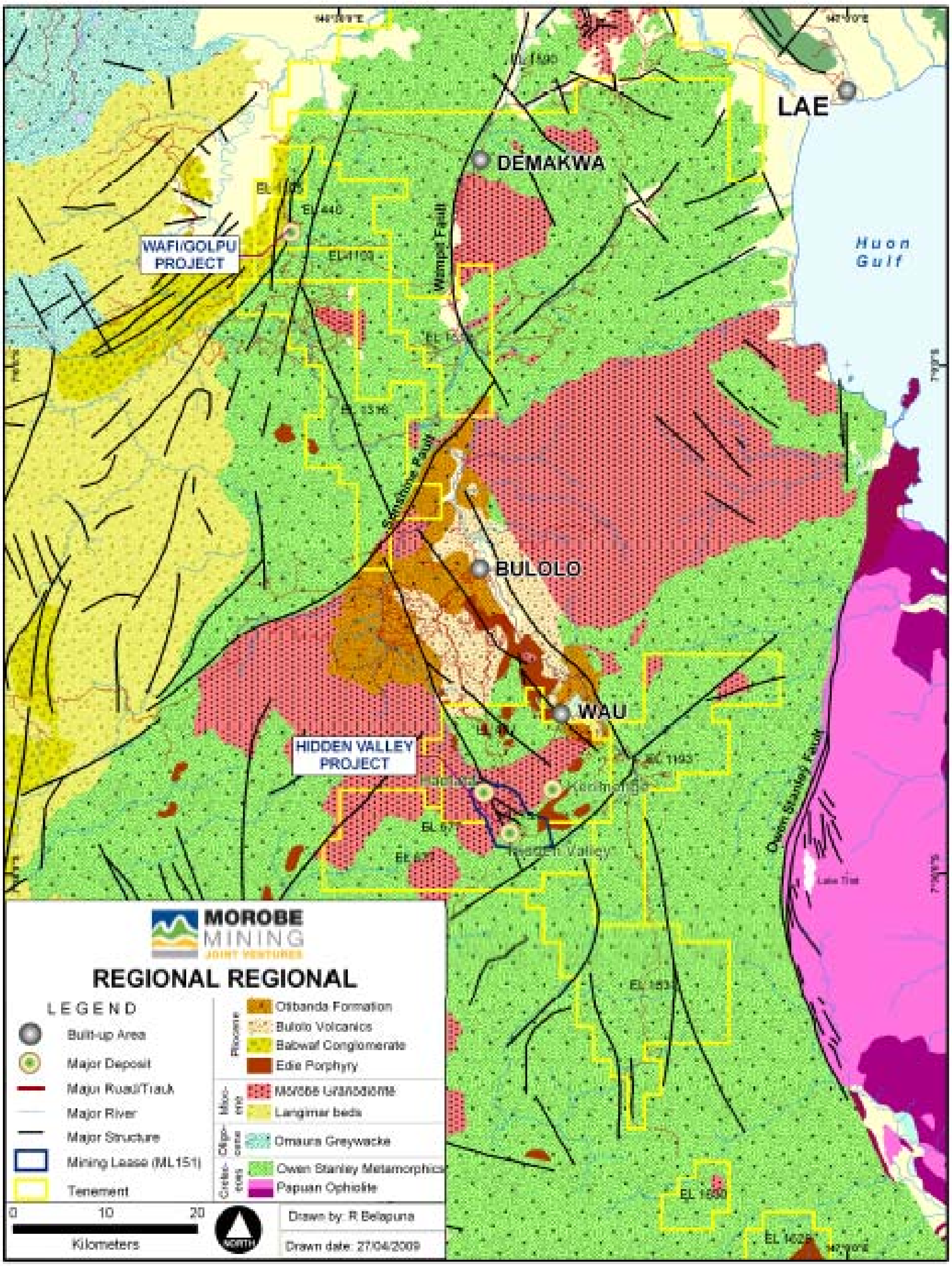
7 GEOLOGICAL SETTING AND MINERALIZATION

7.1 Regional Setting

The Wafi-Golpu project is based around gold and copper-gold deposits located about 65 km west-southwest of Lae, on the western flanks of the Timini Range, Morobe Province, Papua New Guinea

The project is located along the eastern margin of the Aure Trough. The Trough is a geosynclinal structural basin that developed during the Tertiary period and is mainly composed of turbidites and volcaniclastic sediments.

Figure 7.1 Wafi-Golpu Regional Geology



Major regional structures are dominated by north-northeast, north-northwest and northwest trending faults that are parallel to the Wafi Transfer, the Bulolo Graben and the Markham Fault respectively. The north-northeast trending structures are interpreted as strike slip faults that dip to the east and parallel local stratigraphy. North-northwest trending structures are extensional, generally related to the intrusion of the Edie Porphryry, whilst northwest faults parallel the plate suture and are represented by the Markham Fault.

Common litholigies within the region include schist, phyllite, shale, grewacke and conglomerate of the Cretaceous aged Owen Stanley Metamorphics which overlie the basement metamorphic geology. The Owen Stanley Metamorphics are overlain by Oligocene to Miocene aged volcanic, volcaniclastic and sedimentary rocks of the Omaura Greywacke and Langimar Beds. Pliocene sedimentary rocks of the Babwaf Conglomerate unconformably overlie the Oligocene and Miocene units.

Increased igneous activity during the Miocene and Pliocene resulted in the emplacement of the Morobe Granodiorite batholiths and Edie Porphyry into basement and younger stratigraphy. These intrusives variously comprise granodiorite, diorite, monzodiorite, microdiorite, andesite and dacite porphyry.

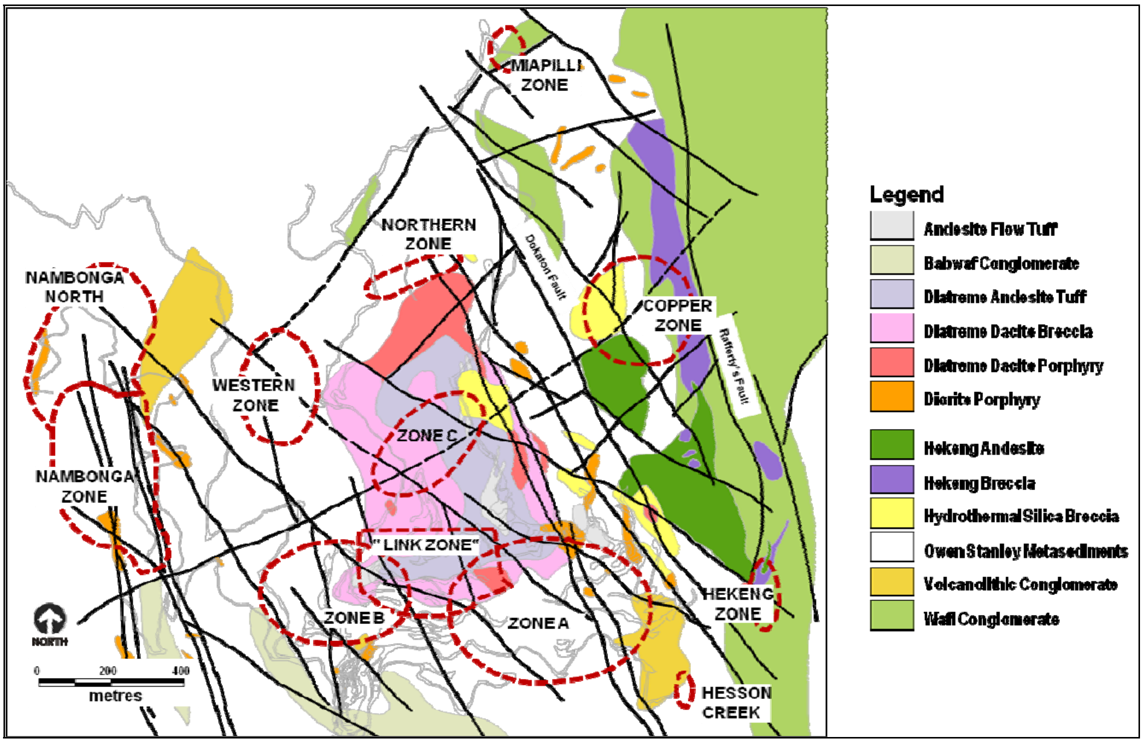
Significant epithermal and porphyry related mineralization were localised in favourable settings as a result of regional tectonics and associated igneous activity.

7.2 Project Scale Geology

The Owen Stanley Metamorphics form the basement within the Wafi-Golpu project. The Owen Stanley Metamorphics comprises inter-bedded conglomerate, sandstone and siltstone horizons. The sediments have been regionally metamorphosed to greenschist facies, are weakly to moderately foliated and have an overall northerly strike and dip 30° to 60° to the east. There is considerable lithological variation from conglomerate to mudstone within the units but correlation of individual units is difficult.

The Owen Stanley Metamorphics are intruded by the Wafi Diatreme complex within the central portion of the project area. The Wafi Diatreme is a roughly rectangular shaped feature that is of dimensions approximately 800m x 400m at surface with steep inward dipping sides that contain a mix of intrusive and sedimentary breccias, volcaniclastic units and tuffs. These are intruded by several phases of unmineralised dacitic porphyries. The diatreme has a complex internal structure. Domes and dykes of andesite to dacite composition are associated with the diatreme breccia. The breccia contains clasts of porphyry quartz veins and phyllic altered wall rock - it is interpreted that it was emplaced after the porphyry copper-gold event. It is speculated the diatreme-dome event was related to an intrusion at depth that may also be responsible for the late-stage high sulphidation system. This alteration grades from quartz-alunite-sericite at depth to quartz-alunite-pyrophyllite at shallower levels. Intense quartz-sericite alteration is marginal to the alunite-sericite zone.

Figure 7.2 Local Geology of the Wafi-Golpu Area



A number of small dioritic stocks occur proximal to the diatreme, however pre-date the Wafi Diatreme. The most significant are the diorite intrusions of the Golpu Intrusive Complex and Nambonga Diorite intrusions. These intrusions are associated copper-gold mineralization.

A small area of younger porphyritic Hekeng Andesite outcrops between Wafi (Zone A) and the Golpu Porphyry and is not altered or mineralised. Other younger units are the Babuaf Conglomerate, which occurs in the west and the Quaternary Wafi Conglomerate in the east. A thin unit known as the Hekeng Breccia outcrops to the east of the Dokaton Fault.

Miocene age Langimar beds crop out along the western margin of the project area, west of Buvu Creek. They are interpreted as a sliver of sediments in the Buvu Thrust Complex with Langimar beds thrust over the Babuaf Conglomerate to the West, and Owen Stanley Metamorphics thrust over Langimar beds. The Langimar beds comprise interlayered black shales, poorly sorted volcanic derived silt, and sandstones.

West of the Buvu thrust complex, Babuaf Conglomerate crops out between the Wafi project area and the Watut River. Babuaf graben sediments comprise well sorted conglomerates, sandstones, siltstones and mudstones.

7.3 Mineralization

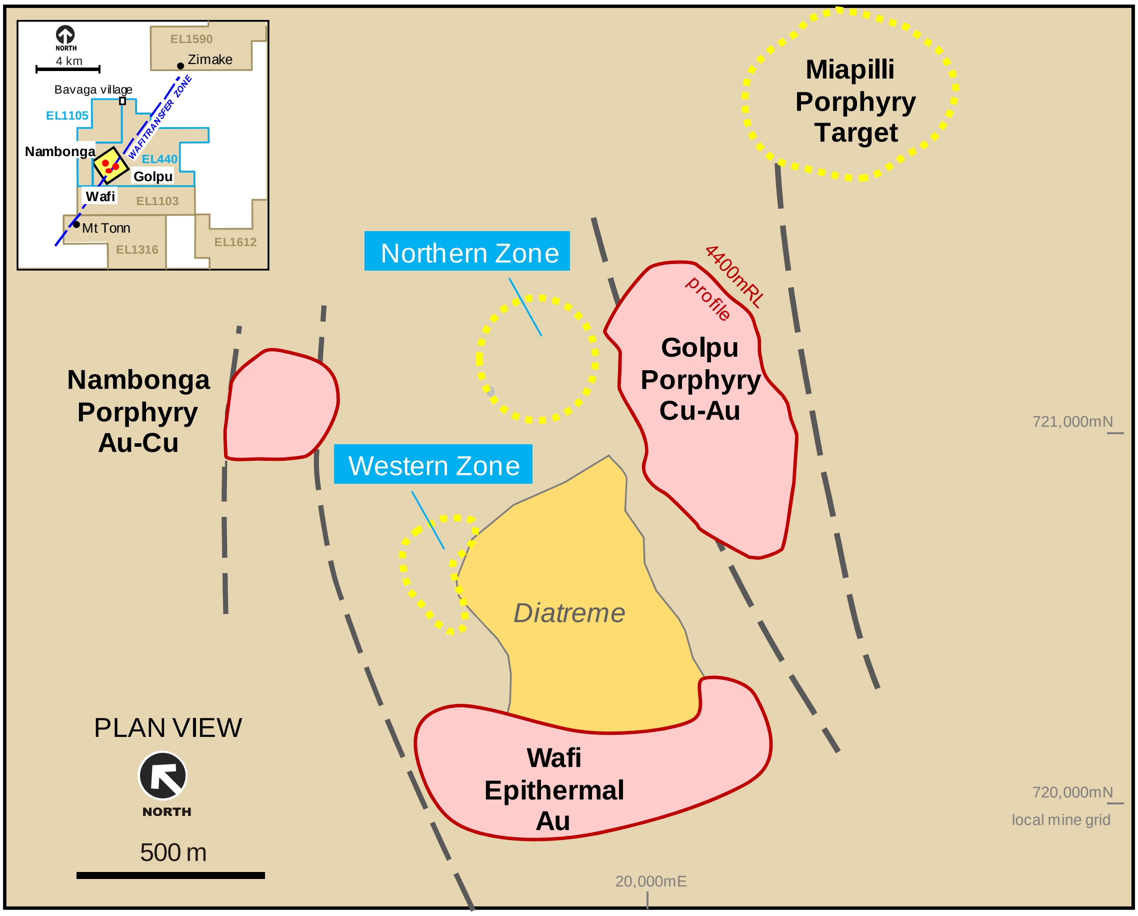
The Wafi-Golpu Property contains a major mineralised system. Wafi-Golpu is a complex mutliphased mineralised system which comprises copper gold porphyry intrusives which are followed by later stage epithermal gold mineralization events.

The Wafi-Golpu project contains three major deposits localised around a Wafi Diatreme complex. These deposits include:

- Wafi Epithermal gold deposit
- Golpu Porphyry copper - gold deposit
- Nambonga porphyry gold - copper deposit

A summary of these deposits follows:

Figure 7.3 Wafi-Golpu Major Deposits

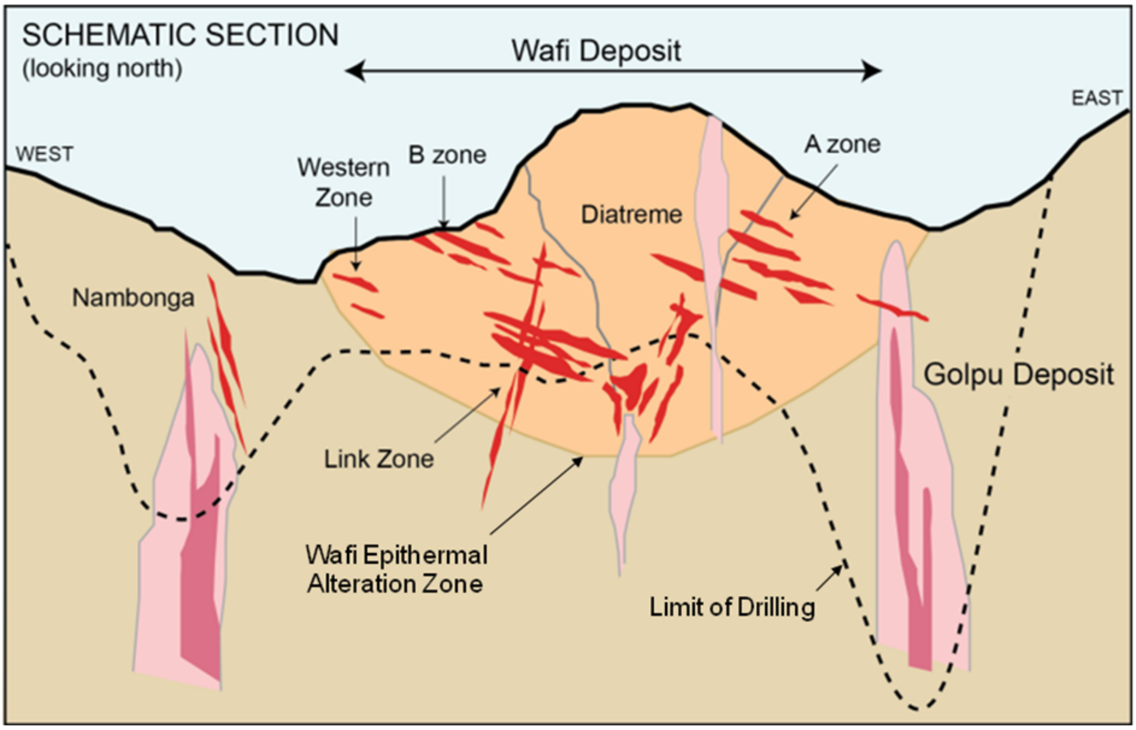


7.4 Wafi

The Wafi gold deposit is hosted in the metasedimentary units of the Owen Stanley Metamorphics and peripheral to the diatreme breccia complex. The Wafi mineralization has been defined over a surface area of dimensions approximately 1,100m x 800m and depth of up to 600m below surface with the majority of the material potentially exploitable by open pit mining.

Alteration at Wafi is typical of high sulphidation epithermal mineralised systems with advanced argillic minerals characterised by quartz-alunite grading outwards to dickite-kaolinite then to minerals formed at the margins including carbonates-smectite-chlorite-chalcedony. Weathering has affected the upper portion of the deposit but below the base of oxidation, primary sulphides are predominantly pyrite with lesser enargite and tennantite. Mineralization is sub-parallel to bedding and appears preferentially hosted in coarser grained sedimentary units.

Figure 7.4 Wafi-Golpu Schematic Section (Looking North)



The gold mineralization can be broadly separated into the A Zone, B Zone, NRG and the Link Zone. The Link Zone is a more discrete, higher grade zone characterised by both high sulphidation and low sulphidation mineralization.

The non refractory NRG zone (part of A Zone) is located above the interpreted base of weathering and is comprised of a combination of oxide, transitional and minor fresh mineralization.

Mineral paragenesis is summarised as:

- Metamorphic event producing quartz in bedding-parallel veins.
- Porphyry event recognized as albitization of feldspars, formation of pervasive biotite throughout the metasediments with potassic feldspar development as selvedges to porphyry-related quartz veins, and sericite/chlorite overprinting of earlier potassic alteration. The phyllic overprint is possibly related to the collapse of the porphyry system and the incursion of meteoric water.
- Diatreme emplacement due to the emplacement of melts into collapsing meteoric system resulting in diatreme breccias and dacite bodies.

- Zoned high/low sulphidation epithermal events with temporal and spatial alteration zonation from earliest to latest:
  - Argillic alteration: alunite ± pyrophyllite overgrowing quartz;
  - Intermediate argillic alteration: dickite/kaolinite ± sericite/illite;
  - Low temperature argillic alteration: carbonate/smectite/chlorite/chalcedony.

7.5 Golpu

The Golpu porphyry related copper gold deposit consists of a stockwork vein array hosted by altered hornblende porphyry intrusive and surrounding metasediments adjacent to the diatreme breccia.

Four porphyries have been identified Golpu, Golpu West, Hornblende porphyry and diorite porphyry. All porphyries are now classified as Hornblende porphyry. The porphyries are interpreted as multiple intrusive complexes distinguished by different textures. Intrusives range from small dykes to small stocks / bosses and apotheoses. Single intrusions pinch and swell vertically over tens of metres and form dykes, pipes and stocks.

The Golpu porphyry comprises dominantly sparsely porphyritic (groundmass 60-70%) feldspar-phyric diorite. More crowded variants also occur: primary igneous texture comprises coarsely crystalline interlocked phenocrysts (0.5- 2mm; 30-40%). K-feldspar (1-2mm, 30%) and plagioclase (0.5-2mm, 20%) occurs with interstitial relict hornblende (0.5mm; 1%). Relict plagioclase (oligoclase) is tabular and compositionally zoned (with the outer rim altered by K-feldspar). Groundmass comprises less than 30% by volume and occurs as graphic interlocked crystals of feldspar and quartz. Accessory minerals include apatite, titanite and zircon. These intrusions occur as narrow pencil-like intrusive stocks.

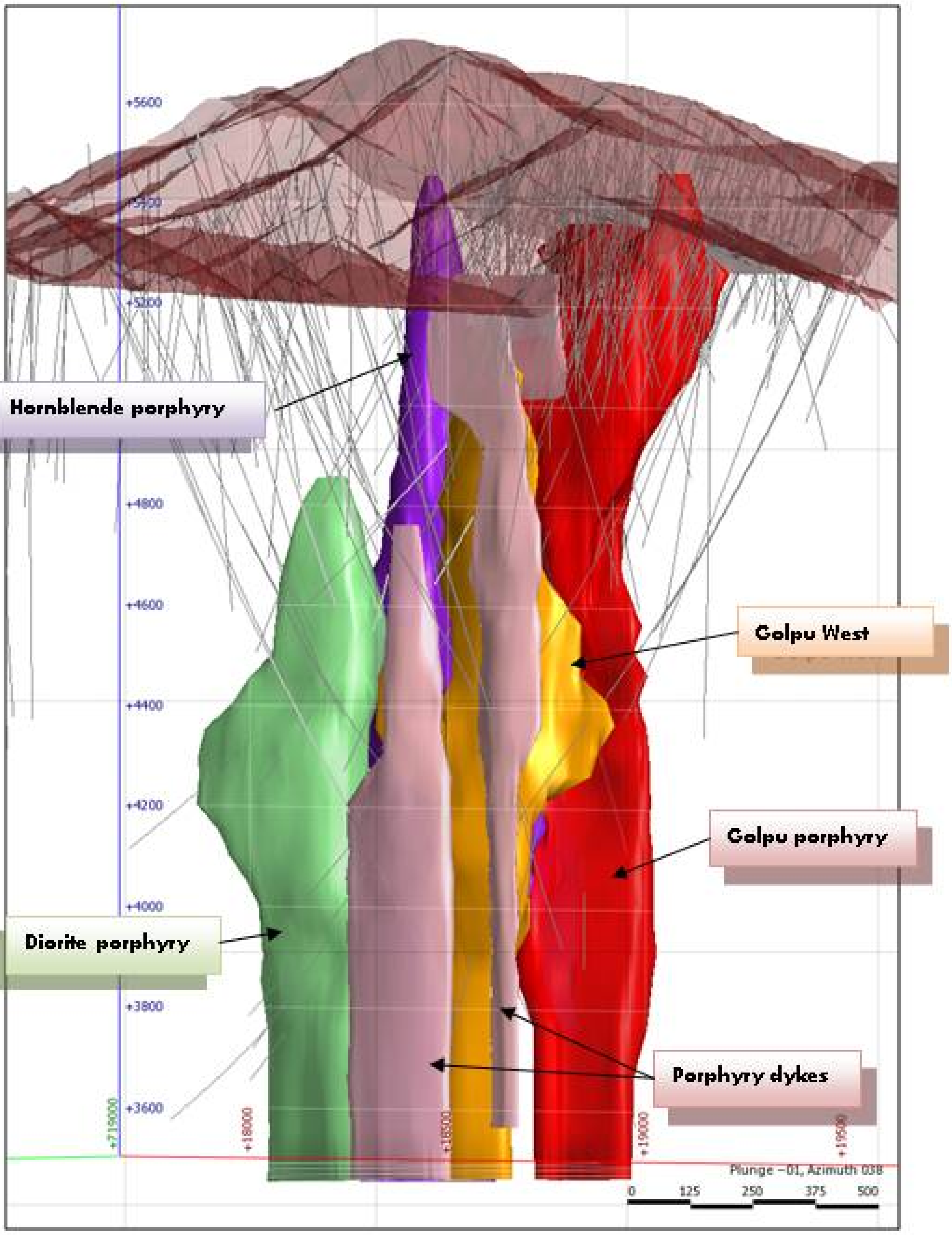
The Hornblende porphyry primary igneous texture is distinctly porphyritic with large tabular crystals set in a finer grained groundmass (30-40%). Plagioclase (up to 3mm, 15%) occurs with smaller tabular K-feldspar (up to 2mm; 5-10%). Plagioclase occurs as twinned crystal clusters. Isolated tabular (up 2 mm; 1-2%) hornblende is distinct; relict hornblende is implied from distinct crystal form (with the pseudomorphs largely replaced by biotite-K-feldspar). Groundmass comprises graphic interlocked crystals of feldspar and lesser quartz. However a feldspar crowded phase to the east of the Hornblende Porphyry core has now been intersected – again it appears the porphyry contains significant textural contrast and is accordingly multiphase.

The diorite porphyry is the only quartz eye porphyry currently interpreted as a large intrusive body – most quartz eye porphyries are narrow, thin dyke like bodies within larger intrusive units or isolated dykes hosted by sediments. Primary igneous porphyritic texture (groundmass up to >60%); tabular and zoned plagioclase (1–3mm, 30%); zoned ‘square’ feldspar are distinct. Rare quartz eyes (<0.5 mm; <2%) and isolated biotite phenocrysts (1mm, 1%) occur throughout. Groundmass comprises graphic interlocked crystals of feldspar and lesser quartz. Accessory minerals include apatite, titanite and zircon.

The Hornblende Porphyry is the most mineralised porphyry drilled to date but there is no clear evidence that it is the source of the mineralised fluids.

The host metasediments are composed of siltstones and sandstones with minor volumes of conglomerates and shales. Most units are felsic to quartzose felsic with a significant volcanic source rock component. The 'metasediment' sequence also includes minor dacite porphyry, fragmental volcanic and possible tuffs.

Figure 7.5 Schematic Sectional View of the Golpu Porphyry Complex



7.5.1 Alteration

Hydrothermal alteration at Golpu forms up-right domains that enclose the Golpu Intrusive Complex.

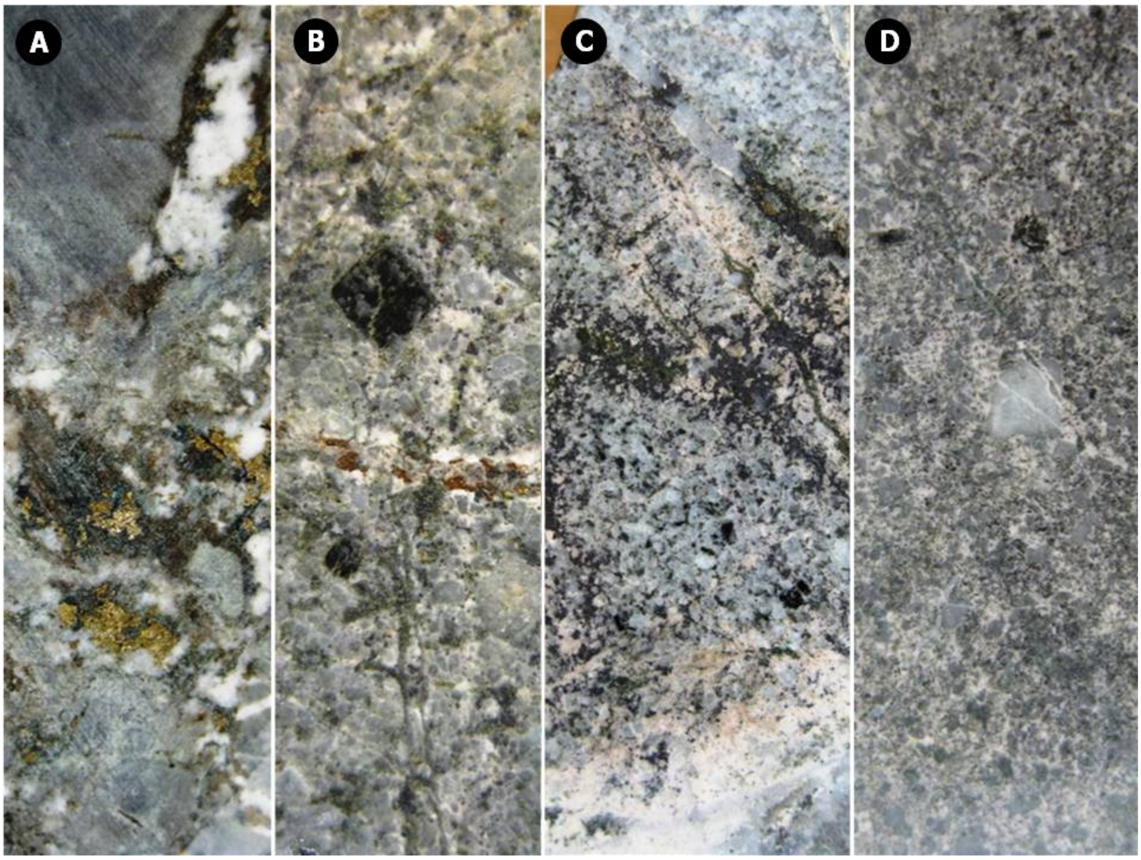
Hydrothermal alteration related to the porphyry Au-Cu mineralization forms a predictable zonal arrangement grading from potassic core to propylitic margins with indicator minerals:

- K-feldspar inner core;
- magnetite-biotite zone;
- actinolite-biotite (-magnetite-K-feldspar-albite-epidote);
- biotite (± minor magnetite) alteration; and
- chlorite (propylitic) alteration.

Alterations systems associated with the high sulphidation epithermal mineralization at Wafi overprints and telescopes down onto the Golpu porphyry alteration system. Key epithermal alteration zones interpreted within the Golpu model include advanced argillic alteration with alunite, dickite and kaolinite as indicator minerals over phyllic alteration typified by sericite + pyrite. A high sulphur domain is modelled below the phyllic zone - it reflects the combined impact of both the lower portions of the epithermal system and the outer pyritic shell of the porphyry alteration.

The better gold and copper grades accompanies ‘potassic’ alteration of moderate to strong pervasive biotite + magnetite alteration with K-feldspar in the centre of the alteration. High Cu-Au grades occur where pervasive biotite alteration hosts quartz-magnetite-copper sulphide stockworks. Outwards and upwards, biotite-magnetite alteration grades into biotite-only assemblages. The best developed k-feldspar + magnetite alteration is laterally restricted to within several tens of metres from intrusives. Pervasive biotite-magnetite replacement of the metasedimentary rocks immediately adjacent to the porphyritic rocks gives way to microfracture controlled biotite-only alteration on the periphery of the deposit. The outer-most alteration is chlorite with pyrite, +- albite and anhydrite. Zonal alteration patterns at Golpu are shown in Figure 7.6.

Figure 7.6 Zoned Alteration at Golpu



Section A: Calc-sodic (actinolite-biotite-albite) alteration is found on the distal parts of the deposit.

Section B: The bulk of the mineralization is hosted in potassic (biotite-K-feldspar ± magnetite) alteration.

Section C: Isolated domains of calc-potassic (magnetite-biotite-actinolite ± K-feldspar) occurs in the core of the deposit.

Section D: The core of the deposit comprises potassic alteration that includes pervasive K-feldspar replacement.

Advance argillic (clay-quartz-pyrite ± alunite) alteration of the Wafi Au-Ag system forms a sheet-like draped cap that overprints the upper most parts of the Golpu copper-gold deposit. Disseminated and lithological controlled sulphide mineralization is hosted in texturally destructive clay alteration that comprises quartz-alunite-kaolinite (dickite-diaspore) and pyrite. Multiple stacked sheets of hydrothermal replacement is layered up-wards from basal kaolinite-quartz-alunite alteration, kaolinite-chalcocite-pyrite, vuggy quartz (covellite-enargite). Single layers are metres thick and are part of the thicker (100s of metres) lithocap. Regionally, the clay blanket extends over several kilometres. Veins of pyrite ± pyrophyllite-dickite cut the pervasive clay alteration. Modelling of the advanced argillic alteration (quartz-alunite) alteration indicates a sheet-like body broadly dipping to the north-east at shallow angles.

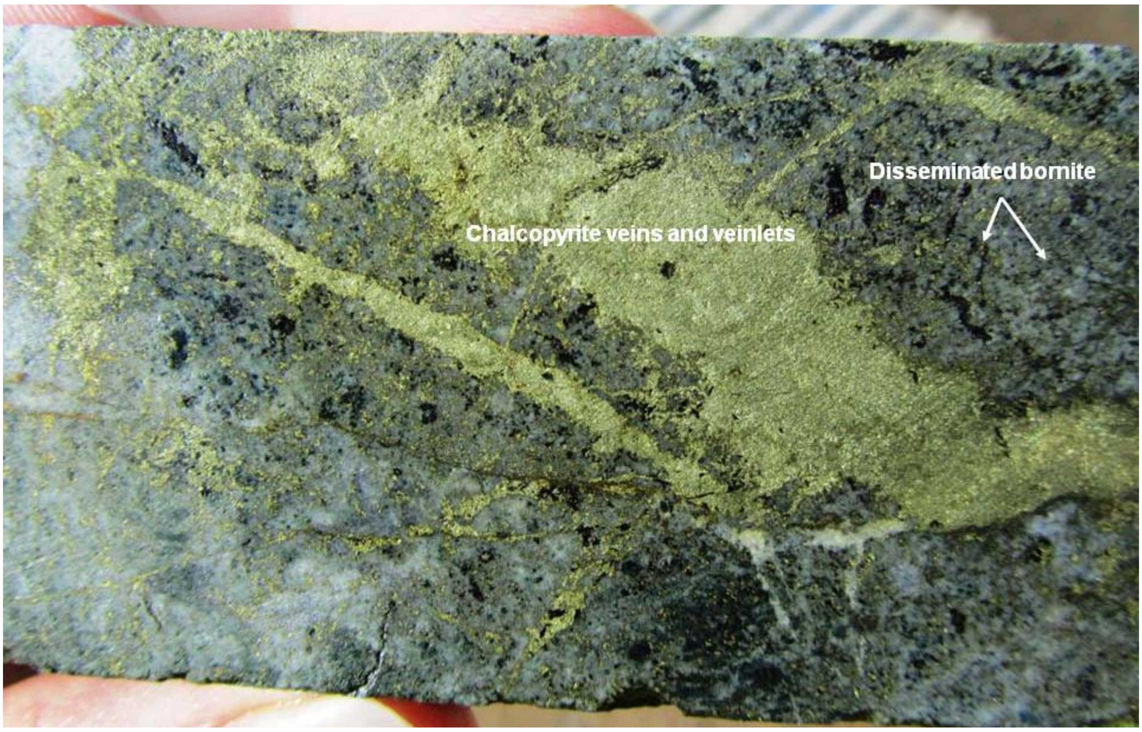
7.5.2 Mineralization

The Golpu porphyry deposit is a major porphyry copper and gold deposit.

The overall dimensions of the mineralised system as currently defined is approximately 800m north-south x 500m west-east and of a vertical extent greater than 2,000m.

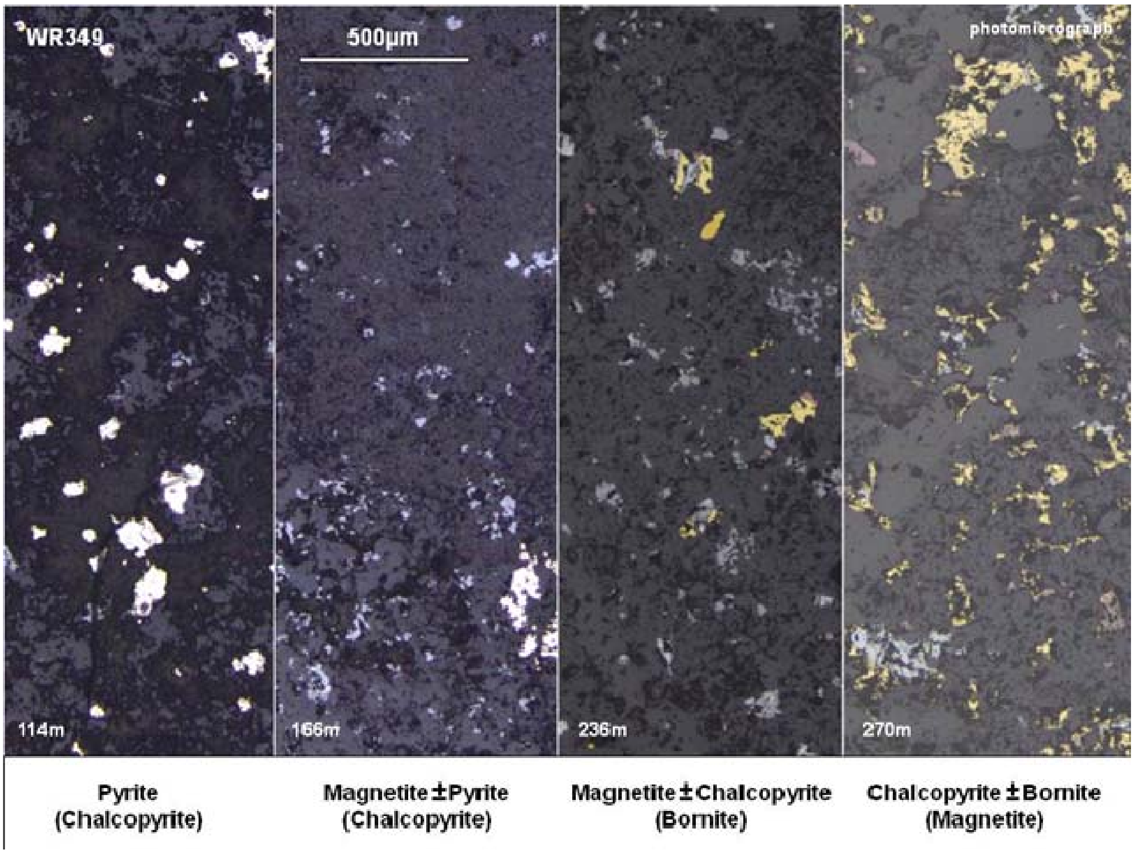
Mineralization is derived from either the porphyry or epithermal systems; within the porphyry environment, mineralization is disseminated, microfracture and stockwork vein controlled. Figure 7.7 is a section of drill core from the Golpu deposit showing sulphide mineralization.

Figure 7.7 Sulphide Mineralization in the Core from Golpu (WR377)



The dominant Cu-Au sulphide species varies laterally and vertically within the deposit from an inner bornite (plus chalcopyrite) core, outwards to chalcopyrite only to chalcopyrite-pyrite to a pyrite only shell. Volume proportion of disseminated Cu-Fe sulphides varies between trace and up to 5% by volume. Total volume proportion of sulphides in the outer parts of Golpu can be in excess of 10% as pyrite. Disseminated sulphides are typically located at the site of relict Fe-bearing phases including primary phenocrystic hornblende and hydrothermal alteration derived biotite-magnetite in turn both as replacement of the igneous groundmass and mafic phenocrysts. Figure 7.8 shows the sulphide zonation within the deposit, moving from pyrite to chalcopyrite/bornite in the core.

Figure 7.8 Lateral Zonal Arrangement of Sulphide Species (WR349)

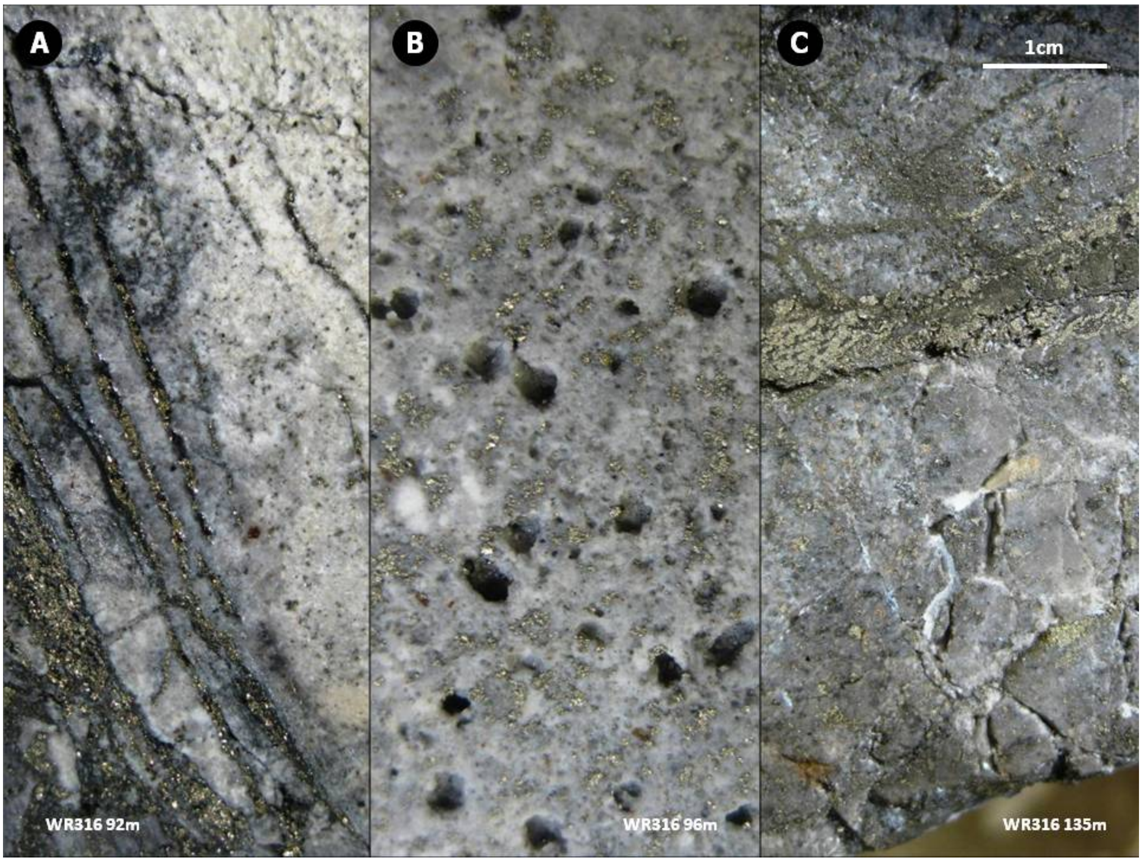


In the Wafi epithermal system which occurs as a 'draped cap' over the Golpu porphyry system, advanced argillic alteration contains primary copper mineralization as chalcocite, but gold occurs within pyrite or as electrum associated with pyrite-enargite-tetrahedrite. Mineralization appears to broadly follow the metasedimentary and volcanic host rocks stratigraphy (i.e., 40-50° to E to NE). The Au-Cu-bearing lenses occur in kaolinite-chalcocite-pyrite and vuggy quartz +- covellite +- enargite bands up to 20m thick.

Relict porphyry-style veins are preserved within the clay alteration at the top of the Golpu copper gold deposit. These veins appear to have the Cu-Fe sulphides removed (leaving a skeleton of quartz). Etched and irregular molybdenite veins also occur – it is argued these are stable remnants of the porphyry mineralization. Based on these observations, it is interpreted that the porphyry copper gold mineralization has been partially removed from the 'lithocap' by the acid fluids related to formation of the overprinting high-sulphidation system – the epithermal system has been 'telescoped' down over the pre-existing porphyry system. The high-sulphidation system has added its own gold to the district. Therefore, the gold found in the clay alteration within the 'lithocap' outside of the porphyry is spatially and temporally unrelated to the copper and gold found in the Golpu deposit.

Figure 7.9 shows the alteration assemblage of the Wafi epithermal system that caps the Golpu porphyry copper gold deposit.

Figure 7.9 Alteration Assemblage of the Wafi Epithermal System



Section A: Quartz-alunite-kaolinite alteration.

Section B: Vuggy quartz with alunite and pyrite.

Section C: Massive quartz-alunite-pyrophyllite.

7.6 Nambonga

7.6.1 Geology

The Nambonga deposit is located on the western side of the Wafi Diatreme complex hosted by metasediments of the Owen Stanley Metamorphics that is also associated with the Wafi and Golpu deposits.

The Nambonga copper/gold mineralization is hosted by the Nambonga porphyry stock. Petrographic analysis of samples has identified two possible porphyry phases (hornblende andesite and diorite porphyry). The diorite is medium-grained, containing plagioclase and hornblende phenocrysts set in a feldspathic matrix.

The stock is a low grade copper and gold mineralized system localised along major northwest arc-parallel and northeast transfer faults.

The diorite intrudes metasiltstone, metasandstone and minor metaconglomerate of the Owen Stanley Metamorphics. To the west, tuffaceous siltstone and volcanolithic sandstone of the Langimar Beds unconformably overlie the Owen Stanley Metamorphics.

Within the porphyry system, a typical porphyry alteration zonation is recognized, grading outwards from inner potassic alteration dominated by potassic feldspar into peripheral propylitic alteration, and upwards into a sericite-dominant phyllic zone. The phyllic alteration overprints the early potassic event and may have remobilized the primary copper mineralization and enhanced the overall copper/gold grades.

The upper part of the stock in phyllic alteration is brecciated, particularly on the hanging wall of the porphyry. This alteration envelope is mushroom shaped and tends to decrease in width with increasing depth.

Much of the mineralization is associated with silicification, either pervasive or as veins. Quartz stockwork veins up to 10 mm wide and overprint the porphyry, especially in the upper levels. The veins are intergrown with small amounts of anhydrite, chalcopyrite, pyrite and magnetite.

7.6.2 Mineralization

The Nambonga mineralization extends over an area of approximately 200m x 200m and to a vertical extent of 800m.

Mineralization at Nambonga consists of disseminated and vein style copper/gold mineralization structurally-controlled base metal mineralization in steeply dipping lodes.

Chalcopyrite is the dominant copper sulphide mineral in the porphyry at Nambonga. The chalcopyrite and pyrite form anhedral grains ranging up to 0.2 mm wide and tend to occur as centerlines to quartz veins. The magnetite forms anhedral grains up to 0.4 mm wide and is generally present in the margins of the quartz veins or in the wall rock adjacent to quartz veins. Minor magnetite, pyrite and chalcopyrite are also disseminated through the host rock. Gold was not observed in thin section and it is likely to be intergrown in a lattice with chalcopyrite or pyrite. Arsenic is negligible to low throughout the porphyry and surrounding metasediment carapace, with the exception of the massive sulphide shoots.

Structurally-controlled base metal mineralization forms steeply dipping lodes of variable thickness. The lodes are usually at the margins of the diorite porphyry, where a competency contrast may have acted as a dilational zone between the porphyry and wall-rock metasediments. Paragenetically, the massive sulphide bodies have formed much later than the porphyry intrusion and associated mineralization.

8 DEPOSIT TYPES

The principal deposits within the Wafi-Golpu project are porphyry copper-gold mineralization and epithermal style mineralization, the characteristics of these deposits are summarised below:

8.1 Porphyry Cu-Au deposits (Golpu, Nambonga)

- Porphyry deposits are low grade high tonnage deposits.
- Sulphide minerals are disseminated and fracture controlled within zones of extensive hydrothermal alteration.
- Fracture-controlled sulphide mineralization is closely associated with porphyritic intrusive rocks.
- Porphyry deposits originate from magmatic volatile phases exsolved from silicic magma ascending through the Earth's crust.
- Zones of extensive alteration also occur around these intrusions (that can be up to km-scale).
- Porphyry deposits are characterized by several alteration assemblages:
  - Potassic
  - Propylitic
  - Phyllic (QSP)
  - Intermediate argillic
  - Advanced argillic.
- The bulk of the Cu and Au mineralization is associated with fractures that cut the central high-temperature potassic core.

8.2 High Sulfidation Epithermal Deposits (Wafi)

- Copper-gold vein, stratabound & breccia-hosted deposits associated with broad zones of clay alteration and silicification.
- Also known as acid-sulfate, high sulfur and kaolinite-alunite deposits.
- Form in the shallow crustal environment by the interaction of acid (pH < 2), oxidised (H2S ~ SO42-), moderate to high temperature (~ 200 to 350°C) fluids with host volcanics.
- Deposits may be associated (genetically and/or spatially) with porphyry systems.
- Hypogene clay and sulfate alteration minerals in the main upflow zones.
- Zones of silicification and advanced argillic alteration enclosed by an outer zone of propylitic alteration.
- High Au ± Cu ± Ag ± As grades in the central siliceous and advanced argillic zones.

- Sulphide, sulfosalt and Au mineralization is hosted by the central residual (vuggy) quartz and advanced argillic zones.
- Hypogene covellite and alunite are diagnostic.
- Enargite (Cu_3AsS_4) is a common Cu-bearing phase.
- Morphology varies from structurally controlled vein-style to stratabound.

9 EXPLORATION

The Property has been subjected to a long history of exploration which commenced in 1977. Gold mineralization was initially discovered at the overlying Wafi deposit by CRAE in 1979. The underlying Golpu porphyry copper-gold deposit was not identified until 11 years later when Elders Resources Limited intersected the Golpu porphyry in 1990. The exploration history is summarised in Table 9.1 with further detail provided in Section 6 of this report on the corporate history of the Wafi-Golpu Property.

Table 9.1 Exploration History of Wafi-Golpu Property

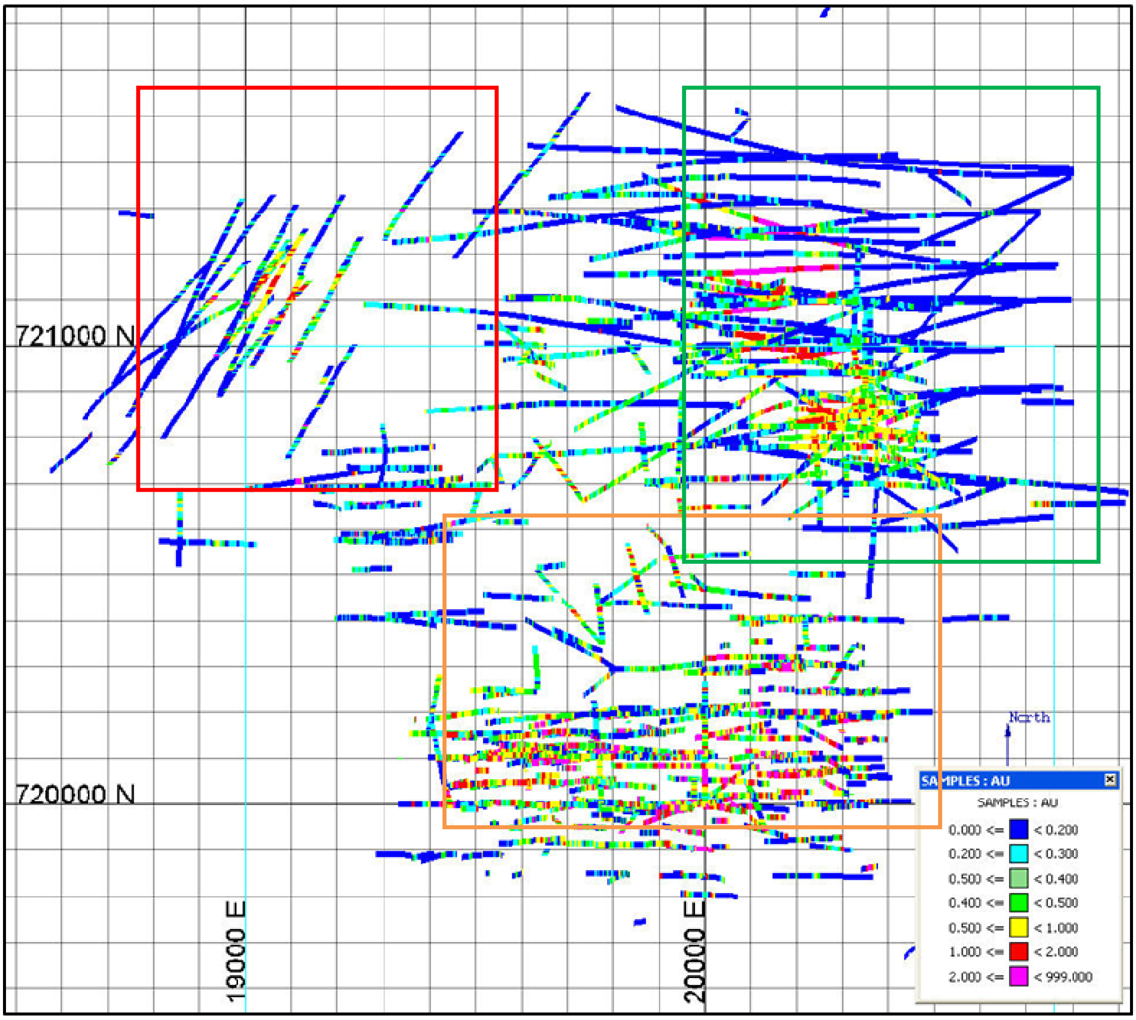
Year	Event
1977	CRAE identified mineralized float in regional geochemical sampling program.
1979	Discovery of outcropping mineralization at Wafi A Zone.
1980	Mt Wanion Exploration License granted; EL440.
1980-1982	Ridge and spur sampling program completed.
1983	Drilling commenced.
1985	Geophysical surveys completed.
1986	Initial resource estimate of Wafi gold deposit.
1987	Metallurgical test work identified primary mineralization was highly refractory with low cyanide leach recoveries.
1988	Joint venture with Elders Resources Limited.
1990	Elders Resources Limited hole WR095 intersects Golpu copper/gold porphyry mineralization.
1991	CRAE reacquire EL440 from Elders Resources Limited.
1993	Golpu PFS.
1997	High grade Wafi Link Zone discovered.
1998	Australian Gold Fields Limited briefly acquired project from CRAE.
1999-2001	Project placed on care and maintenance.
2001	Aurora Gold Limited acquired project ownership.
2003	Abelle Limited merges with Aurora Gold Pty Ltd and acquired project ownership.
2004	Harmony acquires Abelle Limited and ownership of Wafi-Golpu.
2005	PFS on Golpu commenced.
2006	Mineral Resource estimate.
2007	Mineral Resource and mineral reserve estimates and PFS completed with marginal economic returns.
2008	WGJV founded by Harmony and Newcrest 50:50 ownership.
2009	Discovery of Golpu extensions to the west and at depth; updated Wafi-Golpu concept study commenced.
2010	WGJV Mineral Resource estimate and updated Wafi-Golpu PFS commenced.
2011	Further Golpu drilling and revised Mineral Resource estimate.
2012	Further Golpu drilling, revised Mineral Reserve estimate and resource estimate for Golpu and Wafi.

Exploration and resource delineation drilling by the WGJV has focused on deep drilling of western and down-dip extensions of the Golpu copper-gold porphyry deposit.

10 DRILLING

Spatially, the Golpu and Wafi deposits are located in close proximity to each other. The Golpu deposit is located immediately north of and below the Wafi deposit. Drill holes targeting Golpu often intersected zones of mineralization which form part of the Wafi Mineral Resource. Drill holes targeted at Nambonga porphyry mineralization are located to the west of the diatreme. Figure 10.1 shows the relationship between drill holes targeted at the three locations.

Figure 10.1 Plan View of Drill Hole Traces, June 2012



Holes are coloured by gold grade. Drill holes located within red box are located at Nambonga, orange box are located at Wafi and green box are located at Golpu.

10.1 Wafi

The Wafi Mineral Resource estimate was completed in January 2012 with drill hole data available at that time. A total of 535 drill holes had been completed in the Wafi area (over the Wafi, Golpu and Nambonga deposits and surrounding zones) since 1983, comprising 221,767m of diamond drilling (DDH) and 17,180m of reverse circulation (RC) drilling (Table 10.1). Of these, 198 drill holes targeted the Wafi deposit main gold zones of A, B and Link Zones for a total of 59,449m of drilling.

Table 10.1 Summary of Wafi Drilling History to March 2012

Year	Company	No of Holes	Hole Numbers	Metres DDH	Metres RC
1983	CRA	4	WR001 - WR004	628	-
1983 - 1985	CRA	20	WR005 - WR024	5,161	-
1985 - 1986	CRA	7	WR025 - WR031	2,492	
1989	Elders	58	WR032 - WR085	3,489	2,100
1990	Elders	10	WR086 - WR095	3,265	-
1991	Elders/CRA	9	WR096 - WR103A	4,134	-
1992	CRA	4	WR103B - WR106	2,178	-
1993	CRA	8	WR107 - WR114	3,941	-
1994	CRA	2	WR115 - WR116	1,761	-
1995	CRA	22	WR117 - WR136A	11,082	-
1996	CRA	13	WR137 - WR149	5,762	-
1997	CRA	11	WR150 - WR160	4,610	-
1998	CRA/AGF	15	WR161 - WR175	5,859	-
2003	Abelle	18	WR176 - WR193	8,219	-
2004	Harmony	70	WRC001 - WRC070	-	13,155
2005	Harmony	11	WR194 - WR207	6,104	-
2006	Harmony	27	WR208 - WR233	11,806	-
2007	Harmony	39	WR234 - WR255 WRC071 - WRC087	6,149	- 1,925
2008	Harmony	19	WR256 – WR274	7,724	
2008	MMJV	24	WR275 – WR304	15,659	
2009	MMJV	35*	WR305 – WR332	21,049	
2010	MMJV	59*	WR333 – WR383	44,557	
2011	MMJV	47*	WR384 – WR418	43,465	
2012	MMJV	3	WR419 – WR421	2,670	
Total		**535**		**221,767**	**17,180**

* Includes wedges

Diamond drilling was done by wireline methods using PQ, HQ and NQ diameter core. The drill density at the Wafi deposit does not have a uniform spacing but is typically between 50 x 50m to 100 x 100m and increases to 200 x 200m at depth. Most drilling is clustered in the areas around the high grade Link zone and the high grade portions of A Zone.

Drill hole collar locations were surveyed in the Wafi grid by a licensed surveyor using a theodolite or total station survey instrument. The relationship between the Wafi grid and the Universal Transverse Mercator Grid Zone 55M is outlined in Table 10.2.

Table 10.2 Grid Transformation Parameters

East UTM	North UTM	RL UTM	East Wafi	North Wafi	RL Wafi	Rotation
428363.53	9243569.3	-	10169.62	713931.56	5000	45.1819
440303.63	9239956.3	-	21140.29	719880.65	5000	-

Downhole surveys were completed on all diamond drill holes typically at 25m and then every 50m downhole. Some drill holes were surveyed using an Eastman single shot camera and others using a Reflex downhole survey tool.

Downhole surveys were not completed for 2007 RC drill holes. The design collar azimuth and dip was used for these holes.

10.1.1 Logging

Detailed logging of geology and alteration was completed for all drill holes. The logging codes have evolved over time with increased geological understanding of different rock types and associations. Core photographs are available for drill holes completed since 1996. Core recovery is recorded for all diamond drilling, loss of core during drilling is not material for any of the Wafi-Golpu deposits. For most drill holes, logging includes details of:

- core recovery
- rock quality description
- lithology
- alteration
- weathering
- structural features.

Detailed geotechnical information was collected for some later diamond drill holes.

RC cuttings for each metre drilled were sieved and stored in chip trays for each hole. The cuttings were logged for:

- lithology
- alteration
- weathering
- structural features.

10.1.2 Sampling

Diamond drill core was split using a core saw and half submitted for assay. The remaining half core was stored on-site. In 2012, the Wafi site core farm was transferred to a dedicated secured core farm facility at Nine Mile, Lae. The half core sent for assay was bagged in labelled calico sample bags with the sample number scribed on an aluminium strip included in the bag. The calico bags were placed in larger polyweave bags and transported by road or helicopter to Lae by company employees.

Sample lengths were mainly 2m for drill holes WR001 to WR175 and then 1m for drill holes WR176 onwards. Sample numbers and drill hole intervals were recorded by the responsible geologist and given to the core yard technician for cutting and sampling. A sample dispatch sheet documenting the sample numbers and required assay work was sent with the sample batch to the laboratory.

The sampling procedure for the RC drill holes WRC001 to WRC070 was:

- sample bag checked, aluminium tag in bag with the right number
- attach the bag to the sampler on the rig
- when the sample bag fills, weigh the sample
- if the sample is insufficient, use the manual riffle splitter to split the rejects and get the required sample weight
- samples are arranged in sequence and blanks and duplicates inserted into the locations specified by the geologist. Duplicate inserted taken at about 1 in 40 samples
- sample dispatch filled out and samples put into poly-weave bags in manageable weights and despatched to Wau.

The sampling procedure for the RC drill holes WRC071 to WRC087 was:

- calico sample bags written up
- standard, blank or duplicate assigned to every tenth sample
- assay pills to monitor sample preparation and analytical accuracy inserted at random samples throughout sequence
- 1m interval of sample collected from cyclone
- sample put through riffle splitter
- approx 3 kg collected in calico bag
- reject collected in white polyweave bag
- hole interval, sample recovery and condition (wet/dry) recorded in sample book
- samples transported to site and then dispatched Intertek Laboratory in Lae.

10.2 Golpu

Diamond drill holes are the principal source of geological and grade information for the Golpu deposit. Three main periods of diamond drilling have been conducted over the Golpu deposit. An initial program completed by CRAE between 1990 to 1996, followed by Harmony between 2005 to 2008, and more recently MMJV since 2009. The data used for the June 2012 Mineral Resource[4] estimate contained 535 drill holes of which 149 targeted the Golpu deposit totalling 127,283m (Table 10.3).

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[4] *Estimate reported in August 2012.*

Table 10.3 Summary of Golpu Drilling History to June 2012

Company	Number of Holes	Metres Drilled	Average Depth (m)	Start Date	Finish Date
Elders	7	2,979	426	Oct 1990	March 1991
CRAE	33	18,149	550	Oct 1991	Feb 1996
Harmony	12	7,653	638	Oct 2005	Jan 2008
MMJV	97	98,502	1,015	July 2009	On-going
Total	**149**	**127,283**	**854**		

Diamond drilling was completed using wireline methods using PQ, HQ and NQ diameter core. Drilling density varies from 50m x 50m above 5100mRL to 200m x 200m below 4100mRL.

All diamond drill hole collar locations have been surveyed in the Wafi grid by either licensed surveyor using a theodolite survey instrument or company geologists with a differential global positioning system GPS instrument. Downhole surveys were completed on CRAE diamond drill holes mainly using an Eastman single shot camera typically at 25m and then every 20m to 50m downhole. More recently drill holes have been surveyed using a Reflex downhole survey tool at 30m intervals and at 10m intervals in some deep wedged holes where control was more important. A gyro survey tool has been used for 13 recent drill holes and associated wedges; surveys are taken at regular 10m intervals.

Logging and sampling of earlier diamond drill holes was as outlined for Wafi drilling. Most sample lengths at Golpu are either 1m (about 80%) or 2m (about 20%). Elders and CRAE routinely sampled at 2m intervals while Harmony and WGJV have routinely sampled at 1m intervals and more recently 2m intervals. To maintain the integrity of the core during cutting, the core is wrapped in tape to prevent it from breaking. Core cut during Harmony and WGJV drilling tenure has been along the orientation line indicating the bottom side of the hole. There is no record for the earlier drill holes whether the core was cut along a consistent orientation line. The likelihood of a sampling bias resulting from inconsistent sample selection is not considered to present a material impact on sample quality due to the stockwork nature of mineralization.

10.3 Nambonga

The Nambonga Mineral Resource estimate is based on drill hole data available at November 2008. A total of 27 diamond drill holes were completed for a total of 15,417.85m.

Diamond drilling was completed using wireline methods using PQ, HQ and NQ sized drilling equipment. Most samples collected from the porphyry were in HQ and NQ core size. The drill hole density at collar is approximately 100m along 80m spaced sections. Drill hole spacing in the mineralized zones is typically greater than 60m but may be more than 100m in some areas.

Most diamond drill hole collar locations have been surveyed in the Wafi grid using a theodolite survey instrument and seven drill hole collars surveyed by GPS. Downhole surveys were completed on all holes typically at 25m and then every 50m downhole. The drill holes were surveyed using an Eastman single shot camera and recent drill holes were surveyed using a Reflex downhole survey tool.

Most diamond drill hole samples are 1m with lengths varying at contacts of mineralized lithological units and also varied in zones of poor core recovery.

The drill core was split using a core saw and half core was sent to laboratories for assay. The remaining half core was stored onsite at the Wafi-Golpu core facility. The half core sent for assay was bagged in labelled calico sample bags with the sample number scribed on an aluminium strip included in the bag. The calico bags were placed in larger poly-weave bags and transported by road or helicopter to Lae laboratory.

Core was wrapped in tape during sampling to maintain core quality. More recent oriented core is cut along the orientation line at the bottom of hole to reduce the possibility of sample bias. Sample numbers and drill hole intervals were recorded by the responsible geologist and given to the core yard technician for cutting and sampling. A sample despatch sheet documenting the sample numbers and required assay work was sent with the sample batch to the laboratory.

Core recovery is recorded during logging of the drill core by measuring the length of recovered core and comparing it to the known drilling depths at the end of each run. Drilling has typically been triple tube to maximise core recovery and the quality of core. Core recovery is typically good with greater than 95% recovery in the mineralized rock types.

11 SAMPLE PREPARATION, ANALYSES AND SECURITY

Spatially, the Golpu and Wafi deposits are located in close proximity to each other. The Golpu deposit is located immediately north of and below the Wafi deposit. Drill holes targeting Golpu often intersected zones of mineralization which form part of the Wafi Mineral Resource. Drill holes targeted at Nambonga porphyry mineralization are located to the west of the diatreme. Table 11.1 summarizes the history of drilling in the Wafi/Golpu/Nambonga areas, recording laboratory and assay methods if documented.

Table 11.1 Summary of Laboratories and Assay Methods

Hole ID	Primary Laboratory	Element	Method
WR001 - WR004	Pilbara Laboratories	Au Ag, Cu, Pb, Zn, As	Fire Assay (50g) Not recorded
WR005 - WR024	Pilbara Laboratories	Au Ag, Cu, Pb, Zn, As	Fire Assay (50g) Not recorded
WR025 - WR031	Pilbara Laboratories	Au Ag, Cu, Pb, Zn, As	Fire Assay (50g) Not recorded
WR032 - WR037	Pilbara Laboratories Lae	Au Ag, Cu, Pb, Zn, Sn, W, As, Sb, Mo, Se, Te, Ba, Bi, Cd and Co	Fire Assay (50g) 1 in 10 samples sent to PNG Analytical for base metal analysis. Method not recorded
WR038 - WR085	Pilbara Laboratories Lae	Au Base metals and Ag	Fire Assay (50g) Selected zones. Method not recorded
WR0086 - WR099	Pilbara Laboratories Lae	Not recorded	
WR100 - WR104	Pilbara Laboratories Lae	Au Cu, Pb, Zn, Ag, Mo Sb	Fire Assay (50g) AAS Hydride AAS
WR105 - WR108	Pilbara Laboratories Lae	Au Cu, Pb, Zn, Ag, Mo, As, Fe Sb	Fire Assay (50g) AAS Hydride AAS
WR109 - WR112	Pilbara Laboratories Lae	Au Cu, Pb, Zn, Ag, Fe As, Mo Al, Ba, K and Ti	Fire Assay (50g) AAS AAS Nitrous Oxide IC-POES
WR113 - WR118	Pilbara Laboratories Lae	Au Cu, Pb, Zn, Ag, Mo, As and Fe Ba, Ti, K, and Al	Fire Assay (50g) AAS IC-POES

Hole ID	Primary Laboratory	Element	Method
WR118A - WR136A	Analabs Lae	Au Cu, Pb, Zn, Ag and Mo As, Fe, Ba, Ti, K and Al	Fire Assay (50g) AAS IC-POES
WR137 - WR152	Analabs Lae	Au Ag, Al, Ba, Cu, Fe, Mo, Pb, Ti, Zn	Not recorded Not recorded
WR153 - WR160	Analabs Lae	Au Cu, Pb, Zn, Mo, Ag, As, Fe, Ba, Ti, K, Al, Bi, Sb	Fire Assay (50g) AAS IC-POES
WR161 - WR175	Analabs Lae	Au Cu, Pb, Zn, Ag, Mo, As, Bi, Sb S and CO3	Fire Assay (50g) AAS Selected composite pulps
WR176 - WR193	Analabs Townsville	Au Ag, Cu, Pb, Zn, Mo, Mn, Fe, As, Sb S	Fire Assay (50g) AAS LECO
WRC001 - WRC070	SGS Wau and SGS Townsville	Au Cu, Pb, Zn, Mo, Mn, As, Sb S	Fire Assay (30g) AAS Leco
WRC071 - WRC087	Intertek Jakarta	Au Ag, Cu, Pb, Zn, Mo, Mn, Fe, As, Sb S	Fire Assay (30g) ICP Leco
WR194 - WR207	SGS Wau and SGS Townsville	Au Ag, Cu, Fe, Mn, Mo, Pb, Zn, Cu, Zn As, Sb S	Fire Assay (50g) AAS Hydride AAS LECO
WR208 - WR421	Intertek Jakarta	Au Ag, As, Cu, Fe, Mn, Mo, Pb, Sb, Zn S	Fire Assay (50g or 30g) ICP LECO

Sample preparation protocols for drilling in the Wafi/Golpu/Nambonga areas have varied over time. Sample preparation for drill holes WR032 to WR137 was carried out at Pilbara (Analabs) Laboratories in Lae. The sample preparation process was:

- drying
- crush to nominal 5 mm
- coarse disc pulverise to nominal 180 microns
- split 500 g
- fine pulverise in ring mill to nominal 75 microns.

Sample preparation for drill holes WR176 and WR207 and WRC001 to WRC070 was carried out at the Wau laboratory with pulps sent to SGS Townsville for assay. The sample preparation process at Wau was:

- drying
- jaw crush to nominal 10 mm
- crush in terminator crusher to nominal 2 mm
- split 1 kg in rotary splitter
- pulverise 1 kg in LM2 to nominal 75 micron
- split 100 g pulp.

Sample preparation for drill holes WR208 to the present was carried out at Intertek Lae sample preparation facility with pulps sent to Intertek Jakarta for assay. The sample preparation process was:

- weigh entire sample
- dry in oven (105ºC standard, 65ºC if mercury to be analysed)
- weigh dry sample
- jaw crushing to nominal 2 mm
- riffle split 1.5 kg
- pulverise 1.5 kg to -200 mesh (75 micron) using LM5 mill
- 250 g pulp sent for analysis.

With respect to sample security, diamond drill core is delivered directly from the drill rig at the end of each shift by the drill crew to the logging shed within the Wafi Camp security compound – fenced and 24 hour patrolled. Core is marked up and photographed as soon as possible to identify any core loss and ensure size and consistency of the samples. Historically all core was sawn in half at the Wafi site and half core for assay bagged into calico bags and in turn secured in plastic bags. Samples are identified by both internal aluminium tags and external labelling. Some core is now directly shipped as plastic wrapped and secured trays to the dedicated core farm within the security patrolled compound at Nine Mile, Lae. Core is sawn, bagged and identified as for the Wafi site procedures.

Whether transported as trayed whole core or sawn core samples, all transport is always under the direct supervision of WGJV employees within tamper evident packaging from site until delivery to the Intertek Laboratory in Lae. Pulps and crusher residues are returned from the Lae laboratory to the Nine Mile core farm for long term storage again under direct supervision of WGJV staff.

Core samples are prepared in Intertek, Lae within their secured premises and pulps are air-freighted by international couriers to Intertek Laboratory in Jakarta, Indonesia for assaying. A detailed labelling, documentation and tamper evident packing protocol is in place for this transfer. Pulps are stored on a long term basis in Jakarta. Assay results from Intertek Jakarta are returned to WGJV network and loaded to the Wafi database by dedicated administrators after correlation against despatch records and after passing the QAQC protocol.

11.1 Wafi Assay QAQC

There have been different quality assurance and quality controls (QAQC) applied to the Wafi project since the start of the project, noting that some of the Wafi drill holes also pass at depth into the Golpu porphyry style mineralization.

The QAQC controls applied to samples from the earlier drill holes WR001 to WR031 are not well documented and apart from selected umpire check assays, there is no data for these holes.

Elders Resources used Pilbara Laboratories in Lae to process samples for drill holes WR032 to WR099. Regular submission of standards and duplicates does not appear to have been carried out.

CRAE identified a significant bias in the Elders Resources sample data for drill holes WR032 to WR085 and a program of re-assay and check assay sampling was carried out during 1996 and 1997. The re-assays are reported as being at least partly incorporated into the drill hole database. As the bias had not been resolved, samples from the affected Elders drill holes were not used in grade estimation in the Wafi resource estimate.

CRAE is reported to have included standards and blanks in sample batches for some drilling but these are not documented. Umpire assays at a second laboratory appear to have been completed and are partly reported in Section 11.2 on QAQC for Golpu drilling.

Drilling by Abelle Limited and Harmony included regular standards, blanks and duplicates. Nineteen different standards were used between 2003 and 2007 with almost all results falling within a two standard deviation range with a small number of outliers.

Pulp repeat assays, and coarse split duplicates were submitted for assay. The pulp repeats illustrate suitable precision and the coarse split duplicates illustrate acceptable repeatability through the sample preparation process.

Figure 11.1 shows a scatter plot of gold assays for field duplicates for reverse circulation drilling during the periods April to August 2004 and April to June 2007. The results show good repeatability with a small number of outliers.

Figure 11.1 Scatter Plot of Gold Assays for Coarse Duplicates for Reverse Circulation Drilling

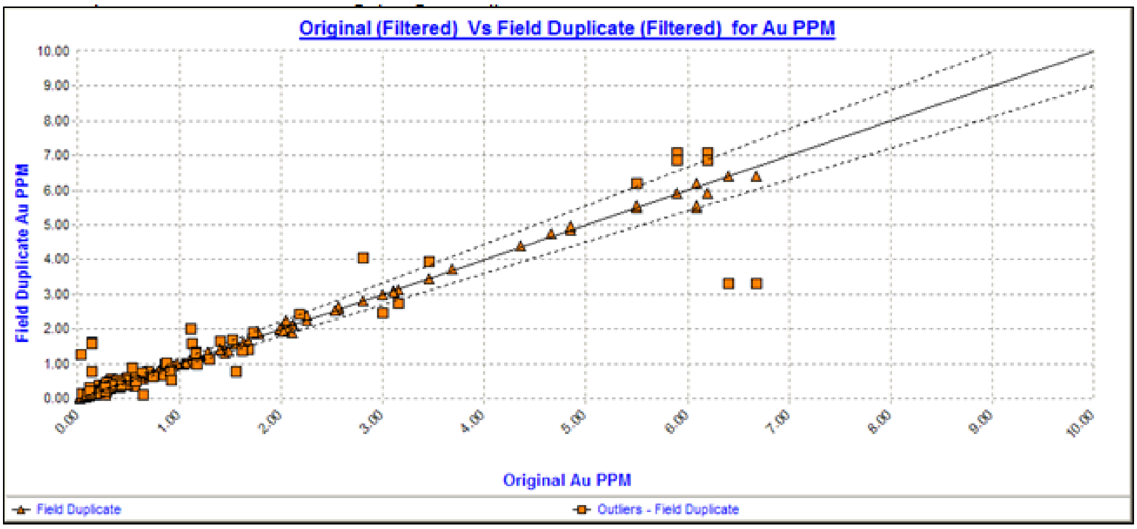


Figure 11.2 shows a scatter plot of gold assays for quarter core duplicates. The results show good repeatability with a small number of outliers.

Figure 11.2 Scatter Plot of Gold Assays for Quarter Core Duplicates

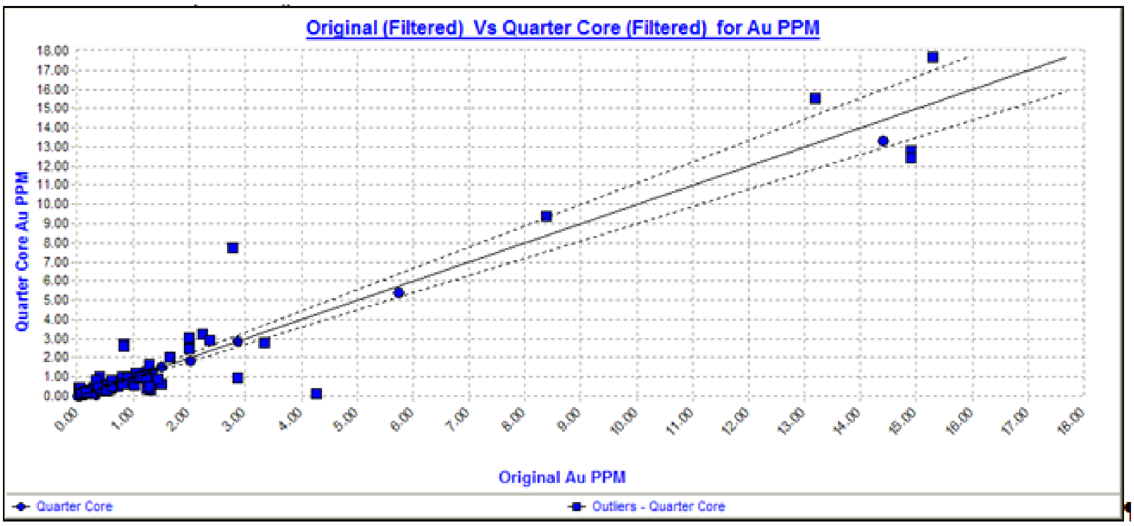
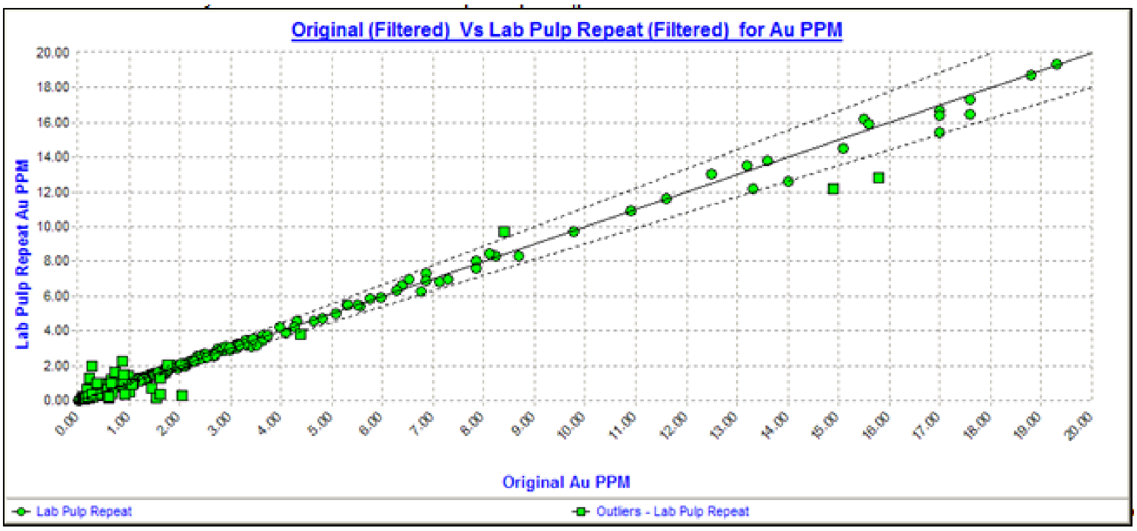


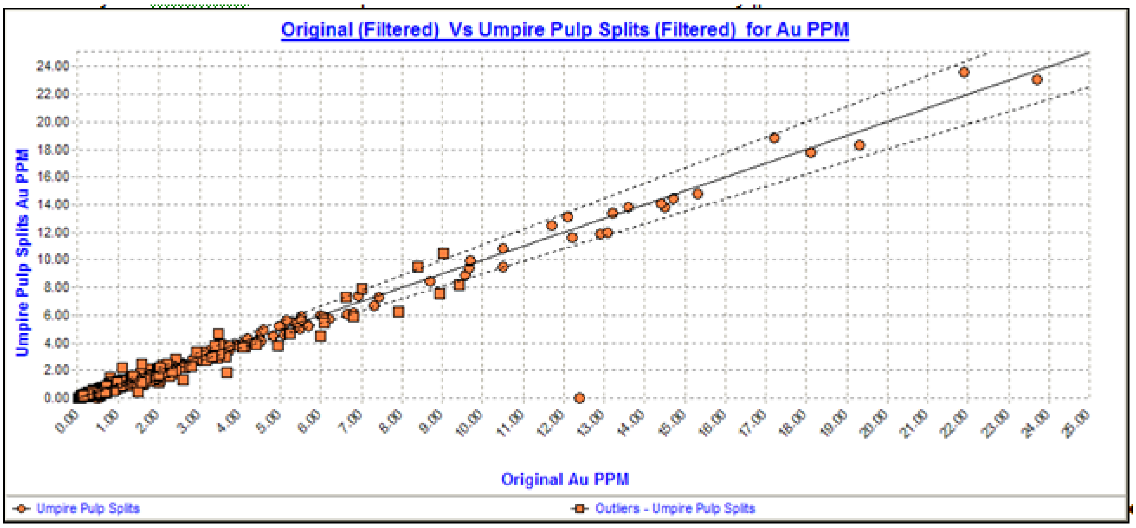
Figure 11.3 shows a scatter plot of gold assays for pulp repeat assays. The results show good repeatability with a small number of outliers.

Figure 11.3 Scatter Plot of Gold Assays for Pulp Repeats



Selected pulps from mineralized intervals were sent to the SGS Townsville laboratory for check. The umpire assays show that there is no bias present between the Intertek Jakarta and SGS Townsville laboratories (Figure 11.4).

Figure 11.4 Scatter Plot of Gold Umpire Assays



11.2 Golpu Assay QAQC

QAQC protocols for Golpu drilling have been inconsistent and varied over the project's almost 21 year history.

11.2.1 Drilling 1990 to 1996

Drilling by CRAE from 1990 to 1996 appears to have been supported by regular submission of pulp splits to a second laboratory. Insertion of certified standards, quarter core or coarse reject duplicates does not appear to have been routine practice. The results of pulp duplicate assays for this period are summarized in Figures 11.5 and 11.6. There does not appear to be a systematic bias in copper or gold assays results between the laboratories.

Figure 11.5 Comparison of Pulp Duplicate Assays for Copper

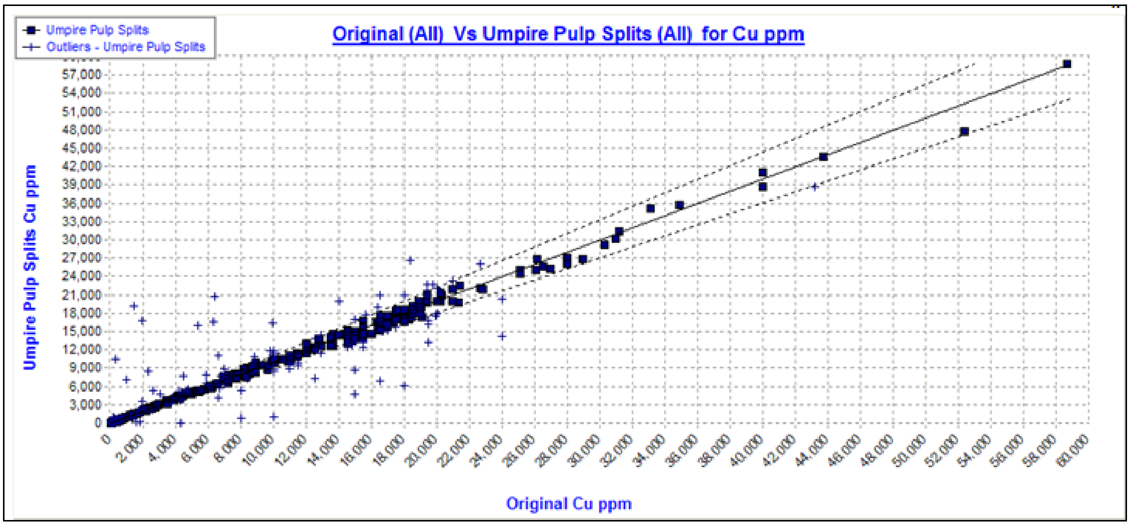
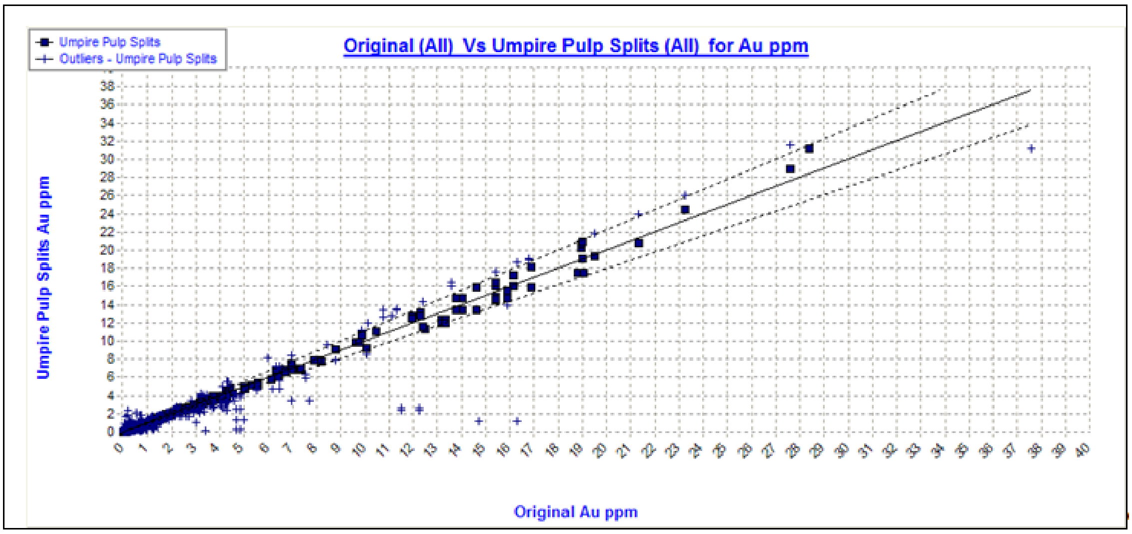


Figure 11.6 Comparison of Pulp Duplicate Assays for Gold



11.2.2 Drilling 2005 to 2007

Drilling by Harmony to 2007 included submission of certified standards, blanks, quarter core duplicates and re-assay of selected pulp splits at a second laboratory. Copper and gold results from quarter core duplicates (Figures 11.7 and 11.8) compare fairly well although there are a number of samples outside the ±10% range.

Figure 11.7 Comparison of Quarter Core Duplicate Assays for Copper

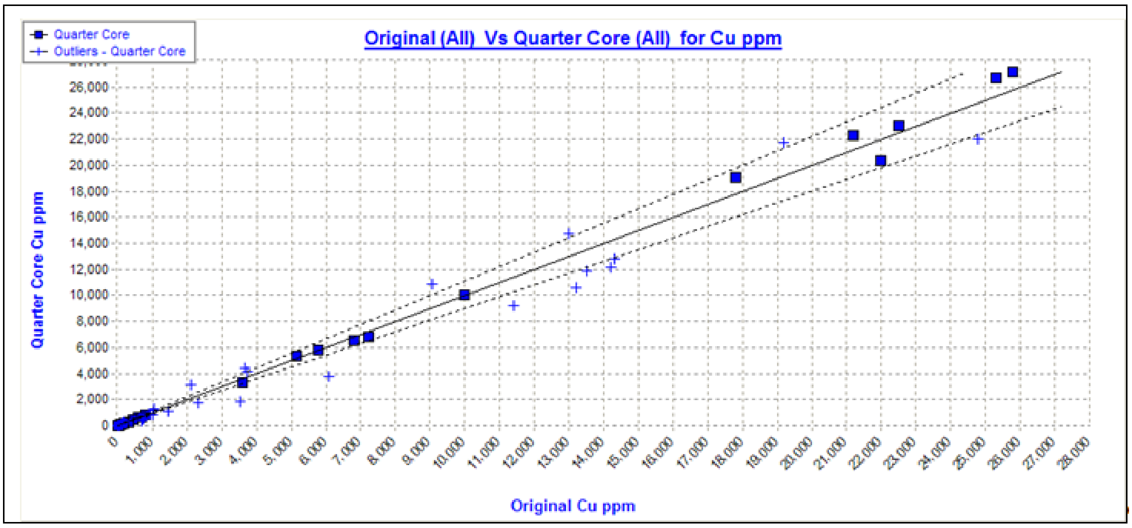
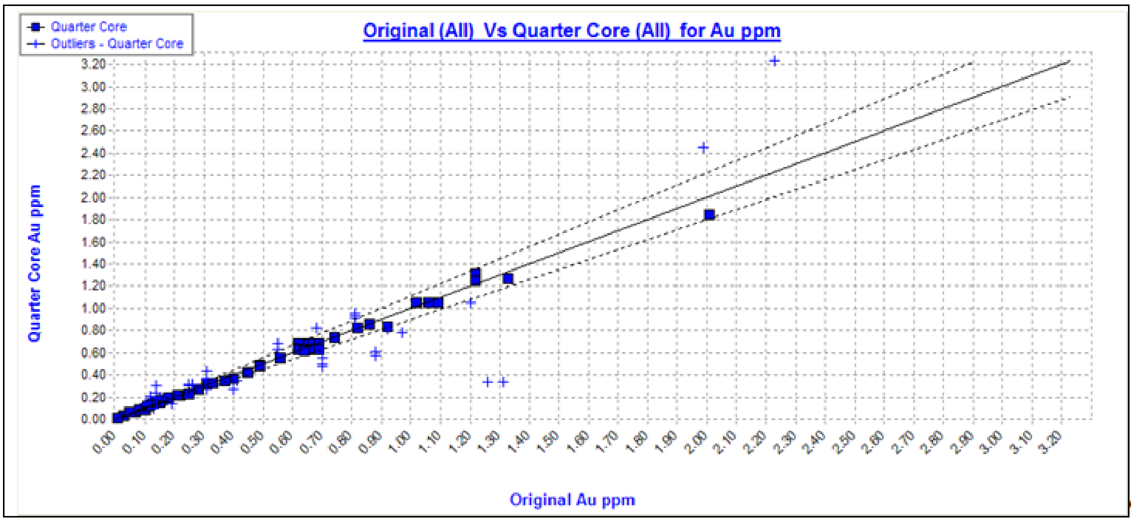


Figure 11.8 Comparison of Quarter Core Duplicate Assays for Gold



A selection of pulps was sent to SGS Townsville for re-assay in 2007 (Figures 11.9 and 11.10). The copper assays show a consistent difference between the Intertek Jakarta and SGS Townsville laboratories with the Intertek results slightly higher than those from SGS Townsville. No certified standards were included in the batch so it is not possible to determine which set of results is more correct.

Gold assays from the pulps sent to SGS Townsville illustrate a number of samples outside the acceptable limits, however there does not appear to be a consistent bias.

Figure 11.9 Comparison of Pulp Duplicate Assays for Copper

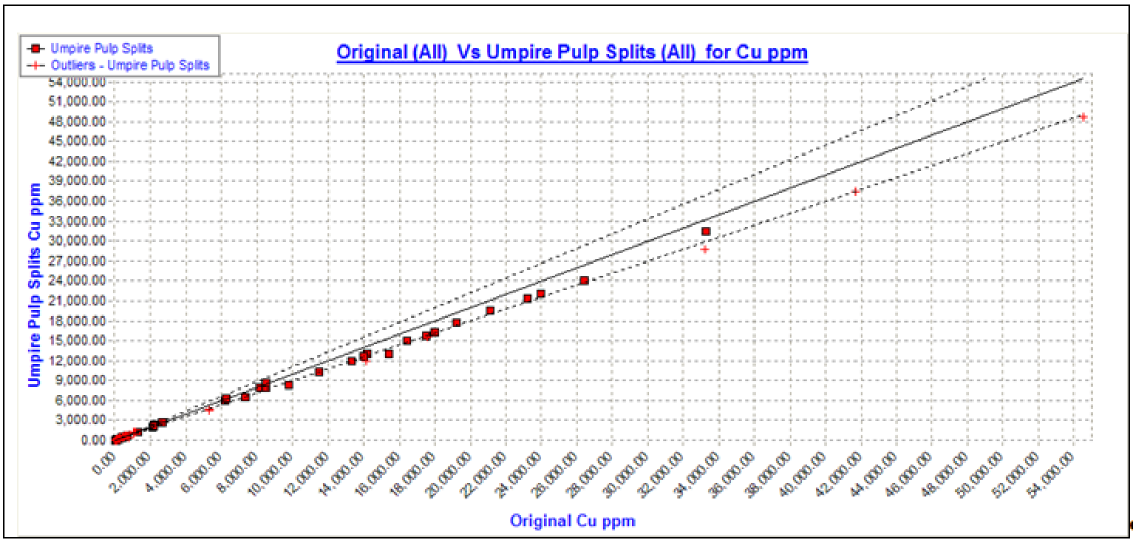
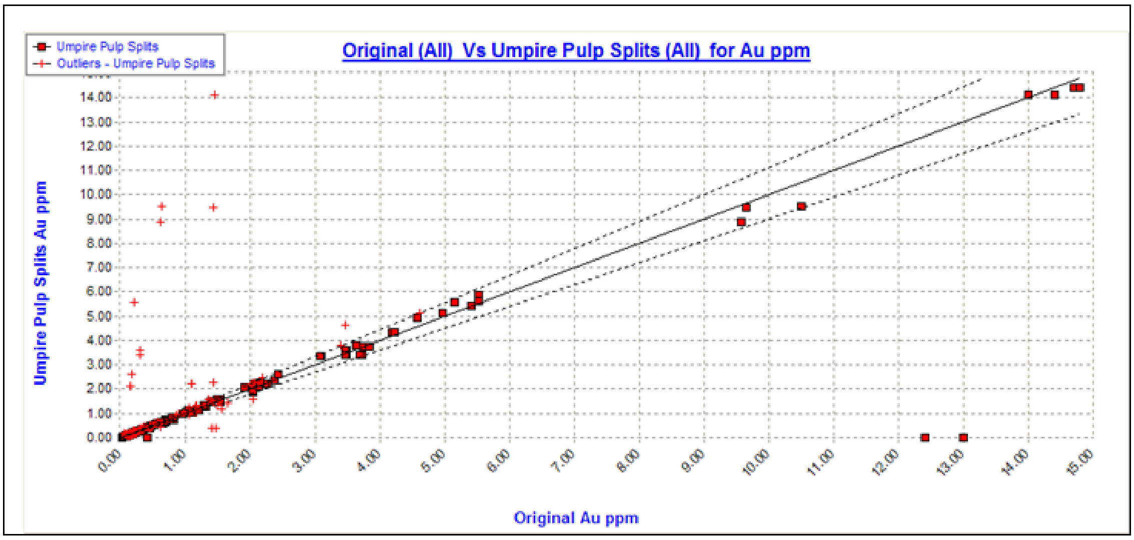


Figure 11.10 Comparison of Pulp Duplicate Assays for Gold



Copper assays from blanks indicate that there are a very small number of distinct outliers probably caused by sample substitution. There is no evidence of contamination.

Certified standards were regularly included but only copper results have been reported. Generally the standards returned assays within two standard deviations of the expected value, however there are a number outside acceptable limits and there is a consistent low bias. These may have been incorrectly labelled standards. Control charts for the most commonly used copper standards are shown in Figures 11.11 to 11.13.

Figure 11.11 Control Chart for Copper Standard GBM396-10

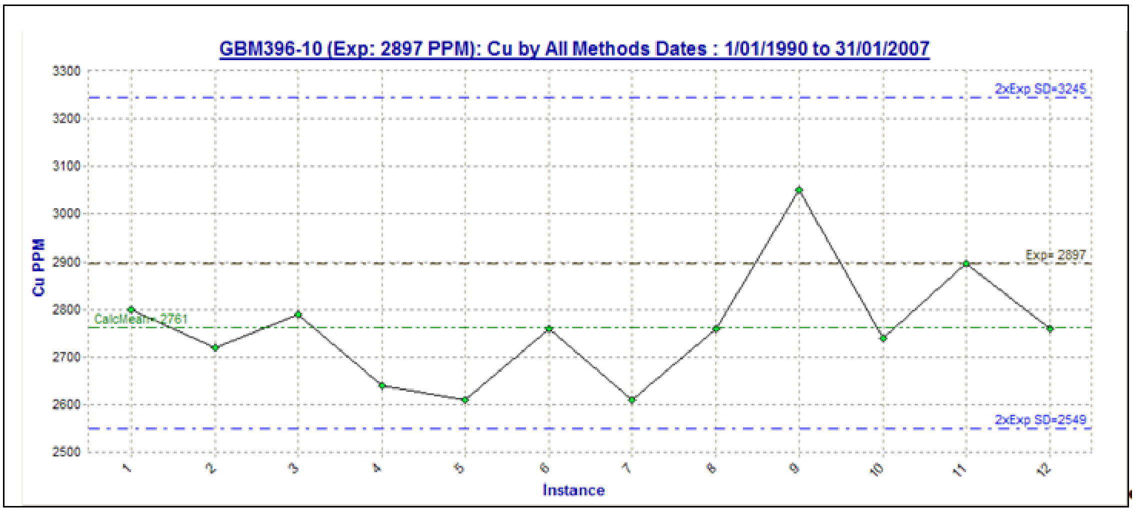


Figure 11.12 Control Chart for Copper Standard GBM398-4C

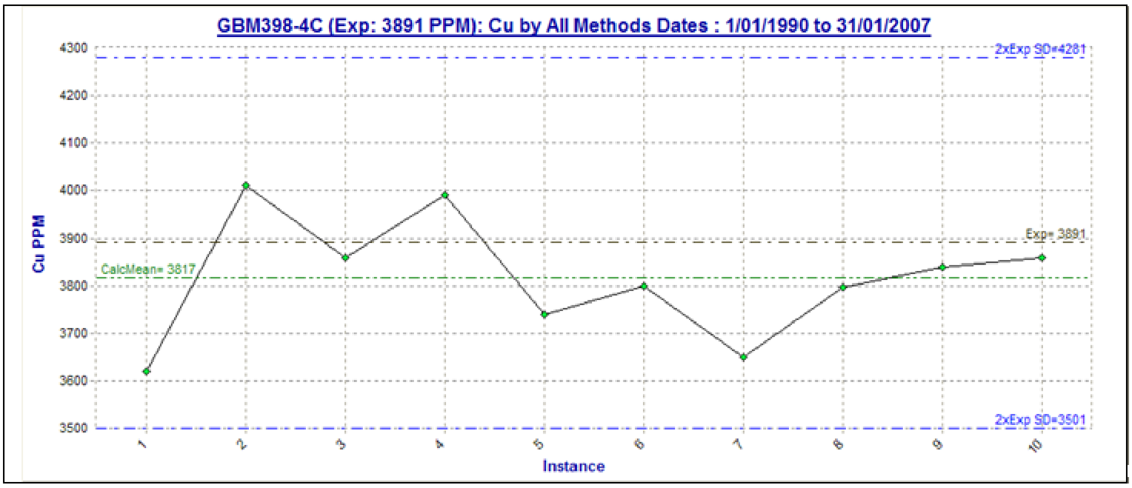
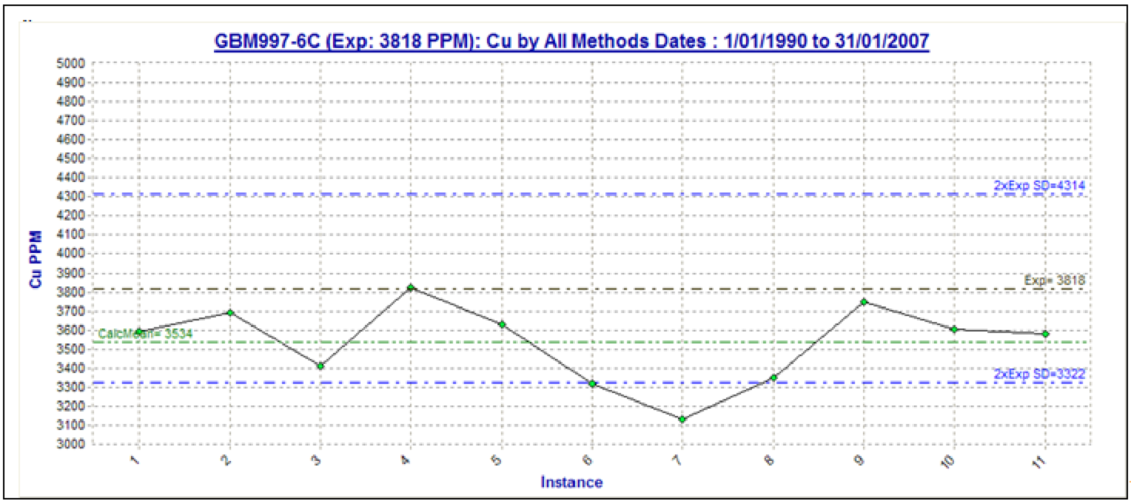


Figure 11.13 Control Chart for Copper Standard GBM997-6C



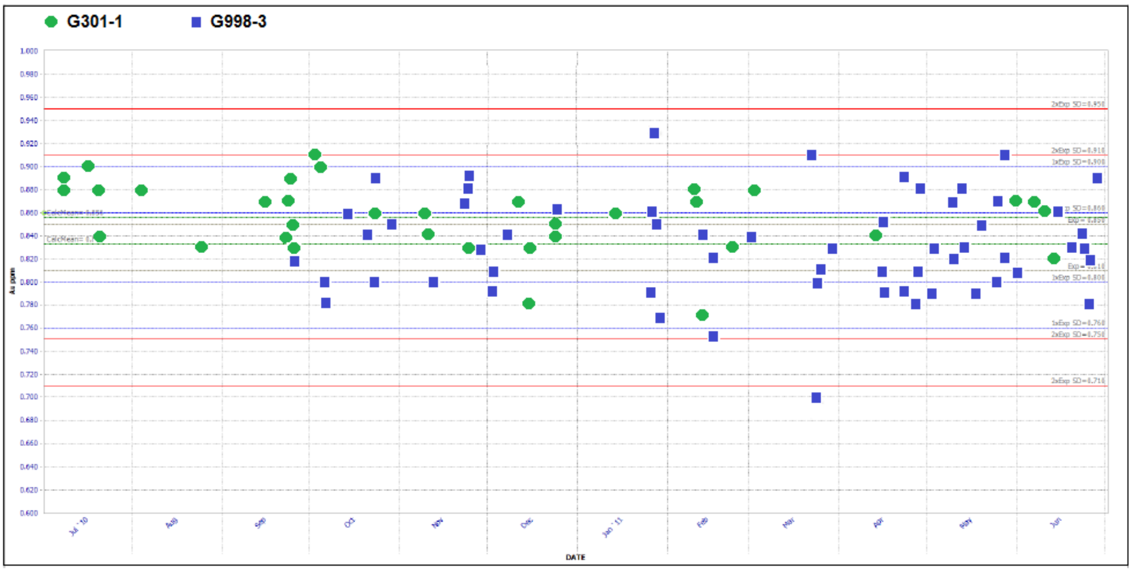
11.2.3 Drilling to 2008 to 2011

QAQC for drilling to 2011 has included certified standards, blanks, coarse crush repeats and pulp repeats.

Gold standards used were commercially available standard reference material from Geostats Pty Ltd. Standards were inserted at an approximate rate of 1:67 drill samples. Up to seven low grade (<1 g/t Au) standards were used. Bias in gold assays was negligible across all grade ranges. However some standards show greater bias than others within the same grade range which may be a function of the standard composition considering that none of the standards are matrix matched to the Golpu deposit.

Different standards have been used over time leading to seven medium grade (1 g/t Au to 5 g/t Au) standards being used during 2011. For most of the individual standards, most results fall within one standard deviation of the expected value. Figure 11.14 shows the chart of two commonly used standards over this period. All except one fall within two standard deviations and only four fall outside one standard deviation of the expected value.

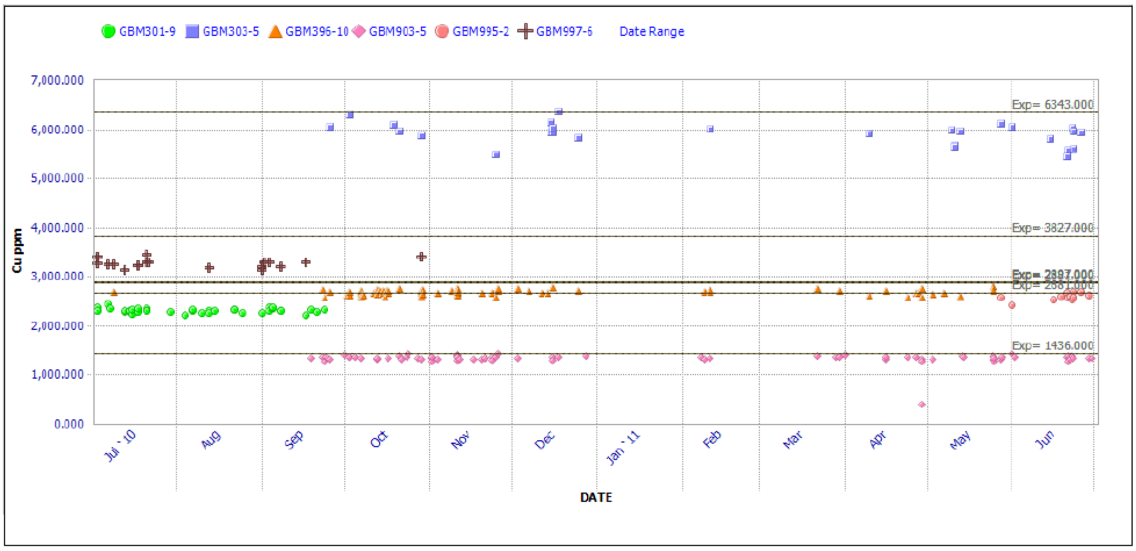
Figure 11.14 Control Plot for Medium Grade Gold Standards



Base metal standards used were commercially available standards from Geostats Pty Ltd. Standards were inserted at an approximate rate of 1:30 drill samples.

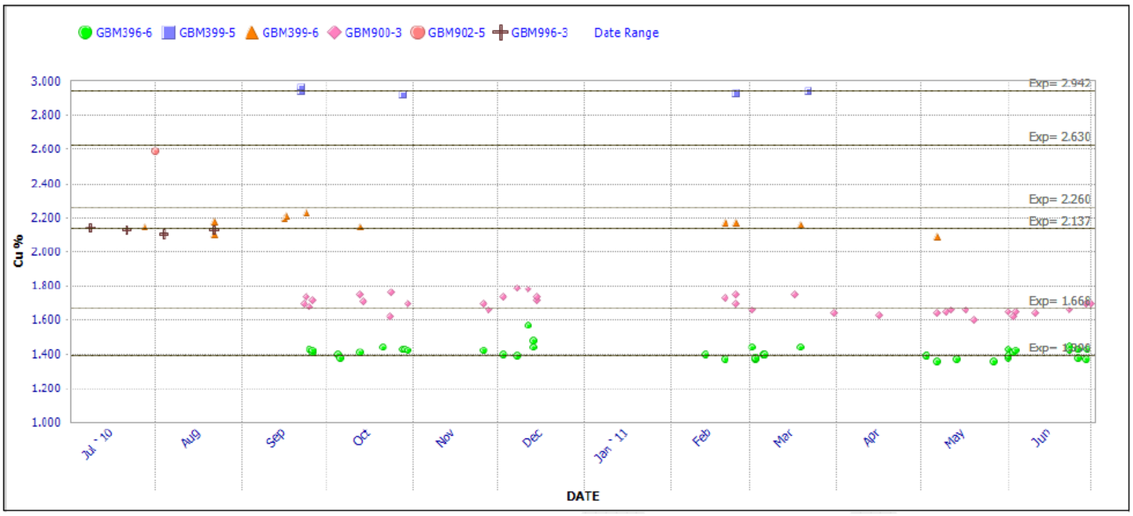
The combined chart of all medium grade copper standards (Figure 11.15) shows the range of values of each standard is consistent.

Figure 11.15 Control Plot for Medium Grade Copper Standards



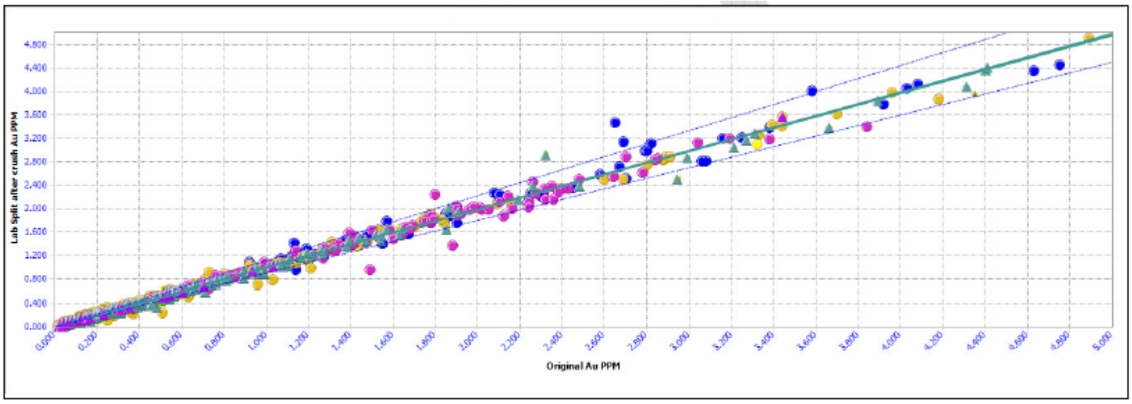
High grade copper standards have been analysed by four acid digest with AAS. Most standards performed within one standard deviation (Figure 11.16).

Figure 11.16 Control Plot for High Grade Copper Standards



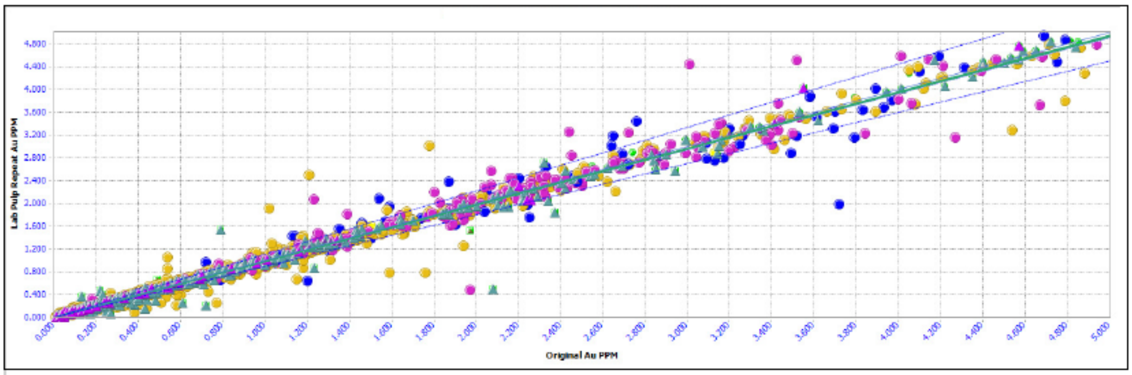
Laboratory splits samples are taken by the sample preparation laboratory after the coarse crush at a rate of 1:18. Figure 11.17 shows a scatter plot of laboratory splits against original sample for gold grades less than 5 g/t Au. Colours and symbols indicate the rock type that is the source of the sample. Repeatability is good and no bias is apparent.

Figure 11.17 Scatter Plot of Laboratory Splits 0 g/t Au to 5 g/t Au



Repeat analyses are conducted on the same pulp at a rate of approximately 1:8. Figure 11.18 shows a scatter plot of pulp repeats against original sample for gold grades less than 5 g/t Au. Repeatability is good although the pulp repeats show greater scatter than the laboratory splits. No bias is apparent.

Figure 11.18 Scatter Plot of Pulp Repeats 0 g/t Au to 5 g/t Au



11.2.4 Drilling 2011 to 2012

QAQC analysis for the past year of drilling and assaying has followed a similar protocol and review process to that followed in the 2008 to 2011 period. Certified standards, blanks and duplicates are submitted with all despatches and reviewed for compliance before uploading to the Wafi Project database. The latest QAQC measures adapted for Wafi samples include the insertion of gold and base metal standards every 40th sample, and blanks every 100th sample. Where batches are below 100 samples at least one blank is inserted.

Example plots for gold standards, copper standards, blanks and gold duplicates for the period mid March 2011 to mid March 2012 are shown in Figures 11.19 to 11.22.

Figure 11.19 Control Plot of Standard G300-7 – Mid Range Au

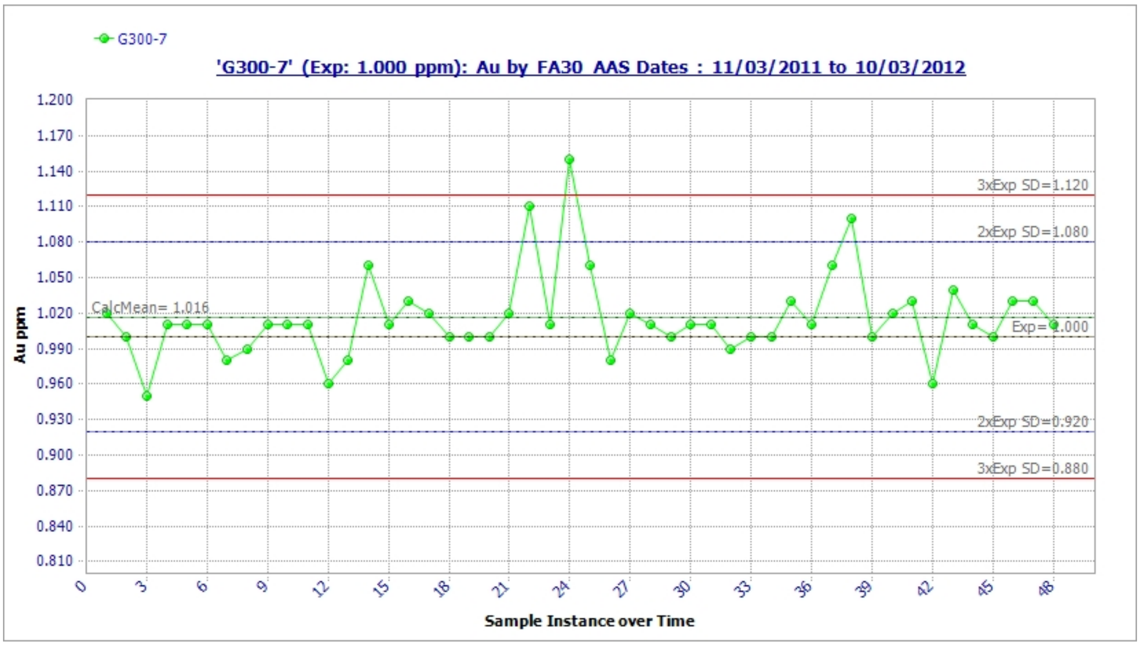


Figure 11.20 Control Plot of Standard GBM900-3 – High Range Cu

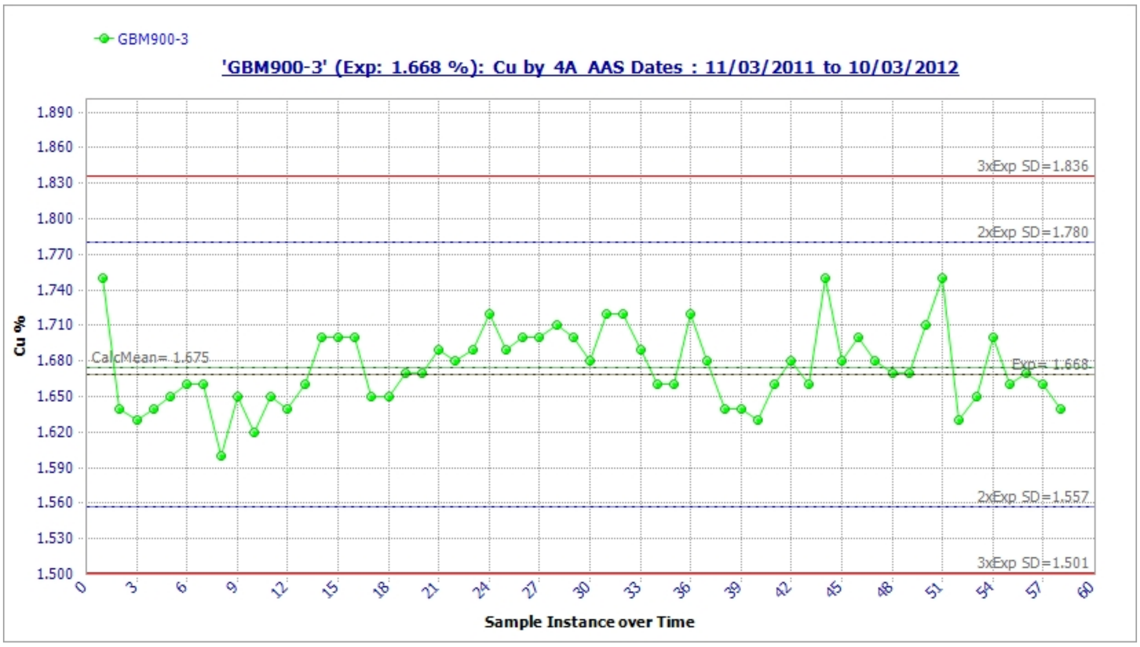


Figure 11.21 Control Plot of Blanks – Au

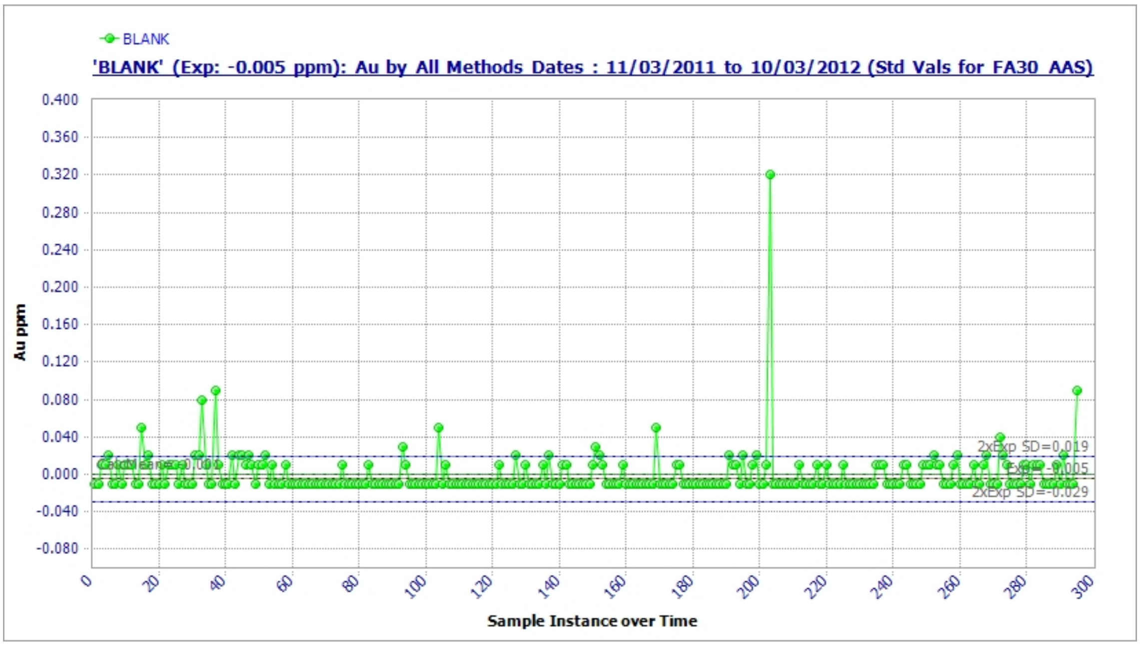
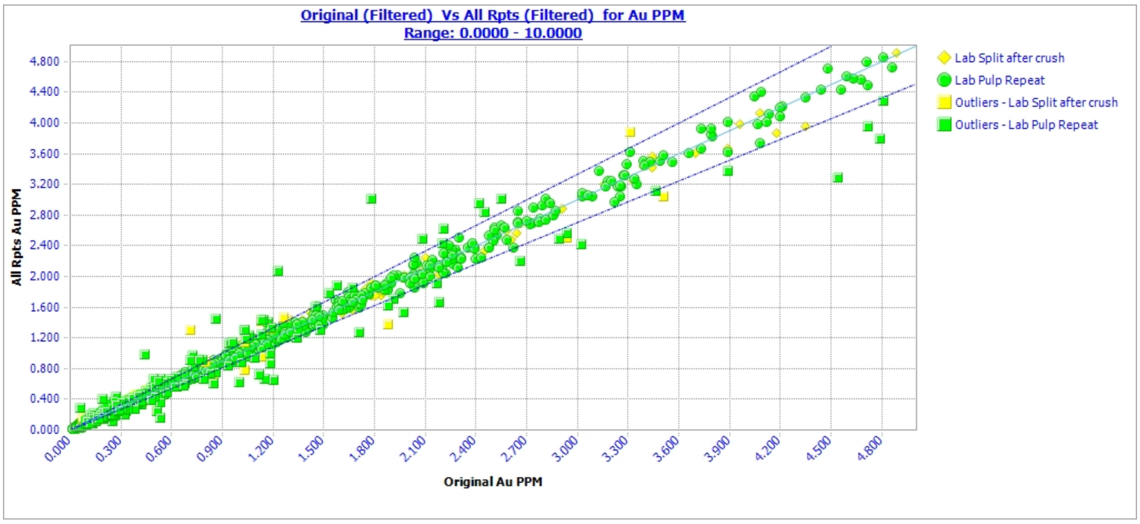


Figure 11.22 Scatter Plot of Pulp Repeats 0 g/t Au to 10 g/t Au



11.3 Nambonga Assay QAQC

Analysis of QAQC data was as per the prefeasibility study protocol. Documentation for the resource estimate summarizes conclusions from this work but does not detail the results. The consultant noted that at the time there was no continuous monitoring of quality control.

Laboratory pulp checks showed good precision between the splits, repeats and original samples. The low gold grade standard being used performed consistently well. Blanks are generally consistent but with some erratic results and bias in some drill holes.

The Nambonga Mineral Resource estimate is classified as Inferred Resource which is an appropriate reflection of the level of QAQC. Further drilling at Nambonga will be supported by routine QAQC protocols.

All holes used in the Nambonga Mineral Resource estimate were drilled by Harmony between May 2005 and September 2008 with applicable QAQC programs. Sample preparation, security and analytical procedures were the same as those used for Wafi and Golpu. These protocols are suitable for the estimation and classification of the Nambonga Inferred Mineral Resource.

12 DATA VERIFICATION

Drill hole data for the Wafi-Golpu project has been collected over many years by a number of operators. Resource documentation indicates that at various times the older data have been reviewed and compiled into a drill hole database. It is unlikely that original laboratory certificates are available for the older data. More current drilling activity by Harmony and more recently by WGJV has operated under standard operating procedures that include data verification before data are accepted into the drill hole database.

Data review was completed before the estimation of the updated Mineral Resources and Mineral Reserves reported in August 2012. Checks included validation of collar surveys against planned locations and downhole surveys were reviewed for consistency of hole path and any discrepancies either assigned a low priority in the database so it would not be used in the final extract dataset or corrected if the error was apparent – all updates were approved by the Mineral Resources Manager. Assays were reviewed for consistency and errors and compared against observed mineralization and spot checks were conducted to ensure QAQC protocols were followed before data was loaded to the database. Logging records were reviewed against core photographs as part of the interpretative geology compilation and wireframing. No material errors were identified after final data extraction for input to the Mineral Resource model estimation.

12.1 Comments and Independent Verification

In the QP's opinion, the sample preparation, security and analytical procedures are consistent with current industry standards and are entirely appropriate and acceptable for the styles of mineralisation identified and appropriate for use in the Mineral Resource estimates for the Wafi-Golpu Property. There are no identified drilling, sampling or recovery factors that materially impact the adequacy and reliability of the results of the drilling program in place on the Wafi-Golpu Property.

The Qualified Person commissioned AMC Consultants Pty Ltd (AMC) to conduct a review of the drilling, sampling and analytical processes and associated Quality Assurance / Quality Control procedures that were relied upon to support the new Golpu estimates. The Golpu Mineral Resource and Ore Reserve estimates have also been the subject of independent external review by AMC. No material issues have been identified in these reviews and AMC concluded that the estimates have been prepared using accepted industry practice and have been classified and reported in accordance with the JORC Code.

13 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 Introduction

Golpu is a copper-gold deposit, with an identified association between the copper and gold. The metallurgical testwork has focussed on a flow sheet design of a typical base metal concentrator and the recovery of copper with associated gold and silver recovered to the copper concentrate. The testwork is preliminary and is yet to be optimised, particularly with respect to recovery of gold.

The initial focus of the testwork was on the higher grade material between 4100mRL and 4850mRL. More recently, this has extended to material up to 5120mRL, with the PFS now based on block caving mining method with extraction commencing with a Lift 1, as development progresses down to the higher grade Lift 2 material.

The key metallurgical testwork for the Golpu deposit can be grouped into three main programs as follows:

- Testwork completed prior to 2011 on samples from above Lift 1 (which is referenced in this report as Historical Testwork). The expansion of the known Golpu resource has meant that the testwork completed prior to the 2011 drilling campaign is less representative of the Golpu deposit.
- Variability testwork, completed on samples over the vertical extent of the known Golpu deposit. The objective of the testwork was to assess the metallurgical response in the upper sections of the deposit to a process flow sheet developed from the Historical Testwork.
- Metallurgical production composites prepared from samples that correspond with the early years of production from the Golpu deposit. The purpose of this testwork program was to develop key metallurgical parameters for use with flow sheet design in the PFS. As a result of subsequent changes to the mining schedule, material from Lift 1 will now be mined before the material represented by these samples.

13.2 Historical Testwork

The pre-2011 samples were selected from the upper levels of the deposit. For purposes of the PFS, the data from these samples mainly provide useful comparisons with the 2011 testwork results.

13.3 Variability Testwork

The key purposes of the Variability Testwork were to:

- Improve the understanding of the variability of the metallurgical responses to the selected flow sheet
- Demonstrate a viable concept for the production of commercial grade concentrates by comminution and flotation

13.3.1 Sample Selection

The Variability Testwork program is based on 103 composite samples from 13 drill holes. The distribution of these samples is summarised in Table 13.1.

Table 13.1 Variability Sample Locations

Location	No. of Samples
Above 5120mRL	17
5120mRL to 4850mRL	16
4850mRL to 4100mRL	53
4100mRL to 3850mRL	17
Total	**103**

Variability composite make up was based on the change in lithology and the vein mineralogy as recorded in the down hole drill logs.

The test samples are considered representative of the porphyry and host rock metasediments, as well as deposit grade ranges and currently identified alteration mineral domains. As such, the test samples are considered to be representative of variations within the mineralisation.

13.3.2 Comminution Testwork

Comminution testwork was conducted using 88 of the 103 samples. It was not possible to generate data for the remaining samples due to insufficient sample mass for reliable testing. Testwork included the SMC Test®, testing for abrasion index (Ai) and Bond ball mill work index (BWI).

The results generally indicate material with low to moderate competency and moderate hardness, with a mean SMC Test® A x b value of 83 and a mean BWI of 14.3 kWh/t. Low to moderate abrasion indices were found, averaging 0.12.

General trends between sample competency, abrasion index and copper head grade suggest that the copper mineralization is associated with silica that has “annealed” rock fractures. These trends are not strong and localised geology is a key determinant of rock competency and abrasion index.

13.3.3 Flotation Testwork

The laboratory flotation flow sheet included a primary grind P_{80} of 106 µm, bulk rougher flotation, regrind to P_{80} of 30 µm, and two-stage cleaner flotation.

13.4 Flash Flotation

Flash flotation technology involves the instantaneous recovery of valuable minerals from the cyclone underflow stream in a milling circuit. Results and key observations from flash flotation tests are:

- Good correlation between gold and copper recoveries
- Lower copper concentrate grade than conventional flotation, probably indicating poor liberation

- Further testwork should be performed at P_{80} = 425 µm
- Good correlation between Au:Cu recovery ratio and Cu:S concentrate ratio, consistent with gold association with copper.

13.4.1 Gravity Recoverable Gold

A preliminary study was completed to investigate the potential for gravity recoverable gold. Gold in the feed was generally found to be very fine at a particle size of 80% passing 8 µm, therefore gravity recovery of gold is likely to be low.

13.5 Conclusions from Variability Testwork

Initial testwork confirms that the key considerations in understanding metallurgy of the Golpu deposit metallurgy are a combination of mineralogy and chemistry. The high pyrite content combined with evidence of alteration of the copper sulphides and the reactivity of the sulphide minerals means that slurry chemistry will be a significant factor in optimising copper recovery in the upper section of the deposit and possibly within localised areas lower in the deposit.

Gold is associated with both copper mineralization and pyrite; hence, high gold recoveries to a saleable copper concentrate are likely to be impacted when pyrite sulphur head grade is high.

Whilst the geology of the Golpu deposit is relatively complex, the metallurgical testwork completed to date indicates consistent trends in both comminution and flotation performance.

Additional sampling and testwork are required to improve the representivity of the sampling and to enable optimisation of the flow sheet design and metallurgical performance. This work will be undertaken during the Feasibility Study phase.

13.6 Mineralogy

Consistent with many porphyry related copper and gold deposits in the Pacific Rim region, the mineralogy of composite samples from the Variability Testwork program showed that the Golpu deposit is complex on a number of levels. The mineralogy is summarised as follows:

- Modal mineralogy clearly divides the deposit into two distinct zones; namely a zone that is affected by the high sulphidation alteration event which is later than, and cuts across, the earlier porphyry copper mineralization and zones where this is absent
- Within the high sulphidation overprint the mineralogy of samples is dominated by the alteration assemblages associated with the overprint, regardless of the precursor lithology. Two main alteration assemblages have been recognised: advanced argillic alteration; and kaolinite+sericite alteration
- Beneath the high sulphidation overprint, the mineralogy of samples is more closely controlled by lithology, with two main lithological groups identified: metasediment and porphyry

- Arsenic in the Golpu deposit is dominantly contained in the sulphides tennantite and enargite located in the alteration zone above the deposit. In the samples analysed, those from the advanced argillic zone tend to have higher arsenic grades and contain both these copper-arsenic sulphides, whereas below the high sulphidation overprint, occasional samples contain tennantite
- Quantitative grain size analysis of grouped copper sulphides indicates a relationship between copper sulphide grain size and the mass fraction of the copper sulphides in the sample. No analogous relationship has been found for the grain size of total sulphide (i.e. copper sulphides plus pyrite) and any grade related parameter
- Trace element analysis of sulphides from the Golpu deposit indicates that the sulphides contain relatively low, <1 ppm gold, with the exception of tennantite which has a median gold grade of 1 to 2 ppm. Trace element mapping indicates gold is present as micro-inclusions in sulphides

The main copper minerals in the upper horizon of the deposit above RL 4850 include chalcopyrite, bornite, covellite, enargite and tennantite. The higher pyrite grades and clay mineral zones are also observed in the upper regions of the deposit. In the upper zones of the Golpu porphyry, pyrite is present in variable but relatively high amounts and clay minerals include alunite, kaolinite and illite.

Main copper mineralization between RL 4850 and RL 3850 includes chalcopyrite and bornite.

Trace amounts of covellite, enargite and wittichenite (Cu_3BiS_3) are also present in the zone below RL 4850.

13.7 Metallurgical Performance Models

Metallurgical domains were constructed using the revised geology model, the expanded mineralogical analyses, and the flotation testwork results from the Variability Testwork program. The objective of creating metallurgy domains is to improve the reliability of the copper and gold recovery estimates for the deposit.

13.7.1 Methodology for Determining the Metallurgical Domains

Both the mineralogy data and associated metallurgical response data were used to delineate a preliminary set of metallurgical domains. Good correlations for the porphyry loads were established, although metasediment samples were difficult to group using solely mineralogy and metallurgical data.

In addition, the revised geological interpretation for the deposit was used to understand the spatial relationship between the geological structures and the testwork samples. The combined geology, mineralogy, and metallurgy datasets were overlaid and used to group areas with similar metallurgical response.

Geological structures were used to isolate areas in the deposit where poor metallurgical test results were observed. These areas of were supported with the review of the mineralogy data.

13.7.2 Metallurgical Domains

A total of 13 metallurgical domains were identified. The location and mineral characteristics for each of the domains are presented in Table 13.2.

All samples used to develop models for the metallurgical domains were tested using a standard ore characterisation flow sheet. The laboratory flow sheet included a primary grind P_{80} of 106 µm, bulk rougher flotation, regrind to P_{80} of 30 µm, and two-stage open circuit cleaner flotation. It should be noted that this flow sheet is not optimised and will be subject to ongoing optimisation and development during the Feasibility Study.

Table 13.2 Metallurgical Domain Summary

Domain	Location	Mineral Characteristics
1	Advanced Argillic shell	Presence of Alu in the absence of Ksp, High Py
2	Supergene	---
3	Porphyries located within the high sulphur zone	Porphyries with Kao/Ser
4	Porphyries located below the high sulphur zone	Porphyries with Ksp (rather than Kao/Ser)
5	Metasediments within the high sulphur overprint, inside the actinolite shell, and excluding the volume defined by Domain 7	Metasediments with Kao/Ser
6	Metasediments below high sulphur overprint, above the Reid fault, and north of 720850 mN	Metasediments with Bt/Ab/Ksp/Py.
7	Metasediments within the high sulphur overprint, below the overhang of the Golpu East porphyry, inside the actinolite shell, and above the Reid fault	Metasediments with Alu/Jar
8	Metasediments below high sulphur overprint, above the Reid fault, and south of 720850 mN	Metasediments with Bt/Ab/ill/Ser
9	Metasediments below the Reid fault and above 4450mRL	Metasediments with Bt/Ab/ill/Ser
10	Metasediments below the Reid fault, in the 3% chalcopyrite shell, and north of 721000 mN	Metasediments with Bt/Ab/Plag/Ksp
11	Metasediments below the Reid fault, in the 3% chalcopyrite shell, and south of 721000 mN	Metasediments with Ab/Ser/Bt
12	Metasediments below the Reid fault, and outside the 3% chalcopyrite shell	Metasediments with Bt/Ab/Ksp
13	Area above the BOCO	---

Note: Ab = Albite, Alu = Alunite, Bt = Biotite, ill = illitie, Jar = Jarosite, Kao = Kaolinite, Ksp = K-feldspar, Plag = Plagioclase, Py = Pyrite, Ser = Sericite

13.7.3 Key Observations

The following key observations are made on samples tested from the metallurgical domains:

- Domain 1 (Advanced Argillic): Characteristic of poor copper and gold recovery performance, typically highly variable, due to the presence of alunite. Samples consumed excessive quantities of lime in the testwork. Analysis of this domain was excluded from the review of testwork due to its location far above the planned block cave and is therefore not significant in relation to the mine plan.

- Domain 2 (Supergene): Not tested during the PFS phase due to the location of the material near the base of completed oxidation (BOCO). Therefore, metallurgical performance was assumed from the 2010/11 testwork. This material is also located far above the planned cave and is therefore not significant in relation to the mine plan.

- Domain 3 (porphyries located within the high sulphur zone): Achieved satisfactory copper performance with variable concentrate grades due to the increased clay content in feed. Several samples achieved increased copper concentrate grades due to the presence of secondary copper minerals in feed. Gold performance is variable.

- Domain 4 (porphyries located below the high sulphur zone): Achieved copper and gold performance typical of copper-gold porphyries.

- Domain 5 (metasediments with kaolinite/sericite): Displayed variable copper and gold performance. The increased clay content results in poor selectivity of copper sulphides and dilution of the copper concentrate.

- Domain 6 (metasediments with biotite/albite/K-feldspar/pyrite): Achieved similar copper-gold performance to the porphyry zones. The metallurgical performance is affected by the reduced feed grades and resulting reduced copper sulphide grain sizes.

- Domain 7 (metasediments with alunite/jarosite): Comprise metasediments within the high sulphur overprint, below the overhang of the Golpu East porphyry, inside the actinolite shell, and above the Reid fault. Since the samples contain alunite and jarosite, the metallurgical performance is variable and shows a significant decrease in copper concentrate grades. Further samples within the domain are required to investigate these effects.

- Domain 8 (metasediments with biotite/albite/illite/sericite): These were isolated from the other domains based on the location and poor metallurgy performance. Limited sampling and testwork was completed to assess the flotation performance of this material

- Domain 9: (metasediments with biotite/albite/illite/sericite): comprise metasediments below the Reid fault and above 4450mRL, which achieved poor gold recovery. Limited sampling and testwork was completed to assess the flotation performance of this material.

- Domain 10 (Metasediments with biotite/albite /plagioclase/K-feldspar): Achieved improved copper-gold performance. This material achieves a reduced copper concentrate grade and requires further testwork to determine options to increase concentrate grade.

- Domain 11 (Metasediments with albite/sericite/biotite): Achieved excellent copper-gold performance. This domain was isolated below the Reid fault, in the 3% chalcopyrite shell, and south of 721000 mN in the absence of spatial data, was based on a single sample.

- Domain 12 (metasediments with biotite/albite /plagioclase/K-feldspar): Achieved excellent copper performance while the gold recovery was less than typical in porphyry zone recovery. Further testwork is required to investigate the deportment of gold to the cleaner and rougher tailings streams
- Domain 13 (area above the base of completed oxidation): Not investigated in the recent testwork campaign as the domain does not impact early production years.

The assessment of the metallurgical domains is based on limited spatial sample availability and flow sheet development testwork. However, development testwork is ongoing with the potential to improve the current flotation performance including:

- grind optimisation to investigate increasing metal recoveries, and reduce project capital and operating costs
- additional cleaner stages to increase concentrate grade
- assessment of options to increase gold recovery
- further reagent optimisation to increase metal recoveries and concentrate grade.

13.7.4 Performance Estimates

Metallurgical parameters for the 13 metallurgical domains were developed in accordance with the mining plan, current at the time. Flotation performance parameters were developed for the metallurgical domains and to support the mine production plan and include:

- gold recovery
- copper recovery, and
- copper concentrate grade.

The metallurgical performance for each of the 13 metallurgical domains identified in the Golpu PFS is summarised in Table 13.3.

Table 13.3 Metallurgical Domains

Domain		Recovery	
Number	Name	Au %	Cu %
1	Advanced Argillic	37	86
2	Supergene	66	90
3	Porphyry - Within High Sulphur zone	57	90
4	Porphyry - Below High Sulphur zone	74	95
5	Metasediment - Within High Sulphur Zone (above Reid)	46	85
6	Metasediment - Bt/Ab/Ksp/Py (above Reid)	34	89
7	Metasediment - Alu/Jar (above Reid)	34	72
8	Metasediment - Bt/Ab/illite/Ser (above Reid)	8	46
9	Metasediment - Bt/Ab/illite/Ser (below Reid)	16	82
10	Metasediment - Bt/Ab/Plag/Kspar	64	96
11	Metasediment - Ab/Ser/Bt	19	90
12	Metasediment - Bt/Ab/K feldspar	36	93
13	Above BOCO	-	-

Average metallurgical recoveries for copper and gold of 93% and 61% respectively were estimated during the PFS.

13.8 Production Composite Testing

While not considered in PFS process design, preparatory works were initiated, as part of the PFS, to support the next study stage.

13.8.1 Sample Selection and Composition

The initial metallurgical production testwork programme was undertaken to assess the response of samples from between 4850mRL and 4100mRL, based on the mine plan at the time. The samples are therefore not an ideal representation of early production based on the mine plan subsequently developed during the PFS, which commences mining higher in the deposit.

- Samples selected to represent the first seven years of production were chosen.
- A total of five production composites were constructed. With a long ramp-up of the mine, production years 1 to 3 were combined as a single composite. Subsequent years were represented by separate composites.
- Samples from the Variability Testwork program were used to construct the production composites.

13.8.2 Summary of Mineralogy

Mineralogy assessment of the five production composites was as follows:

- In all samples, the main copper hosting mineral is chalcopyrite with minor amounts hosted in bornite.
- Each composite contains 8% to 10% sulphides comprising predominantly chalcopyrite and pyrite, with chalcopyrite being slightly more dominant.

- Bulk gangue mineralogy comprises mainly quartz, biotite mica, feldspars and lesser magnetite.
- Total sulphide grain size ranges from 375 um to 579 um, based on the equivalent ellipse grain size calculation.
- Copper sulphides grain size ranges from about 304 um to 443 um, based on the equivalent ellipse grain size calculation.
- In-situ textures reveal that copper sulphides are predominantly associated with non-sulphide gangue minerals and to a lesser extent with pyrite.

13.8.3 Batch Testwork

Testwork consisted of laboratory batch scale flotation tests, as summarised in Table 13.4.

Table 13.4 Summary of Flotation Testwork

Stage	Description	Test Conditions
1	Primary grind	Primary grind P_{80} of 75 µm, 106 µm, 150 µm, and 212 µm
2	Recleaner kinetics	Primary grind P_{80} of 106 µm and regrind P_{80} of 20 µm, 30 µm, and 20 µm
3	Depression testwork	NaCN system, lime system, and $Na_2S_2O_5$ system
4	Selective flotation	Rougher float at pH 11, P_{80} of 106 µm, and regrind P_{80} of 30 µm
5	Locked cycle test	Primary grind P_{80} of 106µm and regrind P_{80} of 30 µm
6	Batch flotation tests	Primary grind P_{80} of 300 µm and regrind 63 µm
7	Primary grind	Primary grind P_{80} of 250 µm, 300 µm
8	Recleaner kinetics	Regrind P_{80} of 63 µm
9	Batch flotation tests	Primary grind P_{80} of 300 µm and regrind 63 µm
10	Locked cycle test	Primary grind P_{80} of 212µm and regrind P_{80} of 45 µm

The following conclusions were reached from reviewing the test results:

- A coarser primary grind of P80 of 212 µm is appropriate for all five composites;
- For all five composites, a rougher laboratory residence time of approximately 16 minutes is required at a primary grind of 212 µm;
- The fast flotation kinetics and corresponding moderate to high grade copper rougher concentrate for the five composites suggests an option to recover this material and process separately to improve flow sheet design;
- An increase in the primary grind requires an increase in rougher laboratory residence time and/or collector addition. Results clearly demonstrate the ability to achieve similar copper recovery to the standard test (used in Phases 1 and 2), when the rougher residence time is increased;
- A decrease in copper rougher concentrate grade is required to achieve satisfactory rougher stage recovery at increased primary grind sizes. Reducing the concentrate grade results in an increase in mass recovered to the cleaner circuit, which corresponds to an increase in the regrind and cleaning circuits to treat the increased mass flow;

- Decreasing the copper rougher concentrate grade reduces the ability of the two-stage cleaner circuit to achieve a final concentrate grade compared to the standard test. Additional stages of cleaning and/or reagent optimisation are required to increase the final copper concentrate grade.

13.8.4 Locked Cycle Testwork

Utilising the findings from the batch tests, Locked Cycle testwork was completed for the five production composites. A coarse primary grind of 80% passing 212 µm and rougher concentrate grind of 80% passing 45 µm were compared with the grind sizes used in Phase 1 and 2.

Locked cycle flotation testwork was completed in two stages, aligned with the batch flotation tests, including:

- A primary grind at 80% passing 106 µm and rougher concentrate regrind at 80% passing 30 µm for all production composites;
- A primary grind at 80% passing 212 µm and rougher concentrate regrind at 80% passing 45 µm for all production composites.

The following observations can be made with respect to the Locked Cycle results:

- Copper recovery to the final concentrate is consistent for the five production composites;
- Gold recovery is variable and performed the poorest for the Year 6 composite;
- Increasing the primary grind size from 75 µm to 212 µm reduces the overall copper recovery by about 5%. As the grind becomes finer, the curve tends to flatten, indicating little recovery benefit from a grind size finer than 106 µm. A similar grind/recovery relationship was observed for gold;
- Copper concentrate grade decreases with the increase in regrind particle size;
- Copper performance for Year 6 composite is atypical of the other production composites and requires further investigation.

Based on these results the following conclusions can be drawn:

- Metallurgical performance for all five production composites is typical of copper-gold porphyry style deposits. Copper recovery reduces with the increase in primary grind size and copper concentrate decreases with the increase in regrind particle size;
- The testwork data for the Year 6 composite suggests further optimisation of the cleaner circuit performance is achievable. The final concentrate particle size and copper grade does not indicate issues with the target regrind size;
- Further testwork is required to optimise the process flow sheet including further testing of composites containing metasediment and host rock to improve the prediction of copper and gold performance;

- Recoveries from the Production Composites are generally higher than the Performance Predictions, based on the Variability Testwork. This is thought to reflect the different nature of the samples: variability samples to characterise the deposit versus higher grade composites selected to predict plant performance.

13.9 Optimisation of Gold Recovery

A benchmarking study was undertaken on similar copper-gold porphyry projects to investigate metal recoveries for steady state operations. Information used for benchmarking was sourced from published papers, the public domain and in-house knowledge.

This study showed gold recoveries at the seven other porphyry projects ranged from 60% to 81%, with a mean of 72.6%. These recoveries are generally higher (and the mean in excess of 10% higher) than those predicted for Golpu.

The benchmarking study demonstrates the need for further flow sheet development work at Golpu and the potential for improvements to the metallurgical performance. An intensive flow sheet development and optimisation program is underway to improve both gold and copper recoveries.

No processing factors have been identified that are expected to have a material effect on potential economic extraction. While the presence of arsenic has been identified in the upper sections of the mineralisation, intermingling of ore, characteristic of the block cave mining method, is expected to ameliorate the potential for arsenic levels to materially impact concentrate quality.

14 MINERAL RESOURCE ESTIMATES

Mineral Resources have been classified and reported in accordance with the JORC Code. There are no material differences between the definitions of Measured, Indicated and Inferred Mineral Resources under the CIM Definition Standards and the equivalent or corresponding definitions in the JORC Code, and any reporting has been modified to the CIM Definition Standards.

Mineral Resources for the Wafi-Golpu project consist of:

- Wafi high sulphidation epithermal gold mineralization including oxide material above the Golpu deposit extractable by open pit mining;
- Golpu porphyry-related copper-gold mineralization;
- Nambonga porphyry-related copper-gold mineralization.

The estimated Mineral Resources for Golpu and Nambonga as at June 2012[5] are presented in Table 14.1. The Golpu Mineral Resource was re-estimated in June 2012 and is reported in a constraining shell at a nominal 0.2% Cu cut-off including any internal waste within that shell, reflecting the expectation that the deposit can be mined using the non-selective block cave method. The Nambonga Mineral Resource estimate was completed in December 2008. This estimate is reported without applying a cut-off on model grades however the estimate has been developed based on an interpretation at a nominal 0.35 g/t Au cut-off.

Table 14.1 Mineral Resources Estimated for the Golpu and Nambonga Deposits

	Tonnes (Mt)	Gold (g/t)	Copper (%)	Silver (g/t)	Contained Gold (Moz)	Contained Copper (Mt)	Contained Silver (Moz)
Indicated Resource							
Golpu (Porphyry Au/Cu)	810	0.64	0.92	1.1	16.6	7.46	29.4
Nambonga (Porphyry Au/Cu)	-	-	-	-	-	-	-
Inferred Resource							
Golpu (Porphyry Au/Cu)	190	0.61	0.80	1.0	3.7	1.52	6.3
Nambonga (Porphyry Au/Cu)	40	0.79	0.22	-	1.0	0.09	-
Total Inferred Resource	**230**	**0.64**	**0.70**		**4.7**	**1.60**	**6.3**

The Golpu Indicated Mineral Resource estimate, as set out above, is inclusive of the Golpu Probable Mineral Reserve estimate. For the purpose of this report, Mineral Resources and Mineral Reserves are reported in 100% terms. Newcrest has a beneficial interest of 50% in these resources and reserves.

5 *Estimate reported in August 2012*.

The Wafi Mineral Resource estimate is presented in Table 14.2. The Wafi Mineral Resource is reported at cut-off grade of 0.4g/t Au for non-refractory, predominantly oxide material and a cut-off grade of 0.9g/t Au for lower recovery, refractory sulphide material. The Mineral Resource estimate was developed using prices of US$1,400/oz gold and US$3.50/lb copper respectively. The Mineral Resource is constrained by a US$1,400 per ounce gold notional spatial constraining pit shell reflecting an open pit mining method. The Wafi Mineral Resource also includes oxide material from the Golpu deposit accessible within the Wafi pit shell and which is excluded from the Golpu Mineral Resource estimate.

Table 14.2 Wafi Mineral Resource at 30 June 2012

	Tonnes (Mt)	Gold (g/t)	Silver (g/t)	Contained Gold (Moz)	Contained Silver (Moz)
Indicated Resource	110	1.7	3.6	6.3	13.0
Inferred Resource	23	1.3	2.5	0.9	1.8

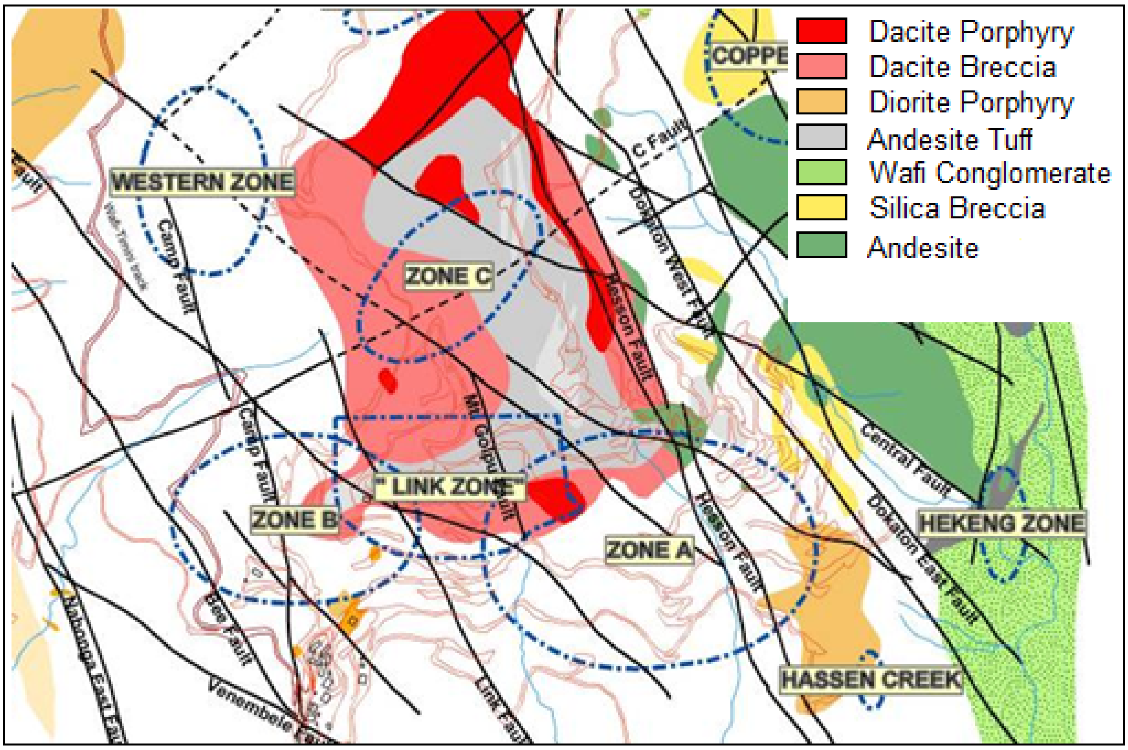
14.1 Wafi Mineral Resource Estimate

The Wafi Mineral Resource was re-estimated in January 2012 (and reported in August 2012) using all data available at that time including recent drilling for metallurgical sample collection and using the revised geological understanding available from the broader Wafi-Golpu project. The estimate was compiled by an external consultant under the direct supervision of the WGJV geology group.

The Wafi gold deposit is a high sulphidation epithermal gold deposit hosted in the metasedimentary units of the Owen Stanley Metamorphics and peripheral to a diatreme breccia complex. The mineralization is identified as three mineralization domains: Zones A and B and Link Zone within a surrounding low grade halo (Figure 14.1). Mineralization occurs as disseminated sulphides and quartz vein stockworks in advanced argillic to intermediate argillic altered siltstone and sandstone units. Gold mineralization is sheet-like and moderately northeast plunging.

The effect of telescoping has placed alteration associated with the Wafi deposit over the adjacent Golpu porphyry related mineralization. The high sulphidation event is not thought to be related to the Golpu suite of porphyries but is possibly a separate later event related to an unknown source.

Figure 14.1 Plan Showing the Location of Wafi Mineralised Zones



Metallurgical test programs have shown that primary mineralization is refractory to conventional cyanidation, and that sulphide oxidation prior to cyanidation may be required to achieve satisfactory gold recoveries. The transitional and oxide parts of the Mineral Resource estimate are referred to as non-refractory gold (NRG) with the sulphide dominant portion as refractory gold (RG).

14.1.1 Domaining

The mineralised halo domain comprises generally lower grade high sulphidation vein mineralization hosted in metasediments and diatreme defined by a low grade 0.2 g/t Au wireframe. For modelling purposes, the deposit was originally defined by 13 mineralised domains based on mineralization, alteration and lithological characteristics within nominal 0.5g/t Au and 0.2g/t Au wireframes. The 0.5 g/t Au shell effectively divides the deposit into two – the A Zone in the east (largely above the base of advanced argillic alteration blanket) and the B Zone in the west (largely below the advanced argillic blanket but within the intermediate argillic zone). A NE-SW oriented structure that cuts to the immediate north of the Wafi deposit appears to offset the mineralization and lithology, providing a northern boundary to the B Zone, and affects A Zone. Additionally, the link zone was wireframed separately based on a nominal 3g/t Au cut-off. These domains where analysed and consolidated into the four broad estimation domains ultimately used in the estimation process.

The final estimation domains, all constrained within the 0.2g/t Au shell, were:

- North of the NE-SW Fault – LMIK domain 40, estimated with hard boundaries;
- Diatreme south of the Fault – LMIK domain 30, estimated with soft boundaries;

- Metasediments south of the Fault – LMIK domain 20, estimated with soft boundaries;
- Main lens of Link Zone – OK domain 10, estimated with hard boundaries.

Weathering characteristics were defined by two surfaces: the top of fresh rock and the base of total oxidation. Material between these two surfaces included partly oxidized material and was classed as transitional. The base of complete oxidation was modelled by extracting a point at the first occurrence of fresh or partly weathered material in each drill hole log. The top of fresh rock was modelled at the point where there was no further partial or fracture oxidation logged.

14.1.2 Data Statistics

Wafi mineralization has been defined over a surface area of 1,100m x 800m and up to 600m below surface, with the majority of the material potentially exploitable by open pit mining methods. Approximately 200 predominantly diamond holes totalling 59,500m were used to estimate the Wafi Mineral Resource, (drilled from 1990 to date). Drilling spacing varies from 50m x 50m near surface to greater than 200m x 200m spacing at depth.

Data were selected within the domain wireframes and composited to 4m intervals. A number of historical drill holes which were considered to be unreliable were excluded from the data. Summary statistics for 4m composites are listed in Table 14.3.

Table 14.3 Summary Statistics for Gold for 4m Composites

Domain	10	20	30	40
Number	336	9426	1220	1351
Minimum	0.185	0.01	0.02	0.01
Maximum	51.87	35.72	9.17	12.46
Mean	7.11	0.96	0.44	0.44
Median	4.93	0.46	0.47	0.32
Standard Deviation	6.87	1.67	0.57	0.51
Coefficient of Variance	0.97	1.74	1.29	1.16

Assay statistics and frequency plots were examined to determine the need for top cuts to limit the influence of statistical outliers. The top cuts applied to each domain are listed in Table 14.4.

Table 14.4 Composite Gold Grade Top Cuts

Domain	10	20	30	40
Top Cut g/t Au	25	20	4.5	4.5
Number Cut	2	6	4	4
% Mean Reduction	-2.0%	-0.4%	-1.4%	-1.3%

Multiple Indicator Kriging was considered an appropriate estimation method for the gold zones at Wafi other than the Link Zone (Zone 10) where Ordinary Kriging was used. Variograms were calculated from the 4m composites to model directional continuity for grade estimation. Indicator variograms have been generated for all 17 indicator thresholds for Domains 20 and 30 and 8 indicator thresholds for Domain 40.

Key aspects of the variography includes:

All variography has been oriented consistent with the zone interpretation. No plunge component has been modelled.

The Au relative nugget (% nugget variance of the total variogram variance) has been modelled at from 22% to 34% for the grouped zones. This is considered relatively low for this style of deposit where relative nuggets are often 40% and above.

The short-range structures generally contribute a significant portion of the non-nugget variance, and have been assigned a range approximating the drill spacing (15m to 25m).

Overall ranges are noted to be in excess of the current drill spacing.

Table 14.5 Variogram Models

Domain 10

Variable	Nugget (C0)	Rotation			Structure 1				Structure 2			
		Strike	Dip	Pitch	Sill 1 (C1)	Range (m)			Sill 2 (C2)	Range (m)		
						Major	Semi Major	Minor		Major	Semi Major	Minor
Au	7.39	0	45	0	11.68	60	60	10	10.29	60	60	30

Domain 20

Variable	Nugget (C0)	Rotation			Structure 1				Structure 2			
		Strike	Dip	Pitch	Sill 1 (C1)	Range (m)			Sill 2 (C2)	Range (m)		
						Major	Semi Major	Minor		Major	Semi Major	Minor
Au Gaus BT	0.740	0	50	0	1.000	28	35	25	0.415	125	105	92
Au Correlogram	0.265	0	50	0	0.514	50	25	20	0.213	145	110	75
Ind_0.1625	0.035	0	50	0	0.030	60	45	20	0.025	195	280	185
Ind_0.22	0.060	0	50	0	0.050	60	45	20	0.047	195	280	185
Ind_0.29	0.070	0	50	0	0.055	60	45	20	0.087	195	280	170
Ind_0.37	0.080	0	50	0	0.073	60	45	20	0.087	195	280	170
Ind_0.48	0.080	0	50	0	0.085	50	45	20	0.085	175	240	130
Ind_0.542	0.085	0	50	0	0.090	40	40	20	0.072	150	230	100
Ind_0.62	0.085	0	50	0	0.090	40	40	20	0.065	140	230	80
Ind_0.7225	0.083	0	50	0	0.085	40	40	20	0.059	120	180	70
Ind_0.855	0.080	0	50	0	0.075	40	40	20	0.055	110	135	65
Ind_1.0253	0.070	0	50	0	0.070	40	40	20	0.047	90	100	55
Ind_1.26	0.065	0	50	0	0.060	40	40	20	0.035	60	70	45
Ind_1.625	0.055	0	50	0	0.040	50	30	15	0.032	50	50	40
Ind_2.2675	0.040	0	50	0	0.028	25	25	15	0.022	45	45	30
Ind_2.765	0.033	0	50	0	0.023	25	25	20	0.013	45	45	20
Ind_3.6413	0.024	0	50	0	0.020	20	20	20	0.004	45	45	20
Ind_4.93	0.015	0	50	0	0.012	20	20	20	0.002	40	40	20
Ind_0.1625	0.006	0	50	0	0.004	20	20	10	0.000	0	0	0

Domain 30

Variable	Nugget (C0)	Rotation			Structure 1				Structure 2			
		Strike	Dip	Pitch	Sill 1 (C1)	Range (m)			Sill 2 (C2)	Range (m)		
						Major	Semi Major	Minor		Major	Semi Major	Minor
Au Gaus BT	*0.090*	*0*	*20*	*0*	*0.107*	*30*	*30*	*10*	*0.092*	*115*	*90*	*50*
Au Correlogram	*0.310*	*0*	*20*	*0*	*0.370*	*30*	*50*	*10*	*0.320*	*115*	*100*	*50*
Ind_0.115	*0.045*	*0*	*20*	*0*	*0.026*	*30*	*70*	*15*	*0.023*	*95*	*75*	*65*
Ind_0.1525	*0.070*	*0*	*20*	*0*	*0.040*	*30*	*70*	*15*	*0.048*	*95*	*75*	*65*
Ind_0.190	*0.085*	*0*	*20*	*0*	*0.060*	*30*	*70*	*15*	*0.060*	*90*	*70*	*60*
Ind_0.2275	*0.100*	*0*	*20*	*0*	*0.065*	*30*	*70*	*15*	*0.074*	*90*	*70*	*45*
Ind_0.2675	*0.105*	*0*	*20*	*0*	*0.080*	*30*	*70*	*15*	*0.064*	*80*	*70*	*40*
Ind_0.300	*0.094*	*0*	*20*	*0*	*0.075*	*25*	*30*	*15*	*0.077*	*75*	*75*	*35*
Ind_0.340	*0.094*	*0*	*20*	*0*	*0.072*	*25*	*30*	*15*	*0.073*	*70*	*85*	*35*
Ind_0.390	*0.092*	*0*	*20*	*0*	*0.065*	*25*	*30*	*15*	*0.070*	*70*	*85*	*35*
Ind_0.4275	*0.092*	*0*	*20*	*0*	*0.061*	*55*	*25*	*15*	*0.057*	*55*	*80*	*35*
Ind_0.4975	*0.090*	*0*	*20*	*0*	*0.057*	*55*	*70*	*15*	*0.040*	*55*	*70*	*30*
Ind_0.5775	*0.080*	*0*	*20*	*0*	*0.049*	*55*	*70*	*15*	*0.030*	*55*	*70*	*30*
Ind_0.7125	*0.060*	*0*	*20*	*0*	*0.058*	*55*	*70*	*15*	*0.009*	*55*	*70*	*25*
Ind_0.9375	*0.048*	*0*	*20*	*0*	*0.024*	*50*	*70*	*20*	*0.019*	*50*	*70*	*20*
Ind_1.110	*0.037*	*0*	*20*	*0*	*0.017*	*50*	*70*	*18*	*0.015*	*50*	*70*	*18*
Ind_1.365	*0.028*	*0*	*20*	*0*	*0.010*	*50*	*70*	*16*	*0.009*	*50*	*70*	*16*
Ind_1.8425	*0.021*	*0*	*20*	*0*	*0.005*	*40*	*50*	*16*	*0.004*	*40*	*50*	*16*
Ind_2.7575	*0.008*	*0*	*20*	*0*	*0.003*	*30*	*30*	*8*				

Domain 40

Variable	Nugget (C0)	Rotation			Structure 1				Structure 2			
		Strike	Dip	Pitch	Sill 1 (C1)	Range (m)			Sill 2 (C2)	Range (m)		
						Major	Semi Major	Minor		Major	Semi Major	Minor
Au Gaus BT	*0.035*	*0*	*40*	*0*	*0.052*	*30*	*90*	*20*	*0.070*	*75*	*90*	*75*
Au Correlogram	*0.300*	*0*	*40*	*0*	*0.310*	*40*	*45*	*20*	*0.390*	*95*	*85*	*86*
Ind_0.1325	*0.028*	*0*	*40*	*0*	*0.027*	*35*	*40*	*15*	*0.030*	*135*	*105*	*70*
Ind_0.22	*0.070*	*0*	*40*	*0*	*0.064*	*35*	*40*	*15*	*0.075*	*135*	*105*	*70*
Ind_0.325	*0.075*	*0*	*40*	*0*	*0.100*	*20*	*45*	*30*	*0.075*	*95*	*105*	*70*
Ind_0.39	*0.084*	*0*	*40*	*0*	*0.066*	*75*	*45*	*25*	*0.090*	*75*	*95*	*70*
Ind_0.4875	*0.080*	*0*	*40*	*0*	*0.049*	*75*	*70*	*20*	*0.079*	*75*	*70*	*60*
Ind_0.6375	*0.060*	*0*	*40*	*0*	*0.039*	*45*	*30*	*16*	*0.056*	*75*	*70*	*50*
Ind_0.9075	*0.037*	*0*	*40*	*0*	*0.020*	*25*	*25*	*16*	*0.029*	*45*	*45*	*32*

14.1.3 Grade Estimation

The nature of the Wafi mineralization lends itself to a Multiple Indicator Kriging estimation method, in this instance a localised Multiple Indicator Kriging (LMIK) method of estimation was used for the bulk of the Wafi resource. Multiple Indicator Kriging was considered an appropriate estimation method as significant short scale variability is noted for the gold mineralization within the defined broad low grade envelope at 0.2g/t Au. LMIK is a robust estimation approach that allows the estimation of a targeted selective mining unit (SMU) volume within larger panels suitable for estimation with more broadly spaced data sets. Ordinary Kriging and nearest neighbour was also used as a comparison estimate for the grade attributes within the model.

The LMIK grades were estimated into panels with dimensions of 100m x 100m x 10m with the probabilities of the grades of the parent block assigned to the SMU blocks using a localisation method.

Gold grades were estimated using LMIK or Ordinary Kriging into a volume model described in Table 14.6.

Table 14.6 Volume Model Parameters

	Minimum	Maximum	Model Extent
Easting	19000	20760	1760
Northing	19500	21000	1500
RL	4000	6000	2000
X Dimension	10	20	-
Y Dimension	10	20	-
Z Dimension	5	10	-

The model was flagged for the base of complete oxidation and the top of fresh rock. Also included in the block model is the refractory category and other key parameters including rock type, alteration, density, accessory elements and estimation quantity variables including number of samples and number of holes used in the cell estimation.

The bulk density data used in the Wafi resource estimation was determined from the bulk density measurements available in the MMJV database. The total number of valid samples available was 8,484, of which 765 are located within the Wafi Domain. A review of the bulk density data collected by previous owners was reviewed and a representative dataset corrected and validated to address any identified issues.

The mean of each estimation domain was calculated based upon flagged bulk density samples. Each estimation domain was defined by lithology, alteration and oxidation state. Bulk density data for the Wafi deposit is summarised in Table .

Table 14.7 Bulk Density Values Assigned to Wafi Domains

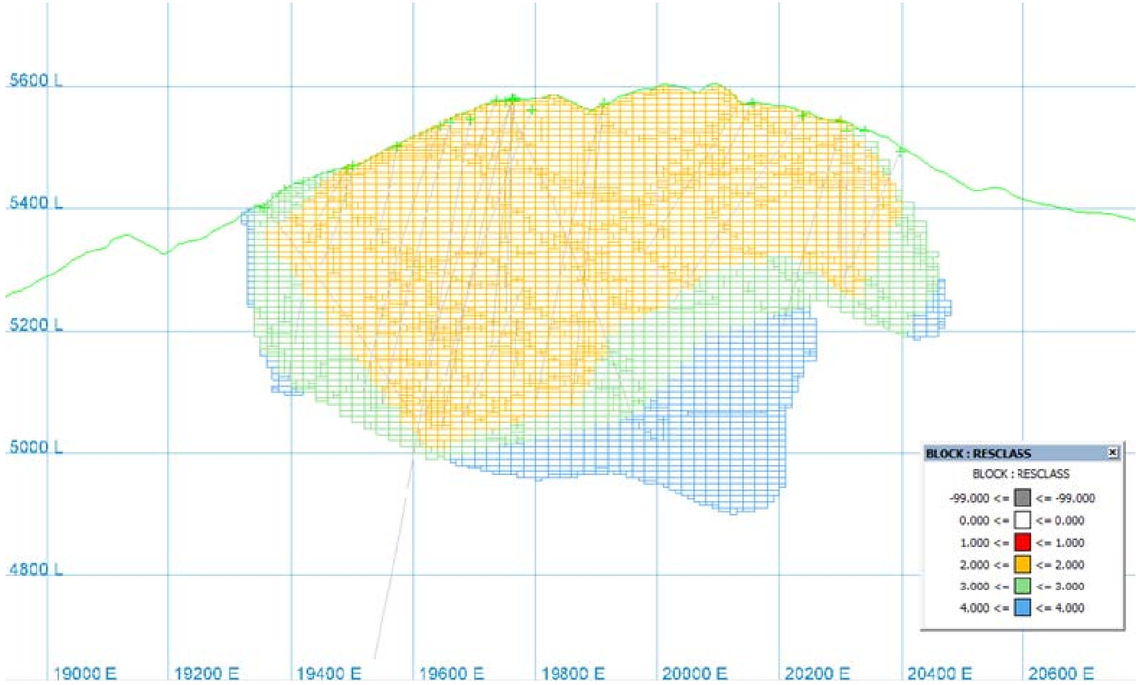
Domain	No. Samples	Minimum Density (t/m^3)	Maximum Density (t/m^3)	Mean Bulk Density (t/m^3)
Conglomerate	161	1.84	3.25	2.84
Argillic Sediments	563	1.35	6.44	2.52
Propylitic Sediments	22	2.4	2.94	2.66
Link zones	19	2.5	3.88	2.77
Argillic oxide	127	1.77	3.95	2.21
Argillic Transitional	38	1.55	3.27	2.33
Argillic Fresh	398	1.35	6.44	2.63
Conglomerate oxide	8	1.94	2.72	2.17
Conglomerate transitional	8	1.84	2.61	2.25
Conglomerate Fresh	145	1.95	3.25	2.51
Diatreme Oxide	201	1.21	5.55	2.21
Diatreme Transitional	53	1.9	3.32	2.45
Diatreme Fresh	214	1.18	6.68	2.63

For the surrounding metasediment host rock the bulk density was assigned a background bulk density default of 2.65 t/m^3 which is based upon a weighted average of all the specific gravity values.

14.1.4 Resource Classification

The Wafi Mineral Resource estimate was classified as Indicated and Inferred Resource. The model was classified using two separate wireframes, one for coding Inferred blocks and a second for coding Indicated blocks. Geostatistical parameters such as kriging efficiency and slope of regression were assessed to validate the interpreted wireframes and to assist the classification which has been based on the wireframes, sample density, confidence in the geological model and known continuity demonstrated in the mineralization. Figure 14.2 provides a north looking view of the Wafi Mineral Resource model. Where the reporting cut-off criteria are met, Indicated Resource blocks are coloured orange and Inferred Resource blocks are coloured green.

Figure 14.2 Resource Classification



Two cut-off grades have been used to report the Wafi Mineral Resource - these are dependent on the metallurgical recovery estimated from testwork in the Wafi Concept Study and anticipated processing cost differences between non-refractory gold (NRG) recovered by typical CIP/CIL processing and refractory gold (RG) that will have lower overall recoveries or will require pre-oxidation treatment. Cyanide solubility of gold, oxidation state and geochemistry were modelled to estimate the NRG/RG distribution within the Wafi model.

Non-refractory gold is reported at a cut-off grade of 0.4g/t Au and refractory gold is reported at a cut-off grade of 0.9g/t Au. These cut-off grades are based on US$1,400/oz gold price with modelled recovery and processing plus realisation costs derived from the Wafi Concept Study. The Wafi Mineral Resource is constrained within a notional spatial constraining pit shell at US$1,400/ounce gold.

An oxidised portion of the Golpu deposit is also included in the Wafi Mineral Resource where it is above the reporting cut-off gold grade and can be included in the Wafi notional spatial constraining pit shell.

14.2 Golpu Mineral Resource Estimate

The Golpu Mineral Resource estimate was revised in June 2012 (and reported in August 2012) using all available data from the on-going drilling program and the increased geological understanding of the Wafi-Golpu system. The revised Mineral Resource estimate was prepared in-house by WGJV geologists.

14.2.1 Geological Framework

The Golpu deposit is centred on porphyry-style mineralization within a larger epithermal and porphyry related complex hosted in metasediments. Two distinct Cu-Au mineralization events have been identified at Golpu. The dominant porphyry style mineralization forms upright mineralised zones centred on a multi-phase intrusive complex of ‘finger’ porphyry stocks and dykes hosted in the surrounding metasediments. At upper levels of the porphyry complex, an interpreted later, high sulphidation epithermal system including argillic and phyllic alteration zones has overprinted the porphyry mineralization forming a sheet-like draped ‘cap’ to the system.

The overall maximum dimension of the mineralised system as currently defined is approximately 800m north-south x 500m west-east and greater than 2,000m vertically from surface. The epithermal overprint occurs down to 250m below surface in the porphyry centre to approximately 600m depth on the eastern porphyry margin.

In the porphyry system, copper mineralization includes disseminated bornite and chalcopyrite cut by widely spaced chalcopyrite veins and veinlets. Sulphides are zoned through the alteration domains from the centre with bornite + chalcopyrite, chalcopyrite, chalcopyrite+pyrite ± molybdenite to a margin domain of pyrite only. The highest grades are associated with the most intense k-feldspar + biotite alteration, typically rich in bornite-gold and lesser covellite and digenite however chalcopyrite is by far the most abundant copper sulphide in the porphyry system. Cu-Fe sulphides occur both in fractures and as replacement of the primary igneous phenocrysts.

Hydrothermal alteration forms predictable zones from inner K-feldspar + biotite, to magnetite + biotite (potassic), outward to actinolite +- biotite (-albite-epidote) altered domains. Laterally the potassic assemblages transitions into propylitic assemblages that comprise chlorite (magnetite-rutile) replacement.

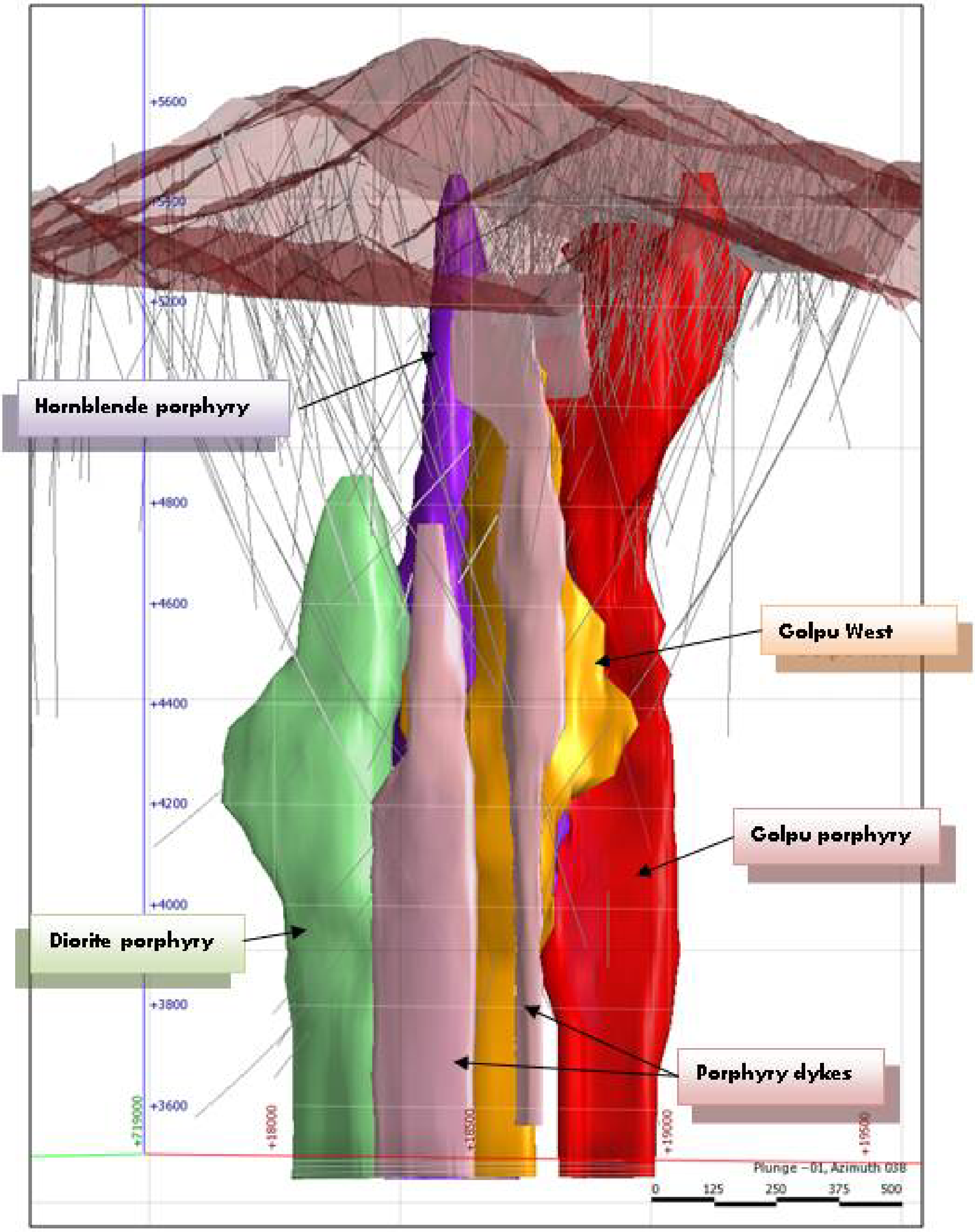
Outer chlorite-sericite alteration transitions upwards to sericitic (phyllic) replacement domains – these may represent the outer portion of the porphyry system and / or the overlying epithermal system.

Multiple mineralizing events have resulted in the juxtaposition of Cu-Au porphyry Cu and the Au-Ag epithermal mineralization.

The Wafi epithermal, high-sulphidation argillic alteration is characterized by vuggy quartz and massive quartz-alunite replacement, and extensive texturally destructive kaolinite-quartz (± alunite-pyrophyllite-dickite) alteration. Gold occurs within pyrite or as electrum associated with pyrite-enargite-tetrahedrite.

Within the porphyries, four spatial groupings – ‘Golpu’, ‘Golpu West’, ‘Hornblende Porphyry’ and ‘Diorite’, with three textural associations are recognised (felsic, coarse grained hornblende phenocrystic and quartz-eye bearing). Some porphyries are vertical ‘finger’ stocks but dykes are common. The metasediment unit has not been modelled as it represents the host lithology surrounding the porphyries (Figure 14.3).

Figure 14.3 Porphyry Wireframes, Viewed from Grid Southwest



Alteration associated with the porphyry complex is based on indicator minerals including k-feldspar, biotite + magnetite, biotite and actinolite alteration. The actinolite indicator mineral shell was used as the outer limit of the porphyry mineralised system below the epithermal alteration. Alteration associated with the high sulphidation overprint includes advanced argillic, phyllic and high sulphur – combined lower portion of the high sulphidation with the outer pyritic shell of the porphyry system.

Fault wireframes include the two east-over-west reverse faults on the upper eastern portion of the deposit (Hekeng Faults) and the significant Reid Fault of similar orientation which displaces the upper Golpu mineralization approximately 100m up-dip and probably 100-200m south. Sub-vertical faults to the west and to the east (Dokaton and Raffertys Faults) may be mineralization bounding faults but drill intercepts in these areas are insufficient to define these margins.

Sulphide distribution shells compiled from logging records include the bornite containing core, chalcopyrite greater than 3%, chalcopyrite greater than 1%, chalcopyrite greater than trace, and a covellite bearing volume formed within the high-sulphidation epithermal influence volume.

Oxidation surfaces have been modelled at the base of complete oxidation (BOCO) and the top of fresh rock (TOFR).

The geological model for the Golpu Mineral Resource estimate includes lithology, alteration, sulphide distribution, oxidation, and major structures. All combinations of lithology, alteration, sulphide distribution and faulting were assessed for use as estimation domains.

14.2.2 Compositing and Domaining

Sample intervals were not uniformly assayed for all elements so separate composites were generated for each element (Au, Cu, Mo, As, Ag, S). Assays were composited to 10m.

The method of selecting appropriate estimation domains was an iterative process based on contact boundary analyses, summary statistics and the spatial location/geometry of the geology wireframes. Importantly during this process the results were verified against the accepted genetic model for Golpu including alteration relationships.

Key assessments included:

- testing for Diffusivity;
- testing for the Proportional Effect;
- Contact Analysis;
- variogram comparisons; and
- top cut assessment.

Key findings were that there are no sharp boundaries at the lithology boundary, the grade distribution is diffusive and that a proportional effect is present. These outcomes have a direct result in the estimation and modelling method selected.

The estimation domains determined for gold and copper estimation are summarized in Table 14.8. Grades were also estimated for silver, molybdenum, arsenic and sulphur with estimation domains determined using a similar approach but alternative alteration shells. Silver was estimated in the same domains as molybdenum (Table 14.9).

Table 14.8 Copper and Gold Estimation Domains

Estimation Domain	Au Code	Cu Code
Above BOCO surface and west of Hekeng Fault	2001	1001
Above Advanced Argillic surface and below BOCO	2002	1002
Inside Actinolite shell, below Advanced Argillic surface and above Reid Fault	2004	1004
Inside Actinolite shell and below Reid Fault	2005	1005

Table 14.9 Silver Estimation Domains

Estimation Domain	Ag Code
Above BOCO surface and west/below Hekeng Fault	6001
Above Hekeng Fault	6002
Inside Advanced Argillic or Phyllic altered volume	6003
Inside Actinolite shell and below phyllic alteration	6004

Composite statistics for gold, copper and silver for 10m composites are listed by estimation domain in Tables 14.10 to and 14.12 respectively.

Table 14.10 Composite Statistics for Gold for 10m Composites – Not declustered

Domain	Count	Minimum (g/t Au)	Maximum (g/t Au)	Mean (g/t Au)	Standard Deviation	Coefficient of Variation
Au2001	1291	0.003	9.107	0.472	0.693	1.468
Au2002	653	0.003	3.074	0.271	0.270	0.996
Au2004	2794	0.036	10.307	0.476	0.452	0.95
Au2005	1587	0.03	12.122	0.732	1.034	1.413

Table 14.11 Composite Statistics for Copper for 10m Composites

Domain	Count	Minimum (g/t Cu)	Maximum (g/t Cu)	Mean (g/t Cu)	Standard Deviation	Coefficient of Variation
Cu1001	1211	0.0005	2.294	0.024	0.110	4.583
Cu1002	649	0.001	7.145	0.490	0.734	1.749
Cu1004	2795	0.008	6.266	0.84	0.563	0.893
Cu1005	1575	0.009	5.583	0.948	1.059	1.085

Table 14.12 Composite Statistics for Silver for 10m Composites

Domain	Count	Minimum (g/t Ag)	Maximum (g/t Ag)	Mean (g/t Ag)	Standard Deviation	Coefficient of Variation
Ag6001	1204	0.05	83.6	2.798	5.931	2.120
Ag6002	576	0.05	18.85	0.731	1.669	2.283
Ag6003	2531	0.05	64.4	1.943	3.297	1.697
Ag6004	3783	0.05	12.6	0.978	0.983	1.005

14.2.3 Grade Estimation

Grades were estimated into a block model using ordinary kriging honouring the estimation domains and using parameters derived from a study of variography. The only exception is inverse distance squared (ID2) was used for the estimation of oxide domains – Au2001 and Cu1001. Variograms were calculated and modelled for gold, copper, silver, molybdenum, sulphur and arsenic.

Variograms were calculated in the horizontal plane, across strike and in the plane of maximum continuity. The nugget component was derived from down hole variograms using a lag of 10m.

All domains generated well structured, easily interpretable variograms in orientations consistent with known geology. The nugget is typical low. The variography orientation for the porphyry domains is more east-west than the elongation northwest-southeast in the porphyry wireframes for the semi-major axis but it is possible that this reflects the strong west–east drilling bias. For the main porphyry domains (inside Actinolite shell), variography was developed on the total domain – not divided at the Reid Fault.

Variogram models for gold, copper and silver are listed in Tables 14.13 to 14.15.

Table 14.13 Variogram Models for Gold 10m Composites

Domain	Relative Nugget %	Relative Sill %	Range (m) First Structure			Relative Sill %	Range (m) Second Structure		
			Major	Semi - Major	Minor		Major	Semi-Major	Minor
Au2001	ID2								
Au2002	13	10.5	45	45	45	76.5	540	540	300
Au2004	7.1	17.9	70	70	70	75.0	150	80	80-
Au2005	7.1	17.9	50	50	50	75.0	150	80	80

Table 14.14 Variogram Models for Copper 10m Composites

Domain	Relative Nugget %	Relative Sill %	Range (m) First Structure			Relative Sill %	Range (m) Second Structure		
			Major	Semi-Major	Minor		Major	Semi-Major	Mino r
Cu1001	ID2								
Cu1002	12.2	25.0	70	70	70	62.8	800	540	350
Cu1004	3.0	29.9	200	120	120	67.2	700	450	300
Cu1005	3.0	29.9	200	120	120	67.2	700	450	300

Table 14.15 Variogram Models for Silver 10m Composites

Domain	Relative Nugget %	Relative Sill %	Range (m) First Structure			Relative Sill %	Range (m) Second Structure		
			Major	Semi-Major	Minor		Major	Semi-Major	Minor
Ag6001	13.6	26.4	30	30	30	60	450	450	100
Ag6002	17.3	26.8	120	50	50	55.8	485	100	100
Ag6003	17.1	40.2	70	70	40	42.7	660	660	250
Ag6004	8.5	36.0	130	35	35	55.5	660	550	550

Details of the volume model are listed in Table 14.16.

Table 14.16 Volume Model Parameters

	Minimum	Maximum	Model Extent
Easting	19600	20920	1320
Northing	720300	721620	1320
RL	3500	5980	2480
X Dimension	10	40	-
Y Dimension	10	40	-
Z Dimension	10	40	-

In the estimation of gold and copper grades, the search ellipse and composite selection parameters reflect the ranges and anisotropy indicated by the variography. The search ellipse and composite selection parameters for gold and copper are listed in Tables 14.17 and 14.18 respectively. A second estimation pass with reduced maximum samples was required to prevent 'screening' from excessive negative weights in some domains while increased search distances were required for some elements as a second estimation pass.

Table 14.17 Search Ellipse Parameters for Gold Estimation

		Search Ellipse						Number of Composites		
Domain	Pass	Bearing	Plunge	Dip	Major	Semi-Major	Minor	Min	Max	Per Hole
Au2001	1	0	0	0	200	120	60	10	20	4
Au2002	1	0	0	-45	340	340	125	12	24	4
Au2004	1	120	85	90	700	450	300	10	20	8
Au2004	2	120	85	90	700	450	300	10	15	8
Au2005	1	1	120	85	90	700	450	300	10	20

Table 14.18 Search Ellipse Parameters for Copper Estimation

		Search Ellipse						Number of Composites		
Domain	**Pass**	**Bearing**	**Plunge**	**Dip**	**Major**	**Semi-Major**	**Minor**	**Min**	**Max**	**Per Hole**
Cu1001	1	0	0	0	200	120	60	10	20	4
Cu1002	1	106	15	42	200	200	200	12	24	4
Cu1002	2	106	15	42	200	200	200	8	8	4
Cu1004	1	120	85	90	700	450	300	10	20	8
Cu1004	2	120	85	90	700	450	300	10	10	6
Cu1005	1	120	85	90	700	450	300	10	20	8
Cu1005	2	120	85	90	700	450	300	10	10	6

The silver search ellipse and composite selection parameters are summarised in Table 14.19.

Table 14.19 Search Ellipse Parameters for Silver Estimation

		Search Ellipse						Number of Composites		
Domain	**Pass**	**Bearing**	**Plunge**	**Dip**	**Major**	**Semi-Major**	**Minor**	**Min**	**Max**	**Per Hole**
Ag6001	1	30	0	-45	450	450	250	10	20	5
Ag6001	2	30	0	-45	1,200	1200	650	4	20	5
Ag6002	1	22.2	-20.7	-41	800	170	170	10	20	5
Ag6002	2	22.2	-20.7	-41	1600	340	340	10	20	5
Ag6003	1	23	0	-45	350	350	200	10	20	5
Ag6003	2	23	0	-45	600	600	300	10	20	5
Ag6004	1	210	-90	0	660	550	275	10	20	8

Density was assigned to the block model based on mean values determined by oxidation, lithology, and alteration domains (Table 14.20).

Table 14.20 Mean Bulk Densities by Lithology and Alteration

Domain	**Mean (t/m^3)**
Oxide	2.37
Transitional	2.57
Argillic overprint	2.75
Phyllic[1]	2.67
Golpu Porphyry[1]	2.61
Hornblende Porphyry & Golpu West Porphyry[1]	2.71
Metasediments[1]	2.71
Diorite Porphyry	2.64

[1] Below argillic overprint

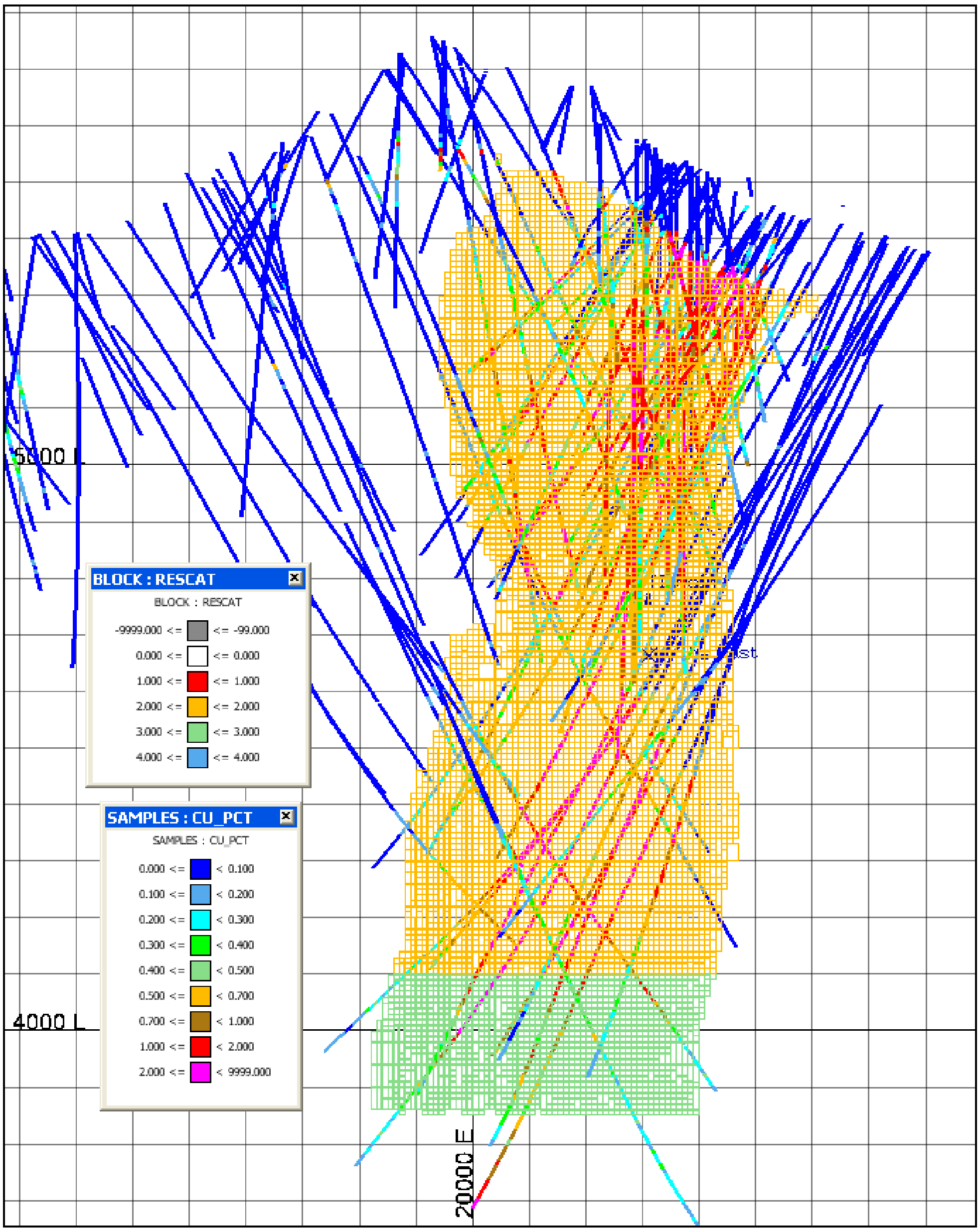
14.2.4 Mineral Resource Classification

The Golpu Mineral Resource estimate has been classified as Indicated and Inferred Resources based on:

- Drill hole density and geological and grade continuity;
- Inside 0.2% Cu grade shell. An enclosing shell was constructed over the estimated blockmodel cells above 0.2% Cu but which includes internal waste and the exclusion of isolated, above-cutoff blocks. This reflects the planned bulk mining method;
- Average Weighted Distance to samples. Percentage of total variance in modelled variograms was used as a guide to reliability with distance - 60% for a guide to Indicated confidence and 80% as a guide to Inferred. For the selected and reported Indicated Mineral Resource, less than 5% of tonnage and contained metal was more than 200m average weighted distance from informing drill hole composites. Similarly, for the reported Inferred classification, less than 5% tonnes and contained metal was more than 300m from average weighted distance from informing drill hole composites.

Using the above review criteria, the Golpu Mineral Resource estimate is reported as Indicated if the material is within a modelled 0.2% Cu shell and above 4100mRL and below the Advanced Argillic surface. Inferred Mineral Resource includes material within the 0.2% Cu shell between 3850mRL and 4100mRL. This is depicted in Figure 14.4.

Figure 14.4 Resource Classification Section 721000N



Indicated (orange) and Inferred (green) resource blocks at Golpu – Drill holes coloured by copper grade. The section width depicted is +-300m.

The Golpu Mineral Resource and Ore Reserve estimates have also been the subject of independent external review by AMC Consultants Pty Ltd. No material issues have been identified in these reviews and AMC concluded that the estimates have been prepared using accepted industry practice and have been classified and reported in accordance with the JORC Code.

In the QP's opinion, the Mineral Resource estimates have been competently conducted using reasonable and appropriate parameters and estimation methods. The QP is not aware of any circumstance that could materially affect the Mineral Resource estimates.

14.3 Nambonga Mineral Resource Estimate

The Nambonga Mineral Resource estimate was completed by WGJV in 2008 based on drilling available at that time and is presented in Table 14.21.

Table 14.21 Nambonga Mineral Resource Estimate

	Tonnes (Mt)	Gold (g/t)	Copper (%)	Contained Gold (Moz)	Contained Copper (Mt)
Inferred Resource	40	0.79	0.22	1.0	0.09

14.3.1 Interpretation and Domaining

Five domains were defined based on mineralization, alteration and lithological characteristics:

- mineralized porphyry core (Domain 1)
- hanging wall porphyry (Domain 2)
- footwall porphyry (Domain 3)
- massive sulphide (Domain 4)
- stockwork (Domain 5).

Only Domain 1 is reported as Mineral Resource.

The mineralized porphyry core was defined based on lithological boundaries, interpreted structural domains, vein density, alteration and gold assay values greater than 0.35 g/t Au. Intense alteration and stockworks, particularly in the upper part of the porphyry obscures the original lithology. Where the original host rock is not apparent, the gold grade and intensity of quartz stockwork was used to define the contact between the mineralized porphyry and the surrounding metasediment.

The stockwork domain surrounds the mineralized porphyry core and is hosted in phyllic-altered and stockwork veined metasediment with the boundary determined by lithological logging and geological interpretations.

The hanging wall porphyry is primarily defined by lithological logging on the hanging wall of the massive sulphide structure which cuts through the Nambonga porphyry.

The footwall porphyry is essentially all other porphyry bodies on the footwall side of the massive sulphide that is greater than 0.35 g/t Au.

The massive sulphide domain is defined by the high grade intercepts of lead, zinc and silver correlation of intercepts across section. It is a near vertical crosscutting structure that appears to have formed much later than the porphyry intrusion and associated mineralization. The presence of hetero-lithic breccias and slickensides within the massive sulphide structural zone implies reactivation of fluid pathways and the host faults.

14.3.2 Compositing and Statistics

The wireframes of the mineralization domains were used to select and flag drill hole samples. Assays were composited to 2m. The porphyry domains are characterized by a good correlation between gold and copper. Base metal correlations are variable, probably due to the nature of the mineralization in veins and structures.

The mineralized porphyry domain displays higher grade gold and copper, relative to the other porphyry domains. All porphyry domains have low coefficients of variance for gold and copper. All of the elements show positively skewed grade distributions.

The massive sulphide domain comprises most of the high grade lead, zinc and silver. Coefficients of variance for all elements are moderate, reflecting more variable gold and copper than other domains, but relatively lower coefficients of variance for base metals.

The stockwork domain is characterized by low grade gold and copper mineralization. The gold and copper grades have a positively skewed distribution and a low coefficient of variance. The base metal grades have a high coefficient of variance due to some high grades, probably in veins and structures of a later phase of mineralization cutting the porphyry.

Summary statistics of 2m composites by geological domain are listed in Tables 14.22 to 14.26.

Table 14.22 Summary Statistics of 2m Composites, Mineralized Porphyry Core

Domain 1	**Au (g/t)**	**Cu (%)**	**Ag (g/t)**	**Pb (%)**	**Zn (%)**
Number	1034	1033	1033	1033	1033
Minimum	0.12	0.01	0.15	0.000	0.004
Maximum	8.79	0.85	77.90	1.36	7.08
Mean	0.85	0.24	2.76	0.02	0.07
Standard Deviation	0.56	0.13	6.17	0.10	0.39
Coefficient of Variance	0.66	0.54	2.24	5.91	5.87

Table 14.23 Summary Statistics of 2m Composites, Hanging Wall Porphyry

Domain 2	**Au (g/t)**	**Cu (%)**	**Ag (g/t)**	**Pb (%)**	**Zn (%)**
Number	329	329	329	329	329
Minimum	0.05	0.01	0.10	0.000	0.004
Maximum	1.78	1.25	212.70	11.85	7.71
Mean	0.45	0.14	1.41	0.04	0.04
Standard Deviation	0.31	0.13	11.74	0.65	0.43
Coefficient of Variance	0.68	0.87	8.31	17.18	12.00

Table 14.24 Summary Statistics of 2m Composites, Footwall Porphyry

Domain 3	Au (g/t)	Cu (%)	Ag (g/t)	Pb (%)	Zn (%)
Number	344	344	343	344	344
Minimum	0.02	0.01	0.10	0.000	0.004
Maximum	2.75	0.67	26.85	0.56	2.75
Mean	0.29	0.08	1.29	0.01	0.05
Standard Deviation	0.29	0.07	2.44	0.05	0.19
Coefficient of Variance	1.00	0.94	1.89	4.25	3.73

Table 14.25 Summary Statistics of 2m Composites, Massive Sulphide

Domain 4	Au (g/t)	Cu (%)	Ag (g/t)	Pb (%)	Zn (%)
Number	112	112	109	112	112
Minimum	0.10	0.01	0.10	0.000	0.005
Maximum	22.37	0.90	287.07	5.09	16.59
Mean	2.38	0.10	22.21	0.46	1.98
Standard Deviation	4.00	0.13	43.24	0.77	3.18
Coefficient of Variance	1.68	1.40	1.95	1.69	1.61

Table 14.26 Summary Statistics of 2m Composites, Stockwork

Domain 5	Au (g/t)	Cu (%)	Ag (g/t)	Pb (%)	Zn (%)
Number	250	250	250	244	250
Minimum	0.05	0.02	0.10	0.000	0.005
Maximum	1.95	0.29	26.52	1.64	4.95
Mean	0.27	0.09	0.77	0.02	0.06
Standard Deviation	0.24	0.04	1.98	0.12	0.36
Coefficient of Variance	0.87	0.50	2.57	8.01	6.06

The need for top cuts was determined by examining frequency distributions and calculating the metal contribution of the upper percentile of the data. The top cuts applied to each element in each domain are listed in Table 14.27.

Table 14.27 Top Cuts

Domain	Value	Number Composites	Top Cut	Number Cut	Uncut Mean	Cut Mean
1	Zn	1033	5.2	2	0.07	0.064
2	Ag	329	111.3	1	1.41	1.10
	Pb	329	6.0	1	0.04	0.02
	Zn	329	3.9	1	0.04	0.02
3	Ag	343	22.8	1	1.29	1.27
	Pb	344	0.26	3	0.01	0.01
	Zn	344	0.93	2	0.05	0.05
4	Ag	109	186.0	2	22.2	20.6
	Pb	112	4.0	1	0.46	0.45
	Zn	112	14.1	1	1.98	1.95
5	Ag	250	9.9	2	0.77	0.68
	Pb	244	0.58	2	0.02	0.01
	Zn	250	0.54	4	0.06	0.03

14.3.3 Grade Estimation

Grades were estimated using Ordinary Kriging with parameters determined from a study of variography. Omnidirectional variograms were modelled using spherical models for gold, copper, silver, lead, and zinc in Domains 2 to 5. Normal scores transformed variograms were calculated for Domain 1 and back transformed.

The variograms of each element were grouped together according to their correlation. Gold and copper were estimated using the same variogram model as were silver, lead and zinc. Grades were estimated for all domains but only Domain 1 (mineralized porphyry core) is reported as a Mineral Resource. The variogram models for Domain 1 are listed in Table 14.28.

Table 14.28 Variogram Parameters for Domain 1

Value	Relative Nugget (%)	Relative Sill (%)	Range 1	Relative Sill (%)	Range 2	Major/ Semi Major	Major/ Minor
Au	0.28	0.43	100	0.29	250	1.56	1.78
Cu	0.23	0.46	80	0.31	200	1.17	1.48
Ag	0.36	0.58	80	0.07	220	1.33	2
Pb	0.47	0.48	105	0.05	150	1	1.5
Zn	0.48	0.4	110	0.12	280	1.75	2.54

Details of the volume model are listed in Table 14.29.

Table 14.29 Volume Model Parameters

	Minimum	Maximum	Model Extent
Easting	40000	40720	720
Northing	79700	80300	600
RL	350	1510	1160
X Dimension	1.25	40	-
Y Dimension	1.25	40	-
Z Dimension	1.25	20	-

Average bulk densities were assigned to the model based on 277 determinations from Nambonga drill core, of which 132 were in porphyry and massive sulphide domains (Table 14.30). The hanging wall porphyry was assigned the same density as the footwall porphyry.

Table 14.30 Bulk Densities Assigned by Domain

Domain	No. of Samples	Mean (t/m3)
1	79	2.78
2*	0	2.731
3	7	2.73
4	23	3.19
5	23	2.87

*Domain 2 was assigned the same density as Domain 3

14.3.4 Mineral Resource Classification

Only the estimate for Domain 1 (mineralized porphyry core) is classified as Inferred Mineral Resource to reflect the confidence in the geological model and the drill hole spacing. The Nambonga Mineral Resource estimate is reported within the geological constraint of the mineralized porphyry core without applying a cut-off on model grades. The estimate has been developed around an interpretation at a nominal 0.35 g/t Au cut-off. Any possible mining would likely be by a non-selective block cave method.

15 MINERAL RESERVE ESTIMATES

A Mineral Reserve estimate for the Golpu deposit was developed from the results of the Golpu PFS for the Golpu deposit using the concurrent Mineral Resource estimate. The Mineral Reserve estimate is reported as being current at 29 August 2012.

15.1 Golpu Mineral Reserve

Mineral Reserves are those portions of Mineral Resources which, after the application of all mining factors, result in an estimated tonnage and grade which, in the opinion of the Qualified Person, can be the basis of a viable project, after taking account of all relevant modifying factors.

The updated Golpu Mineral Reserve is estimated to contain 12.4 million ounces of gold, 5.4 million tonnes of copper and 19.7 million ounces of silver and comprises Lift 1 and Lift 2 of the Golpu block cave mine design considered in the August Golpu PFS. The Golpu Mineral Reserve summarised in Table 15.1.

Table 15.1 Mineral Reserve Estimate for the Golpu Deposit

	Tonnes (Mt)	Gold (g/t)	Copper (%)	Silver (g/t)	Contained Gold (Moz)	Contained Copper (Mt)	Contained Silver (Moz)
Probable Reserve	450	0.86	1.2	1.4	12.4	5.44	19.7

The Mineral Reserve has been classified and reported in accordance with the JORC Code. There are no material differences between the definitions of Proven and Probable Mineral Reserves under the CIM Definition Standards and the equivalent or corresponding definitions in the JORC Code.

The Mineral Reserve estimate presented in Table 15.1 is reported in 100% terms. Newcrest has a 50% beneficial interest in these reserves. The Golpu Indicated Mineral Resource estimate is inclusive of the Golpu Probable Mineral Reserve estimate.

15.2 Mineral Reserve Estimate Assumptions

The magnitude and grade of the Mineral Reserve for Golpu was estimated by reference to the estimated optimum lateral and vertical extents of the minable block. The mining method selected for the deposit is block caving.

Block caving has been selected as the preferred mining method for the following reasons:

- orebody geometry and indicative geotechnical conditions are suited to block caving;
- block caving is a high productivity, low cost mining method;
- higher value material located at depth can be accessed earlier; and
- block caving will deliver the largest reserve outcome and with the highest resource to reserve conversion compared with other mining methods.

The quantity of material within a block cave mine that will eventually be extracted is determined by the block cave footprint (the lateral extents), and the height of draw (the vertical extents).

15.2.1 Financial Assumptions

The 2012 Golpu Mineral Reserve estimate was developed using prices of US$1,250/oz gold and US$3.10/lb copper.

15.2.2 Assumptions Used to Develop Caving Footprint

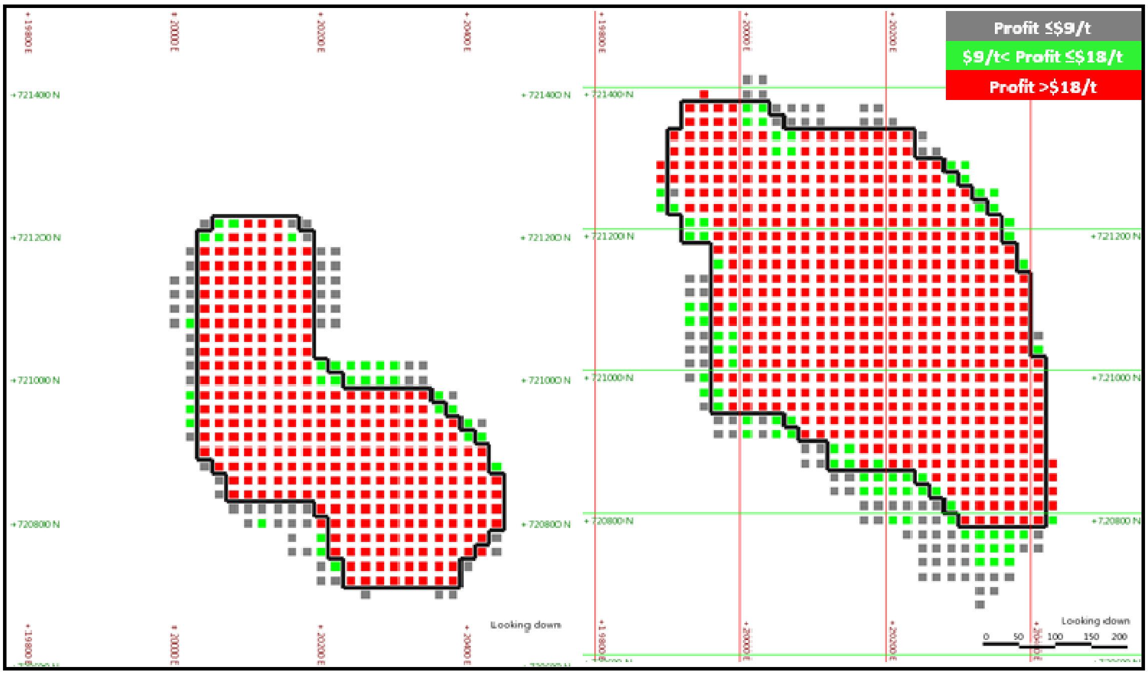
The assumptions used to determine the optimum block cave footprint and height of draw are summarised in Table 15.2.

Table 15.2 Key Parameters for Determining Block Cave Footprint

Item	Unit	Value
Gold Price	US$/oz	1,250
Copper Price	US$/lb	3.10
Mining Cost	US$/t	7.0
Processing Cost	US$/t	8.0
Concentrate Treatment	US$/t	80
Concentrate Shipping	US$/t	46
Drawpoint Establishment	US$/m^2	3,000

The block cave footprints determined for Lift 1 and Lift 2 are illustrated in Figure 15.1.

Figure 15.1 Block Cave Footprints: Lift 1 4850mRL – left; Lift 2 4100mRL - right



15.2.3 Costs and Process Recoveries for Financial Analysis

Mineral Reserves have been classified using a net value, rather than a cut-off grade, to take into account the contributions of both gold and copper. The cut-off value used for this estimate is US$18/t.

Costs used to prepare the Mineral Reserve estimate were based on estimates developed in the Golpu PFS. A mining unit cost of US$8.64/t was estimated using the block cave design adopted in the PFS. A processing unit cost, derived from first principles, of US$7.39/t was estimated.

Metallurgical recoveries adopted for the Mineral Reserve estimate are summarised in Table 15.3.

Table 15.3 Estimated Processing Recoveries by Metallurgical Domain

Metallurgical Domain	Cu Recovery (%)	Au Recovery (%)
Advanced Argillic	86.1	36.9
Supergene	89.9	65.6
Porphyry - Within High Sulphur zone	90.0	51.3
Porphyry - Below High Sulphur zone	94.5	71.7
Metasediment - Within High Sulphur Zone (above Reid)	85.0	34.9
Metasediment - Bt/Ab/Ksp/Py (above Reid)	87.9	30.2
Metasediment - Alu/Jar (above Reid)	71.8	34.1
Metasediment - Bt/Ab/illite/Ser (above Reid)	45.6	8.1
Metasediment - Bt/Ab/illite/Ser (below Reid)	82.0	15.7
Metasediment - Bt/Ab/Plag/Kspar	95.9	63.6
Metasediment - Ab/Ser/Bt	90.3	18.7
Metasediment - Bt/Ab/K feldspar	93.2	36.0

Whilst individual ore types have been characterised from a metallurgical perspective, it is noted that the dynamics of the block caving mining method result in varying degrees of mixing of ore types as extraction proceeds. The PFS estimated an average gold recovery of 61% and an average copper recovery of 93% based on the mine schedule. Metallurgical recoveries are yet to be optimised. Further testwork programs are proposed during the Feasibility Study phase of the project with the objective of improving gold recovery and enhancing metallurgical performance of the concentrator.

15.2.4 Mine Design and Evaluation

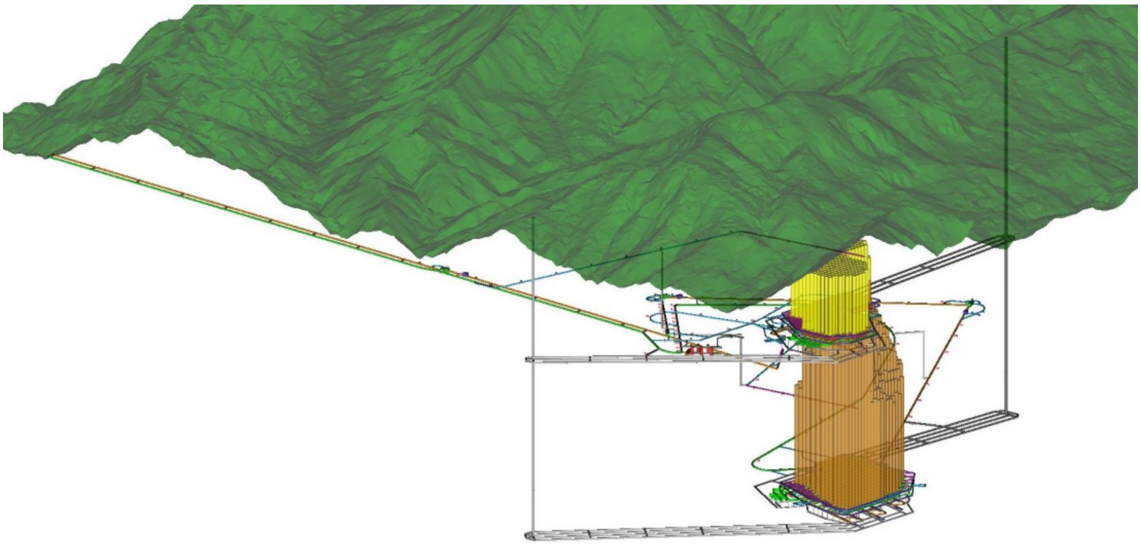
The size of the block cave footprint for each lift was determined based on the number of drawpoints required, the optimal location for extraction levels, and the optimum height of draw, the computer program Block Caving®, a specialist cave mining software tool, was used for this analysis. The estimation process considered the Mineral Resource geometry and grade, geotechnical factors, mining factors, estimated metallurgical recoveries, commodity prices and estimated costs for mining and processing.

The analysis generates a net smelter return (NSR) model. Each parcel of ore within the model was ascribed a value equivalent to the recoverable value of the contained metals net of recovery costs, exclusive of mining costs. For estimation of Mineral Reserve, no economic value was ascribed to Inferred Resource and unclassified material so that the optimum cave footprint would be developed by reference to the Indicated Mineral Resource only.

The NSR value and mining costs were used to estimate the elevation and size of potential block cave footprints that optimized overall value. At each elevation in the block model the program searched for economic columns of rock. The results of each elevation scenario were compared to determine the optimum location for the extraction levels for the block cave. The scenario that contained the highest recoverable value, after deduction of costs, was selected for the mine design and Mineral Reserve estimate.

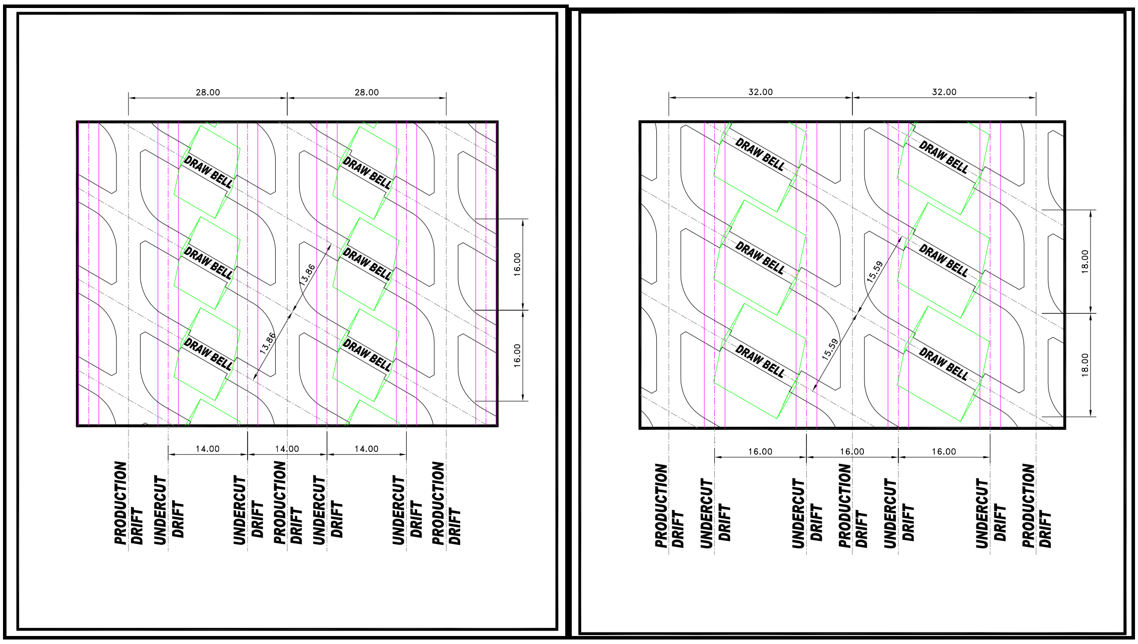
Mine designs and schedules were developed using Mine 2-4D and EPS software, with benchmarked rates used to schedule all key mining activities. An isometric of the mine design is illustrated in Figure 15.2.

Figure 15.2 Isometric of Golpu Design



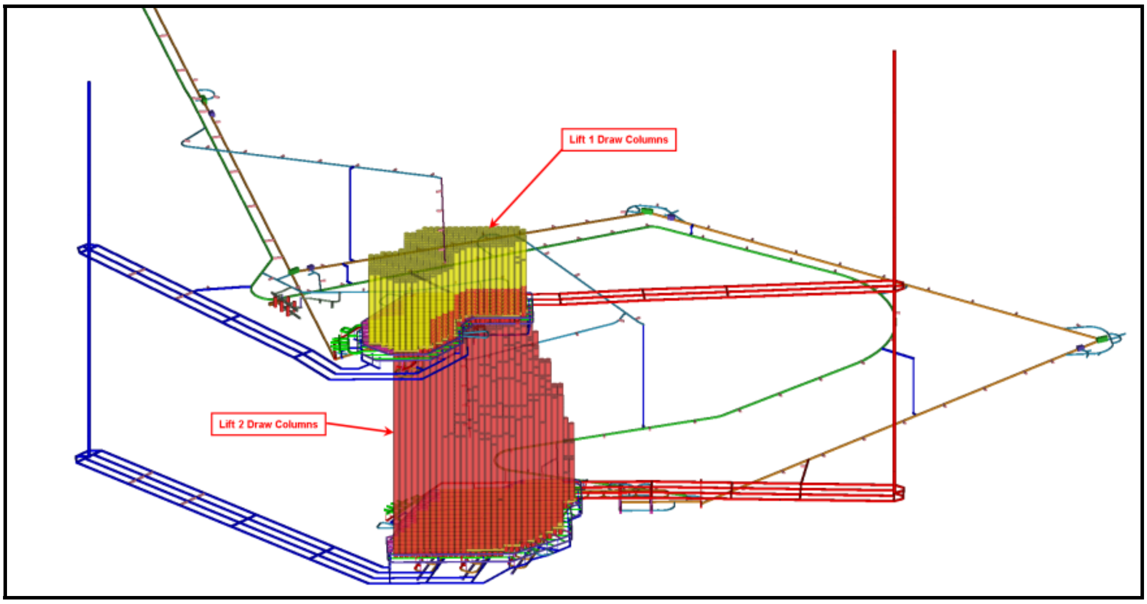
Drawpoints were located at an average frequency of one drawpoint every 225 m^2 in Lift 1 and an average frequency of 270m^2 in Lift 2. This is illustrated in Figure 15.3.

Figure 15.3 Golpu Drawpoint Layout Design (Lift 1- left, Lift 2 – right)



The maximum column heights for Lift 1 (250m) and Lift 2 (750m) are illustrated in Figure 15.4, which also shows the overdraw from Lift 2 of 100m resulting in a maximum height of draw for Lift 2 of 850m (including overdraw).

Figure 15.4 Golpu Block Cave showing Lift 1 and Lift 2



All material within the resultant cave footprint was reported. Inferred Mineral Resource and unclassified material located within the cave footprint was treated as diluting material and included in the estimate at its originally ascribed grades. This is appropriate for the block cave mining method as it is not possible to segregate this diluting material from the Mineral Reserve component during mining and processing.

15.2.5 Checks on Estimation

The Qualified Person commissioned AMC Consultants Pty Ltd to conduct a review of the drilling, sampling and analytical processes and associated Quality Assurance / Quality Control procedures that were relied upon to support the new estimates. The Golpu Mineral Resource and Ore Reserve estimates have also been the subject of independent external review by AMC. No material issues have been identified in these reviews and AMC concluded that the estimates have been prepared using accepted industry practice and have been classified and reported in accordance with the JORC Code.

16 MINING METHODS

16.1 Block Caving Mining Method

The Golpu PFS proposes the block caving mining method for the Golpu deposit. Block caving is a low cost bulk underground mining method, reflecting the relatively small proportion of the total Mineral Reserve that is subject to drilling and blasting and the amount of development required relative to total tonnes mined. Block caving involves construction of a regular pattern of drawpoints beneath drawbells across the orebody, either at the base of the orebody, or at a selected horizon, to form an extraction level. The pattern of drawpoints and drawbells defines the base of the column of rock to be extracted (the footprint). A thin slice of ore, generally about 15m above the drawbells (the undercut), is blasted and extracted. This undercuts the column of ore above the undercut, causing it to cave under gravity and mining induced stresses. Broken ore is extracted through the drawpoints via the drawbells. Orebodies of significant vertical extent subject to block caving can be sub-divided into more than one lift, with drawpoint and drawbell development, undercutting and extraction replicated at the base of each lift.

In block caving operations, establishment of most of the drawpoints in a given lift is completed during the production ramp up phase for the lift. The method requires significant initial capital investment prior to achieving the planned full production rate.

The PFS proposes that initial production from the Golpu deposit commences from Lift 1 while access development continues down to Lift 2. Lift 1 has an extraction horizon located at 4850mRL[6] (approximately 700m below surface) and a 250m column height. The extraction horizon for Lift 2 is located at 4100mRL (approximately 1,450m below surface) with a 750m column height. In the PFS, production from Lift 1 is scheduled to ramp up to 15Mtpa over a four year period commencing in 2019 with development of Lift 2 undercut and initial production scheduled to commence in 2024. Production from Lift 2 would progressively ramp up to reach 22Mtpa in 2029. Mining from Lift 1 would be suspended in 2028 with remaining ore from Lift 1 recovered through overdraw of Lift 2.

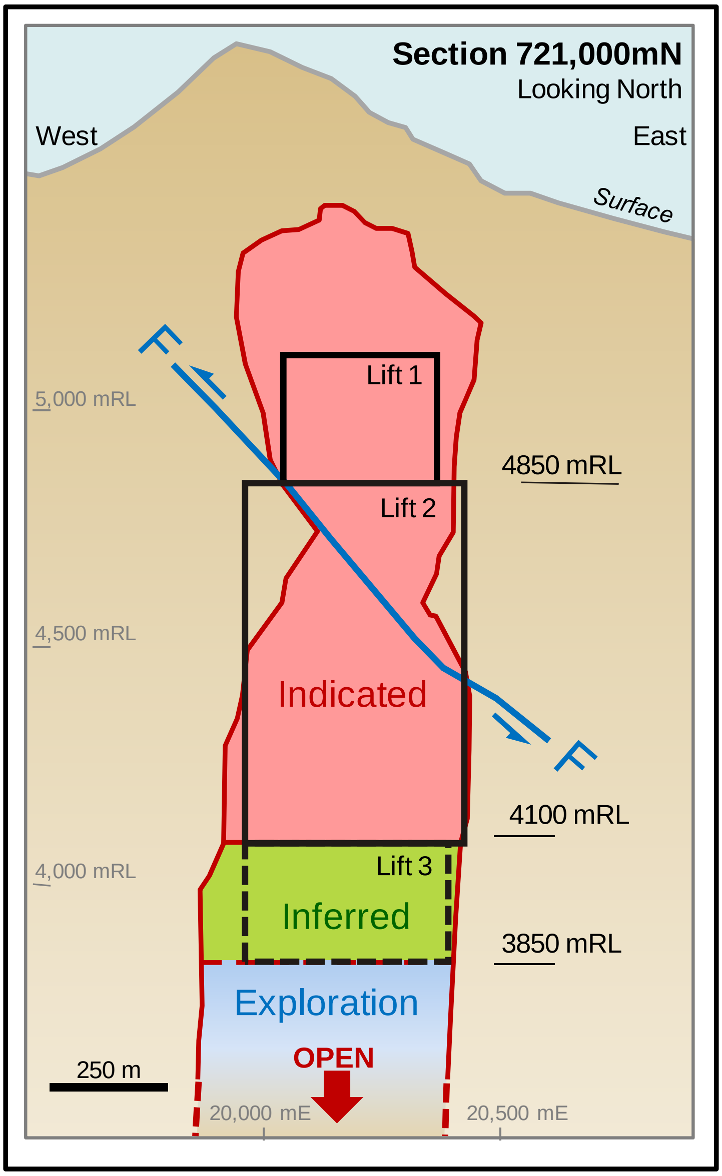
The dimensions of the Golpu block cave are summarized in Table 16.1 and a schematic section through the Golpu deposit showing Lifts 1 and 2 (and a potential Lift 3) is presented in Figure 16.1.

Table 16.1 Golpu Mineral Reserve Block Cave Dimensions

Lift Name	Base of Lift	Number of Drawpoints	Approximate Footprint Dimensions (m)	Nominal Block Height (m)	Depth Below Surface (m)
Lift 1	4850mRL	551	500 x 400	250	700
Lift 2	4100mRL	737	600 x 500	750	1,450

[6] *5,000m has been added to the national height datum to establish the local height datum.*

Figure 16.1 Schematic Cross Section of the Golpu Deposit Showing Lifts 1 and 2



16.2 Geotechnical and Hydrogeological Conditions

16.2.1 Geotechnical Conditions

The host rocks at Wafi-Golpu are comprised of inter-bedded conglomerate, sandstone, siltstone and mudstone of the Early Jurassic to Cretaceous Owen Stanley Metamorphic Complex. These beds have been metamorphosed to lower greenschist facies and are strongly deformed into a series of tight NE trending isoclinal folds. The host rocks have been intruded by Miocene-Pliocene calc-alkaline dioritic intrusives which are associated with the copper-gold mineralization.

Geotechnical domains have been based on the main lithological units and alteration zones. Seven geotechnical domains were identified during the Golpu PFS. Ranges of geotechnical parameters for each domain were developed from drill logs and core photographs as presented in Table 16.2. These parameters show a contrast in rock mass properties between the host rock and the intrusive units.

Table 16.2 Summary of Geotechnical Parameters

Domain	Intact Rock Strength (MPa)	RMR Laubscher's Rock Mass Rating (Range*)	Q' Tunnelling Quality Index (Range*)	GSI Geological Strength Index (Range*)
Partial Oxidation and Advance Argillic	1 - 25	10 (20) 30	0.1 – 2	10 – 20
Metasediments				
Argillic-Phyllic alteration	50 – 80	35 (40) 50	2 – 11	30 – 50
Potassic alteration	50 – 80	40 (45) 50	6 – 11	30 – 50
Golpu Porphyry				
Argillic-Phyllic alteration	50 – 80	40 (45) 55	6 – 30	50 – 60
Potassic alteration	50 – 80	40 (50) 60	6 – 30	50 – 60
Main Hornblende Porphyry	>120	60 (70) 80	30 – 65	70 – 90
Fault Intersection area	10 – 25	10 (15) 25	0.1 – 2	10 – 20
Faults	10 – 25	15 (20) 25	0.1 – 2	10 – 20

** Ranges reflect statistical lower and upper quartile rather than minimum and maximums. Numbers in brackets are averages*

16.2.2 Cavability

An assessment of the relative cavability of the different geotechnical domains has been completed using Laubscher's empirical cavability graph. In making this assessment the following are noted:

- The assessment relies on the understanding of the geometry of geotechnical domains and local geological structures. Further work is planned during the Feasibility Study to better understand the geometry of these domains.

- Whilst rock mass characterisation across the geotechnical domains is limited to ranges and relative comparisons of parameters, this still allows for assessment of the potential mechanics of cave propagation.

- The footprint for Lifts 1 and 2 are much larger than the hydraulic radius required to initiate the cave. In addition, preconditioning techniques will be reviewed, especially for the Hornblende and Golpu West Porphyries to assist cave propagation. Therefore the rock mass is expected to cave satisfactorily.

16.2.2.1 Fragmentation

A series of primary fragmentation curves was developed for the Hornblende Porphyry, Golpu Porphyry and Metasediments using the software package Block Cave Fragmentation (BCF). Secondary fragmentation curves were also developed for the Hornblende Porphyry. The following points are noted from the fragmentation assessment:

- The primary fragmentation of the Golpu Porphyry and Metasediments are at a range where no major productivity issues are envisaged. Therefore, it was not necessary to conduct a secondary fragmentation estimate for the PFS.

- The primary fragmentation curves predicted for the Hornblende Porphyry are coarse, suggesting the potential to impact productivity in the absence of additional measures being put in place. Therefore, a secondary fragmentation analysis has been completed.

The secondary fragmentation estimated for the Hornblende Porphyry is coarse. Hence, the potential implications for mining are:

- Cost estimates allow for sufficient secondary breakage equipment to handle oversize material;
- Dilution of the Hornblende Porphyry by finer fragmented domains (the Golpu Porphyry or Metasediments);
- Recognition in the mining schedule that application of preconditioning technologies may be required for the Hornblende Porphyry to get a finer fragmentation; and
- A slower ramp up rate could be expected in this area.

16.2.3 Hydrogeology

Water management will be important at Wafi-Golpu due to the potential for large inflows into the mine. The conceptual water model is based on:

- Rainfall in the range of 2m to 4m per year;
- Recharge estimated at between 5% and 20% of rainfall, flowing as shallow flow in the oxide zone (interflow), or recharging groundwater;
- Groundwater flows down gradient via faults;
- Mine areas are cut by faults along declines and either cut or bounded by larger fault systems (Rafferty's and Dokaton (northwest) faults).

Total expected inflows estimated in the PFS is summarised in Table 16.3. This is an initial estimate for the purposes of planning and mine design - further analysis and modelling of dewatering demand is planned during the Feasibility Study to increase confidence in the estimate.

Table 16.3 Summary of Expected Water Inflows

Mine Development	Lift (ARI y infiltration)	Inflow Estimates (l/s)
Pre block caving - dewatered mine area to base of Lift 2 (base flow)	Base Lift 2 at 4100mRL	900
Year 20 - Lift 2 enlarged cracking zone and mine void break through	(2 to 100 y ARI for 24 hour rainfall period)	1800 - 2700

ARI: Annual Recurrence Interval

With an assumed final cave disturbance cone of surface area approximately 40Ha and conceptual changes to rock mass drainage over time, an estimate of peak inflows against modelled events is presented in Table 16.4. This is based on application of the Rational Method for estimating peak inflow rates.

Table 16.4 Summary of Peak Flow Expectations

ARI (1 in N Year Event)	1	2	5	10	20	50	100
Minimum flow (l/s)	2.0	35	42	49	70	112	126
Maximum flow (l/s)	67	1,164	1,396	1,629	2,400	3,724	4,200
Expected flow (l/s)	10	175	210	244	349	559	628

The recommended dewatering strategy consists of three major elements:

- Surface water diversion to minimise rainfall migrating into the surface subsidence cone;
- River diversion to re-direct large scale river flow and prevent leakage into the mine via connections through Rafferty's Fault or direct intersection with the subsidence area;
- Installed pumping and storage capacity to deal with expected inflow rates;
- Options for large scale dewatering infrastructure are to be further assessed during the Feasibility Study.

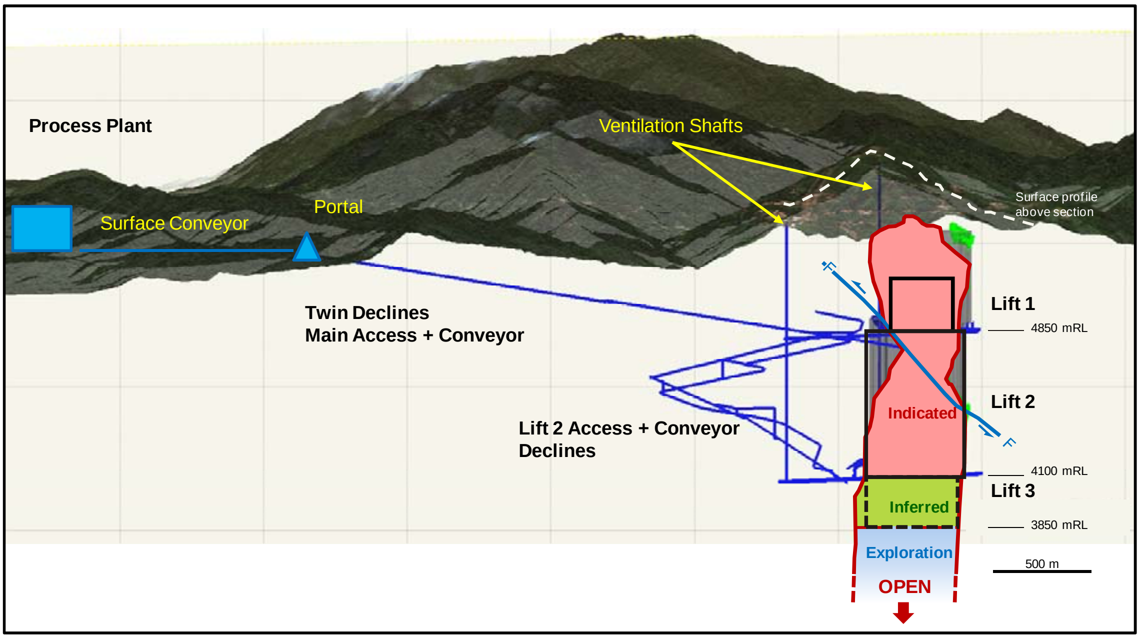
16.3 Mine Design and Layout

16.3.1 Overview

The mine design is divided into two main components:

The block cave design which comprises the design of the undercut, extraction, ventilation, haulage and drainage levels and the infrastructure design which comprises the accesses through ventilation shafts and declines, and major excavations. This infrastructure as proposed in the Golpu PFS is depicted in Figure 16.2.

Figure 16.2 Isometric Showing the Underground Infrastructure



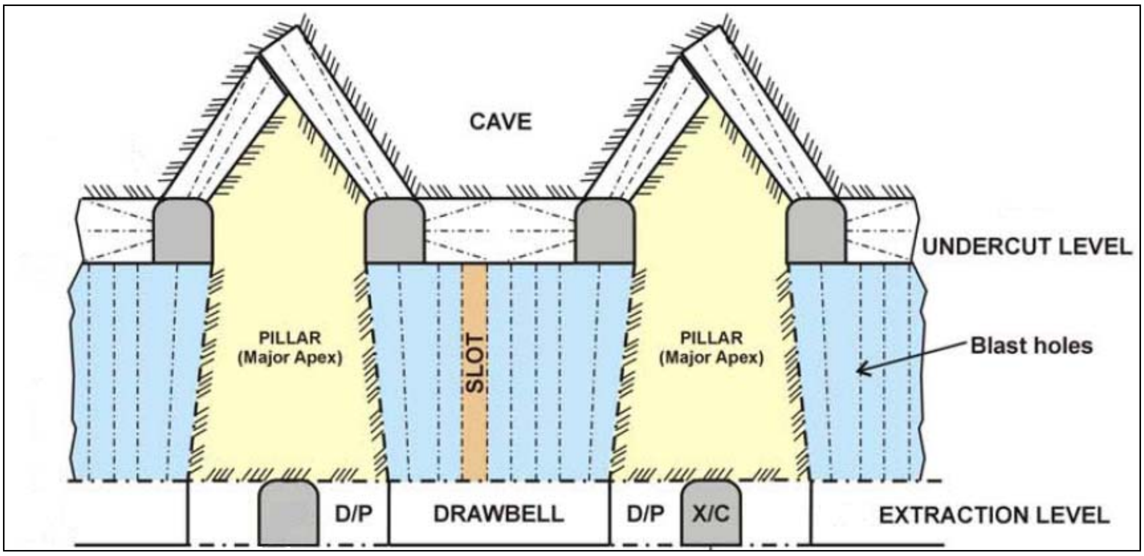
The Golpu block cave has been designed and scheduled as two separate lifts designated Lift 1 and Lift 2. The mine will use a fleet of modern, mobile diesel mining equipment and electro/hydraulic drilling rigs. Each lift will consist of:

- undercut level for the initiation of the cave;
- extraction level for drawing the cave material;
- ventilation level for distribution of intake and exhaust air;
- haulage level for transferring ore to primary crushers, ahead of a conveyor to transport ore to surface;
- emergency drainage sump level.

16.3.2 Undercut Level

A cross section of the undercut level and extraction levels is shown in Figure 16.3. The crinkle undercut arrangement and drawpoint layouts are conventional and have been successfully used at other operating block cave mines. Other configurations of undercut and extraction level design will be assessed during the Feasibility Study.

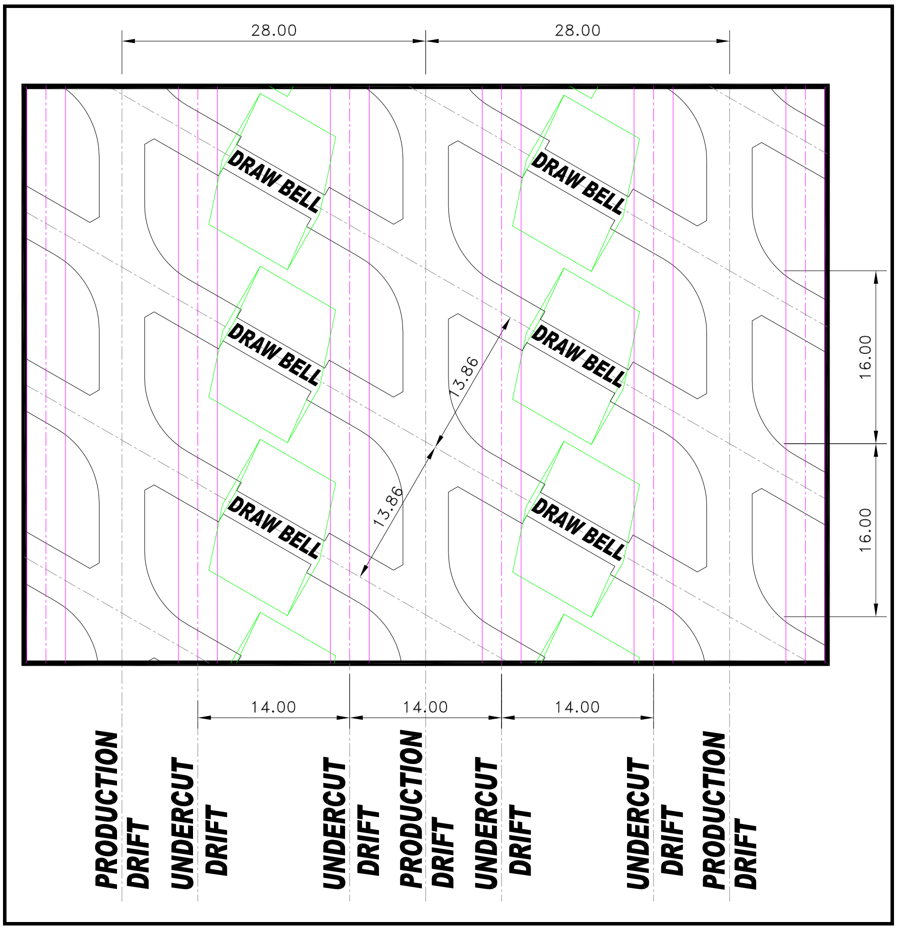
Figure 16.3 Cross Section of Undercut Level and Extraction Levels



16.3.3 Extraction Level

The proposed design of the Lift 1 extraction level is shown in Figure 16.4. This configuration is known as an El Teniente arrangement, and is a conventional design that has been successfully used at other block cave operations. The proposed drawbell spacing is different on Lift 2, but is also based on the El Teniente configuration.

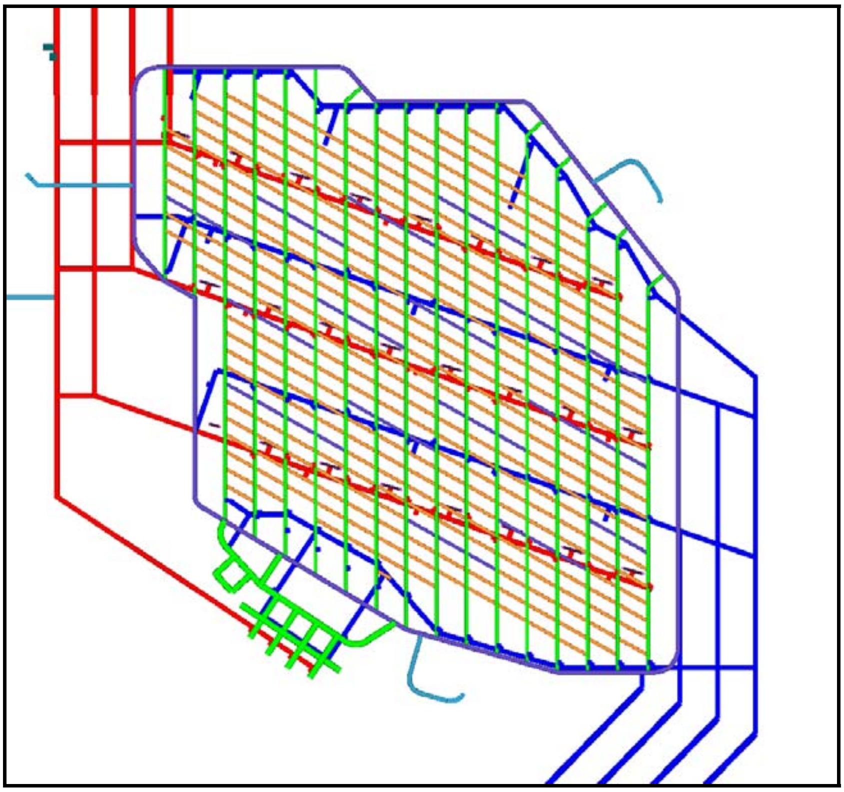
Figure 16.4 Design of Extraction Level (Lift 1)



16.3.4 Ventilation Level

The ventilation level is located between the extraction level and the haulage level, and serves to facilitate primary ventilation flow on the undercut, extraction and haulage levels. Figure 16.5 illustrates the proposed layout designed for Lift 2, where red denotes exhaust drives, and dark blue intake drives.

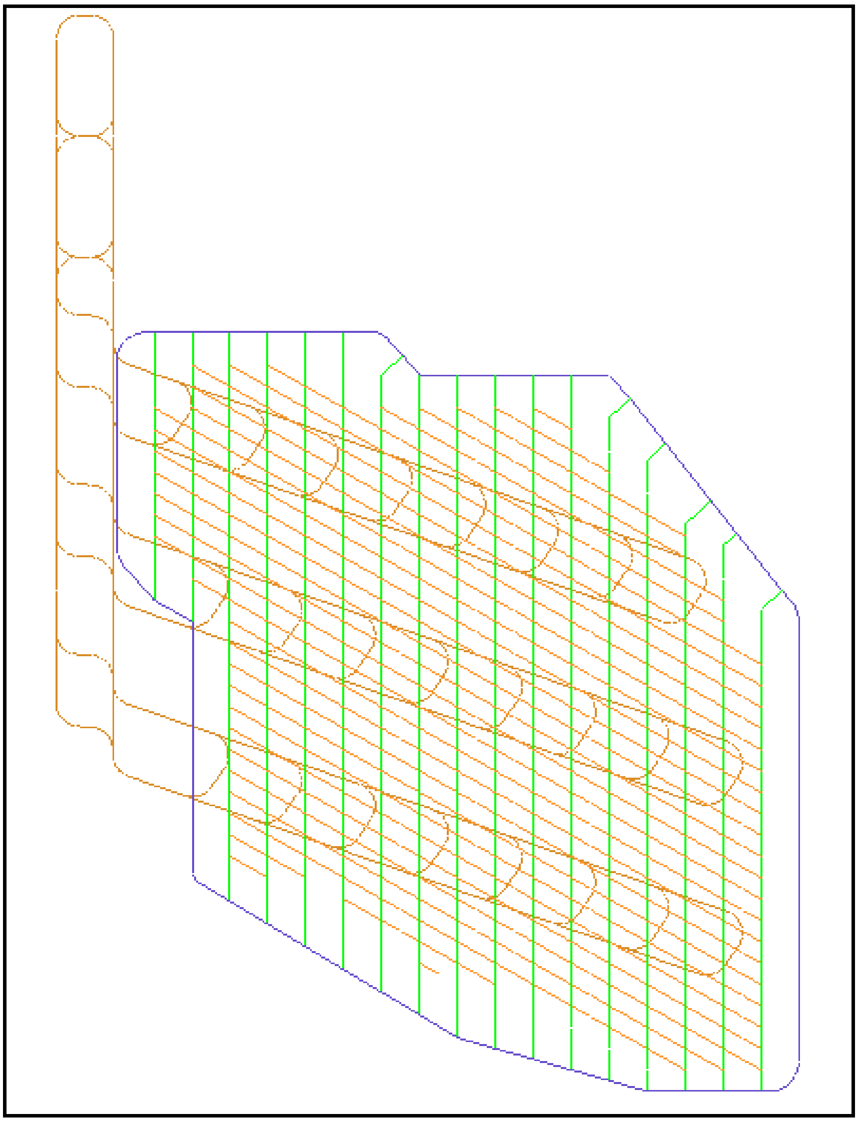
Figure 16.5 Design of Ventilation Level (Lift 2)



16.3.5 Haulage Level

The haulage level is located below the ventilation level. Ore is transferred by trucks from the ore passes to the crusher ROM bin which feeds into a jaw gyratory crusher with a nominal capacity of 3000 t/h. Trucks would be loaded at chutes located on the bottom of the extraction level passes. Figure 16.6 illustrates the proposed haulage level layout designed for Lift 2.

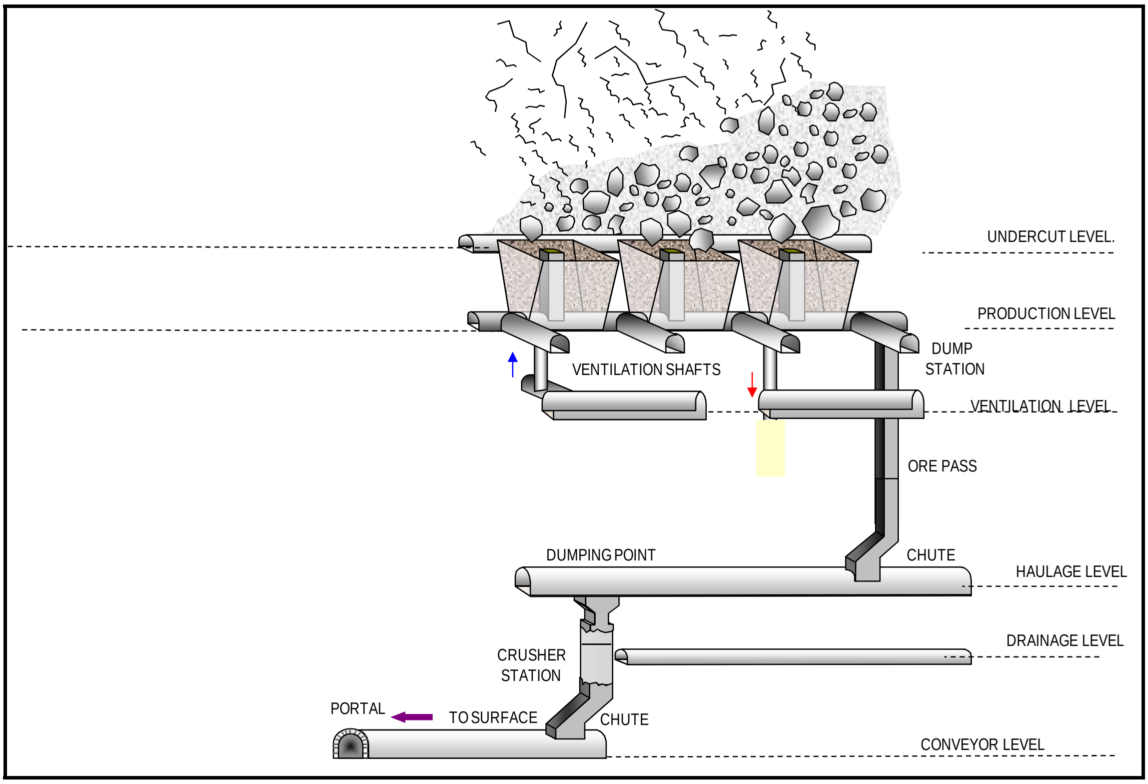
Figure 16.6 Design of Haulage Level (Lift 2)



16.3.6 Materials Handling

A high capacity material handling system is proposed for Golpu. This layout will use LHDs to move ore from the drawpoints to orepasses within the footprint. The orepasses will lead to the haulage level where a fleet of trucks will haul the ore to a primary crusher station. This arrangement is widely used in the industry and is schematically represented in Figure 16.7.

Figure 16.7 Schematic View of the Block Cave Levels



16.3.7 Drainage Level

The PFS proposes a drainage level located below the haulage level which would be designed to provide approximately 20 hours of surge capacity under estimated maximum water inflow rates. The functional requirement is for sufficient volume of excavation to adequately contain the flow during a power outage or period of elevated inflow. The design of the drainage level will be refined in the Feasibility Study.

16.3.8 Mine Ventilation and Refrigeration

16.3.8.1 Mine Ventilation

Ventilation criteria were selected with reference to the legislative requirements, mobile equipment fleet size, production rate, mining environment conditions and sound ventilation practices. A primary airflow requirement of 1900 m^3/s has been estimated when the mine is at its planned maximum production rate. Intake air would be supplied through twin declines from the Watut River Valley and via a 12m diameter ventilation shaft. Air would be exhausted via a similar diameter shaft. Shafts would be located outside the subsidence zone of the caving operation.

16.3.8.2 Refrigeration

A preliminary assessment of mine refrigeration requirements has been completed with an indicative rated cooling capacity of 50 to 60MW identified. The majority of the cooling capacity would be installed on the main intake shaft, with additional capacity required for the Watut incline conveyor. Detailed studies will be completed during the Feasibility Study.

16.3.9 Pumping

Based on the hydrogeological assessment, the main pumping system has been designed for a duty flow rate of 1000 l/s. Smaller pump stations have been designed at each mining lift to transfer water to the main pumping station.

In addition to the duty pumping system designed for removal of water used for mining and normal groundwater and rainwater ingress, the underground mine would require significant standby capacity to cope with infrequent but short duration high intensity rainfall events. In the event that the water inflow exceeds the installed pumping capacity, excess water would be stored in the emergency sump level designed for the purpose of preventing flooding of the active mining horizons.

16.4 Production Rate

A maximum production rate proposed in the PFS Reserve Case of 22 Mtpa was determined by considering the cave footprint area and the maximum vertical rate of cave propagation, which was assumed to progressively ramp up to 250 mm/day for the first 35% of draw, and then be maintained at a maximum rate of 300 mm/day thereafter. The dilution entry point was assumed to commence following extraction of 60% of the design column height.

Loader productivities were considered for different material handling options and in-footprint orepasses have been designed with an average loader tramming distance of 45m. Production from drawpoints would be by a fleet of up to 20 x 17t capacity loaders.

In the PFS Reserve Case, the sequencing of the mining lifts considered the indicative economic footprint outline, the depletion of Lift 1 and the ramp-up of Lift 2. Lift 1 scheduling is based on a maximum production rate of 15 Mtpa, ramping up over four years. Lift 2 scheduling is based on a production rate of 22 Mtpa following a ramp-up period of five years.

The maximum height of draw for Lift 1 is 250 m, and for Lift 2 is 850 m, which includes 100m of overdraw (of remaining Lift 1 material) above the 750m lift height. The mine production schedule adopted for the PFS Base Case is summarised in Table 16.5.

Table 16.5 PFS Reserve Case Mine Production Schedule

Production Period (Year)	Lift 1 Production (Mt)	Lift 2 Production (Mt)	Total Production (Mt)
1	0.4		0.4
2	2.9		2.9
3	6.7		6.7
4	10.2		10.2
5	15.0		15.0
6	14.4	0.9	15.0
7	15.0	3.0	18.0
8	9.3	8.7	18.0
9	6.0	14.0	20.0
10	1.9	20.0	21.8
11		22.0	22.0
12		22.0	22.0
13		22.0	22.0
14		22.0	22.0
15		22.0	22.0
16		22.0	22.0
17		22.0	22.0
18		22.0	22.0
19		22.0	22.0
20		22.0	22.0
21		22.0	22.0
22		22.0	22.0
23		22.0	22.0
24		17.3	17.3
25		13.2	13.2
26		5.5	5.5

16.5 Mine Development

The proposed mining plan for Golpu is to commence advanced exploration works, including development of the twin declines, late in 2013, with ventilation shaft construction commencing mid-2014. These start dates are subject to obtaining relevant government approvals.

First production from Lift 1 is anticipated in 2019 (Table 16.5). The current Mineral Reserve estimate results in a mine life of 26 years.

The total horizontal development requirement over the life of the mine is approximately 154 km. Table 16.6 summarises the life-of-mine horizontal and vertical development requirements for the project.

Table 16.6 Horizontal and Vertical Development Requirements

Development	Units	Quantity
Horizontal Development	(km)	153.7
Raise Borer	(m)	10,600
Shaft Sink	(m)	2,970
Mass Excavation (Major Chambers)	(m^3)	120,600

16.6 Mining Fleet

The mining equipment requirements have been based on scheduled mining activities during the mine development, construction and production phases and consider their applicability in each of these phases of the project. Selection was based on proven equipment in similar mining applications and with regard to attaining the maximum projected annual production. The mobile fleet requirements during the pre-production and initial 10 years production phase of the project are summarised in Table 16.7.

Table 16.7 Mobile Fleet Requirements

	PRODUCTION PERIOD														
	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10
REQUIRED FLEET															
Drifter Jumbo	3	1	2	5	10	13	14	5	16	14	11	11	5	2	1
RoofBolter	2	1	1	3	6	8	8	3	9	8	7	7	3	1	1
Longhole Rig	1	0	0	0	0	2	3	3	3	3	2	4	4	4	4
LHD 17 Tons	0	0	0	0	0	1	3	6	10	14	14	17	17	18	20
LHD 17 Development	3	1	1	3	7	9	10	3	11	9	8	8	3	1	1
Mucking Truck	3	1	1	3	7	9	10	3	11	9	8	8	3	1	1
80T Production Truck	0	0	0	0	0	1	2	4	5	8	8	9	9	10	11
Secondary Breaking Unit	0	0	0	0	0	1	2	3	4	6	6	7	7	8	9
Explosive Charger	2	1	1	3	5	6	7	3	8	7	5	5	3	1	1
Concrete Sprayers	1	1	1	3	7	10	10	3	11	9	8	8	4	2	1
Utility Trucks	2	1	2	4	7	9	10	4	11	10	8	8	4	2	1
Light Vehicles	14	12	13	15	16	18	19	15	21	21	19	20	17	16	16
Surface Transport - Bus	2	1	2	3	4	7	8	5	9	9	8	8	6	5	5
U/G Transport Truck	2	1	1	2	4	6	7	4	8	7	6	7	5	4	4
IT	4	2	3	7	13	17	18	7	20	18	15	15	7	3	2

16.7 Further Mining Potential

Holes drilled at depth beneath Lift 2 (lower horizon of the Probable Ore Reserve) have returned the highest grade drill intercepts so far recorded at Golpu. These indicate potential for a third mining lift (Lift 3) beneath the current base of the Golpu Probable Ore Reserve. The Feasibility Study will assess the opportunity and impact of a third mining lift at Golpu.

17 RECOVERY METHODS

17.1 Mineralogical Considerations

The process flow sheet developed for the Golpu treatment plant is based on the Golpu PFS and the corresponding 2012 Mineral Reserve estimate for the Golpu deposit.

The Golpu porphyry deposit has alteration domains with a potassic zone at depth overlain successively by zones of phyllic and argillic alteration with a supergene zone towards the surface. The mineral assemblage of the zones varies and the concentrates derived from each zone will also vary, however the proposed block caving mining method will result in the mixing of ore from different zones as extraction proceeds.

The supergene zone contains chalcocite, covellite, enargite and bornite while the phyllic and altered argillic zone contains dominant covellite with lesser bornite and chalcopyrite. In the potassic zone, chalcopyrite dominates as the primary copper mineral. Throughout all zones, pyrite is the principal sulphide gangue mineral. Mineralization in the surrounding metasediment comprises assemblages similar to those found in the adjacent porphyry at the same elevation although molybdenum is typically elevated in the peripheral areas of the metasediments.

Gold is nominally associated with the copper but also with pyrite mineralization and gangue.

The copper grade of the concentrate will vary in line with copper mineralogy of the material being processed at any time. With pyrite being the principal sulphide gangue mineral and with gold generally associated with the copper mineralization, the process flow sheet focuses on a sulphide flotation regime to separate the copper minerals from the pyrite and the non-sulphide gangue.

The PFS plant design has been based on the preliminary metallurgical test work, as described in Section 13 of this report and has not been optimised.

17.2 Process Design Criteria

The PFS Base Case is based on a process plant designed to treat Golpu copper-gold ore at a nominal rate of up to 22 Mt/y. It will be constructed and commissioned in a series of five stages over a seven year period as feed material is progressively introduced into the plant according to the mining ramp up schedule. The five stages are:

- Stage 1A - 10 Mt/y ore and 500 kt/y concentrate
- Stage 1B - 10 Mt/y ore and 1000 kt/y concentrate
- Stage 2A - 20 Mt/y ore and 1000 kt/y concentrate
- Stage 2B - 20 Mt/y ore and 1500 kt/y concentrate
- Stage 3A - 22 Mt/y ore and 1500 kt/y concentrate

The key criteria for equipment selection are suitability for duty, reliability and ease of maintenance. Plant design is based on a metallurgical flow sheet with unit operations that are well proven in sulphide mineral flotation plants. The plant layout provides easy access to all equipment for operating and maintenance. The key PFS performance parameters for the plant include:

- Two 12 hour shifts per day and operating 365 days per year
- Availability of the grinding and flotation circuits of 91.3%, (benchmarked against similar process plants) which equates to 8,000 operating hours per year
- The availability of the filtration/de-watering circuit at the port of 80% based on typical installations, equating to 7,000 operating hours per year. Downtime is allowed for regular maintenance of the concentrate filters and the changing out of blinded and holed filter cloths
- Standby equipment installed in critical areas within the circuit
- Automated plant control provided with provision for manual override and control if required

The key metallurgical parameters used for the purpose of process plant design are summarised in Table 17.1.

Table 17.1 Key Metallurgical Design Parameters

Design Parameter	Units	Value
Specific gravity	-	2.8
Bulk density (volume calculations)	t/m3	1.6
Bulk density (mass calculations)	t/m3	2.0
Moisture (mill feed)	% w/w	5
SMC Test parameters, A x b	-	40 - 65
Bond ball mill work index	kWh/t	15 - 16
Abrasion index	g	0.3
Plant feed grade – copper, max for design	%	2.1
Plant feed grade – copper, average	%	1.2
Plant feed grade – gold, average	g/t	0.9
Average copper recovery	%	93
Average gold recovery	%	61
Concentrate grade – copper, range	%	24 - 31

Consumable and reagent consumptions are listed in Table 17.2.

Table 17.2 Consumable and Reagent Consumptions (Per tonne of ore processed)

Consumable/reagent	Units	Consumption
Quicklime	kg/t	1.5
A3894 Collector	g/t	30
IF56 Frother	g/t	25
Pyrite depressant	g/t	20
Flocculant – concentrate thickener	g/t	15
Flocculant – tailings thickener	g/t	20
Grinding media – SAG mills	kg/t	0.61
Grinding media – ball mills	kg/t	0.48
Grinding media – regrind mills	kg/kWh	0.205

17.3 Process Description

A flow sheet schematic for the treatment of the Golpu deposit is shown in Figure 17.1.

The process plant includes the following unit processes and facilities:

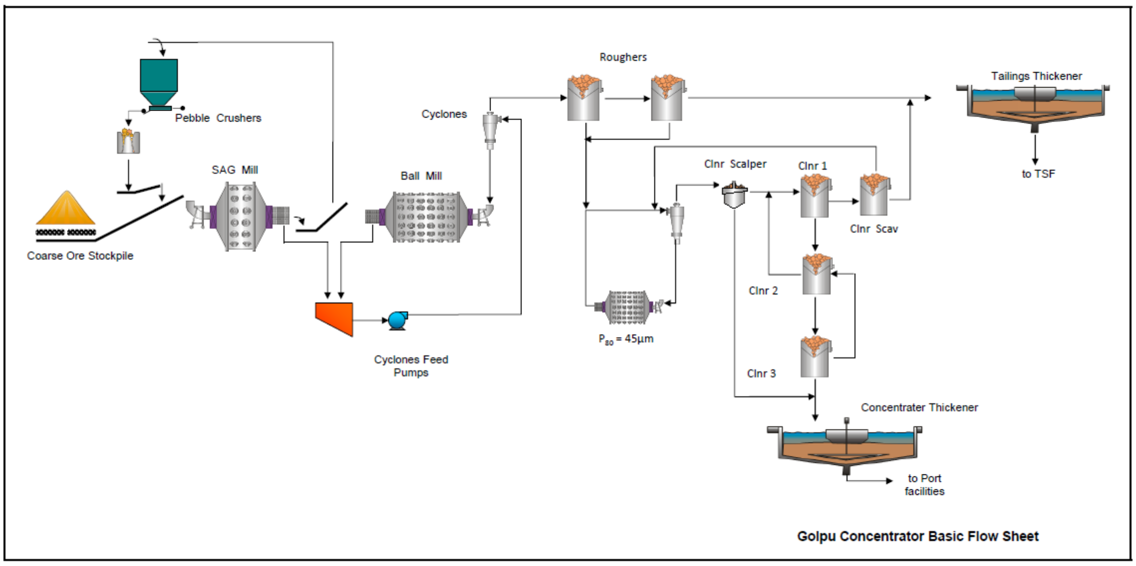
- crushed ore stockpiling and reclaim
- two parallel grinding lines
- SAG and ball mill grinding (SAB circuit) with allowance to retrofit a pebble crusher
- copper flotation comprising rougher flotation, concentrate regrind and three stage cleaning
- copper concentrate thickening and pumping
- tailings thickening, pumping and water recovery
- reagents mixing and distribution (including lime slaking, flotation reagents, water treatment and flocculants)
- grinding media storage and addition
- water services (including raw water, fire water, potable water, gland water, cooling water and process water)
- air services (including high pressure air and low pressure process air)

Table 17.3 summarises the staged installation of the plant to suit the mining schedule ramp-up.

Table 17.3 Staged Concentrator Ramp-up

Stage	Year	Ore Feed	Concentrate	Circuit Description
1A	0	10 Mt/y	500 kt/y	SAB circuit, roughers, regrind, cleaner 1, cleaner scavenger, cleaner 2, cleaner 3, 1 x site concentrate tank , 2 x port concentrate tanks, 2 x concentrate filters
1B	4	10 Mt/y	1000 kt/y	cleaner scalper
2A	5	20 Mt/y	1000 kt/y	additional SAB circuit, roughers, regrind, 3rd port concentrate tank
2B	6	20 Mt/y	1500 kt/y	additional cleaner scalper, 3rd concentrate filter
3A	7	22 Mt/y	1500 kt/y	retrofit 2 x pebble crushers

Figure 17.1 Schematic Process Flow Sheet



17.3.1 Stockpile and Reclaim

Crushed ore is delivered to a single conical, open stockpile via the material handling systems. The stockpile has a 'live' capacity of approximately 60 kt, while 'dead' capacity can be recovered using a bulldozer or excavator.

Coarse ore is reclaimed from the stockpile by four apron feeders, two for each grinding line. Each feeder is designed to provide up to the full feed rate to the SAG mill, but will generally operate at 50% capacity for even draw-down of the stockpile.

Each pair of apron feeders discharges onto a SAG mill feed conveyor (one conveyor per grinding train), which transports the crushed ore to the SAG mill feed chute.

Lime is added to the SAG mill feed conveyor, to maintain the pH at a design level (above pH 7).

17.3.2 Grinding

The grinding circuit consists of two parallel lines of grinding mills, each with nominal 1370 t/h capacity. Each grinding line consists of a single SAG mill, followed by a single ball mill operating in closed circuit with a cyclone cluster. SAG and ball mills are driven by a 14 MW twin pinion drive assembly. The SAG mills are 10.4m diameter by 6.0m effective grinding length (EGL). The ball mills are 7.6m diameter by 12.2m EGL.

The SAG mills are fitted with trommel screens to separate oversize pebbles and scats. Trommel oversize from each SAG mill reports to the respective SAG mill feed conveyor via two transfer conveyors prior to Year 7. From Year 7 onward, pebbles are conveyed to separate pebble surge bins and pebble crushers, with crushed pebbles conveyed to the SAG mill feed conveyors. SAG mill trommel undersize gravitates to the primary cyclone feed hopper where it is combined with the discharge from the ball mill.

Each grinding line uses a single variable-speed cyclone feed pump to transport slurry to a dedicated cyclone cluster. Flotation collector is added to the cyclone feed hoppers.

The cyclone underflow streams report to the respective ball mill feed chute, via a boil box. Cyclone overflow forms the product from the grinding circuits, with a typical size of 80% passing 106 µm, and gravitates to trash screens.

Separate ball storage bunkers are provided for the ball mills. Each ball mill has a dedicated ball charging system. Kibbles are filled from the ball storage bin and transferred by fork lift to the grinding floor.

Separate liner handlers are provided for servicing the SAG mills and the ball mills. Liner bolt removal tools are provided for relining the mills.

17.3.3 Copper Flotation

The flotation circuit consists of two parallel trains of rougher flotation cells followed by rougher concentrate regrind, cleaner scalping via Jameson cells, three stages of cleaning in separate banks of tank cells and cleaner scavenger cells. The cleaner scavenger bank is operated in open circuit.

Trash screen underflow gravitates to the rougher flotation circuit, which consists of two parallel trains of seven 200 m^3 forced-air tank cells. The level in each stage is controlled by an internal dart valve arrangement. Lime slurry is added to the head of the rougher bank for pH control.

Collector and frother are added at the head of the rougher circuits and in stages down the banks.

The copper rougher tailings flow from the parallel trains to the tailings thickener distribution box, where they combine with cleaner 1 tailings, for distribution to the two tailings thickeners.

The regrind circuit consists of two ball mills with dedicated cyclone clusters in closed circuit. Discharge from both regrind mills gravitates to a single discharge hopper, where rougher concentrate and cleaner scavenger concentrate are added to the circuit. Slurry is pumped from the regrind mill discharge hopper to two cyclone clusters by dedicated pumps. Regrind cyclone overflow (at P_{80} 30 µm) from both cyclone clusters is combined and gravitates initially to cleaner 1, and after Year 4 to the cleaner scalper cell(s) (two B6500/24 Jameson cells). Cleaner scalper concentrate is pumped to the concentrate thickener.

Lime slurry is added to both the cleaner scalping and cleaner 1 feed streams to maintain the slurry at pH 10. Collector, frother and depressant (sodium cyanide) can also be added to cleaner 1 feed.

Concentrate recovered from cleaner 1 is pumped to the cleaner 2 flotation bank for further upgrading. Cleaner 1 tailings gravitate to the cleaner scavenger cells. The cleaner 1 bank consists of four 200 m^3 forced-air tank cells arranged in series.

Cleaner scavenger cells recover a low grade concentrate that is pumped to the regrind circuit. Cleaner scavenger tailings are pumped to the tailings thickener feed distribution box. The cleaner scavenger unit consists of two 200 m^3 forced-air tank cells arranged in series.

Cleaner 2 concentrate is pumped to the cleaner 3 flotation bank for further upgrading. Cleaner 2 tailings report back to the head of cleaner 1. The cleaner 2 bank consists of four 150 m^3 forced-air tank cells arranged in series.

Cleaner 3 concentrate is transferred to the concentrate thickener. Cleaner 3 tailings gravitate to the head of the second copper cleaner bank. The cleaner 3 bank consists of three 150 m^3 forced-air tank cells arranged in series with wash water to reduce entrained gangue.

17.3.4 Copper Concentrate Thickening and Pumping

Concentrate is pumped from the copper flotation circuit to a 25m diameter high-rate copper concentrate thickener in each train.

Flocculant is added to the thickener feed stream to enhance settling. The concentrate thickener overflow reports to the process water pond. Copper concentrate solids settle to a density of 60% solids. The thickener underflow stream is pumped to two agitated concentrate storage tanks, which provide 24 hours surge capacity for the concentrate pumping system.

The pumping station consists of two positive displacement pumps operated in a duty/standby arrangement. The concentrate pipeline transports concentrate approximately 100 km from the process plant to port facility in the Lae area, and includes a test loop and pipeline monitoring instrumentation.

17.3.5 Tailings Thickening

Flotation tailings gravitate from each flotation circuit to dedicated 45m diameter high rate thickeners. Flocculant is added to the thickener feed to enhance settling. Tailings are thickened to 60% w/w solids prior to discharge to the tailings pump hopper. Thickener overflow gravitates to the process water tank and is used in the grinding and flotation circuits.

Thickened underflow from both thickeners is pumped approximately 25 km to the tailings storage facility (TSF) via a multi-stage tailings pump set and common pipeline.

Water decanted from the TSF is reclaimed by high volume, low head pontoon-mounted pumps to a head tank near the TSF. Multi-stage centrifugal pumps then return the tailings decant water to the process plant.

17.3.6 On-Stream Analysis and Laboratory

Two on-stream monitoring systems are installed in the concentrator:

- particle size analysers (PSA) are installed to monitor grinding mill performance
- an on-stream analyser (OSA) is installed to monitor flotation circuit performance.

17.3.7 Water Circuits

Raw water reports to the site raw water tank at a maximum rate of 200 m^3/h. It may be used as make-up water to the process water tank, as required.

The raw water tank provides water to the potable water treatment plant and for plant distribution to lubrication areas (for cooling) and the gland water system. The treated water is pumped to a potable water tank which discharges into the potable water reticulation system and the safety shower water network.

The process water pond provides water to the process water tanks for distribution to the grinding and flotation circuits in each train.

18 PROJECT INFRASTRUCTURE

The description of proposed project infrastructure is based on the Golpu PFS. Infrastructure was selected to suit the requirements of the proposed mining and processing facilities and the local environment.

18.1 Port Facilities

It is proposed to establish a port facility in the Lae area. The port facility will consist of concentrate dewatering, storage and ship loading facilities, inclusive of filter facilities, water treatment, concentrate storage shed, load-out conveyors and ship loader.

A number of alternative port options exist which will be examined more closely in the Feasibility Study.

18.1.1 Concentrate Pipeline

The concentrate pipeline from the Golpu mine site to a port facility near Lae would be approximately 100 km in length and have a maximum capacity of 1.5 Mt/y of concentrate. Slurry pipeline slopes have been limited to a maximum grade of 12% and the route will need to be optimised as part of the Feasibility Study phase.

In addition to the pipeline, the major components of the concentrate transport system include the mine site pump station, agitated storage tanks, charge pumps, main line positive displacement pumps and a test loop. The pipeline would be buried for security, with a minimum 1m depth of cover over the pipe for most of the route and 2m depth of cover for water and road crossings. Two methods are proposed for early detection of leaks: pressure wave detection and mass balance monitoring.

18.1.2 Concentrate Filtration and Storage

The concentrate filtration facility storage shed, and ship loader would be built on land secured for that purpose. Typically, the port authority leases land to tenants, who build their own facilities. For purposes of the PFS, it has been assumed that the port authority builds the wharf on which the ship loader is located, but everything above the wharf level is built and maintained by WGJV, including the concentrate filtration and storage facilities.

18.1.2.1 Concentrate Filtration

The concentrate pipeline would discharge concentrate slurry to a series of filter feed tanks at the port. The filter feed tanks would provide 24 hours surge capacity, allowing filter maintenance to be conducted without affecting pipeline operation. The filter feed would be pumped to three vertical plate pressure filters, operated in sequence.

18.1.2.2 Concentrate Storage

Filtered concentrate would be stacked in a covered storage building before load out for export. A transportable moisture limit (TML) of 9% has been assumed for copper concentrate, based on experience with similar projects.

The proposed covered storage capacity at the port would initially be 50kt of copper concentrate (assuming a bulk density of 2.2 t/m^3), doubling to 100kt as mine production ramps up. A 30kt emergency pad is also proposed at start-up, as new concentrators may typically produce some concentrate that falls outside of specifications and requires subsequent blending before shipment.

Shipping parcels are expected to vary in size, depending on the customer, but are typically 15kt or 25kt, with occasional 30kt parcels.

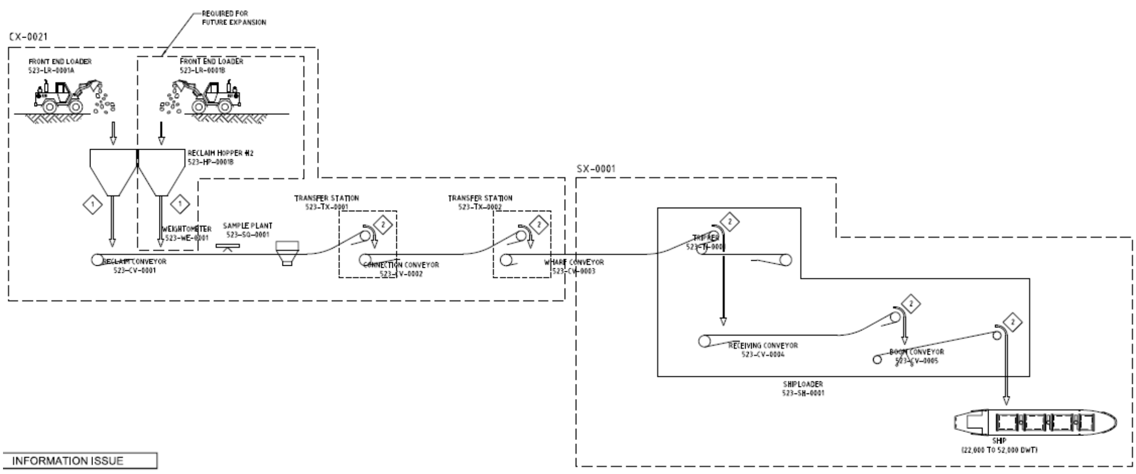
18.1.2.3 Water Polishing Plant

Under the PFS, filtrate from the concentrate filters reports to two agitated precipitation tanks where it is treated to produce a settled sludge, which is collected in the clarifier underflow, and a clarifier overflow. A disc filter is then used to reduce the treated water turbidity of the clarifier overflow to within acceptable limits. The filtered water will be collected in two duty/standby treatment ponds for testing before release to the environment. A portion of the treated water will be collected and used for port services, including gland water, filter cloth washing and manifold flushing.

18.1.3 Copper Concentrate Reclaim and Ship Loading

The proposed copper concentrate reclaim and shiploading infrastructure arrangement is shown in Figure 18.1.

Figure 18.1 Proposed Port Copper Concentrate Reclaim and Ship Loading Arrangement



The reclaim system would be installed in two stages. Under the PFS, the first stage, with 525 t/h capacity, incorporates a single front-end loader feeding a mobile hopper positioned over the reclaim conveyor. The second stage (1,050 t/h) requires extension of the reclaim conveyor, the addition of a second mobile hopper and the operation of a second front-end loader.

A series of conveyors transfers the reclaimed concentrate onto the wharf. Copper concentrate is then loaded onto ships via a travelling shiploader.

18.2 Tailings

A number of potential tailings storage sites have been identified. Each option has the capacity to store the tailings produced over the life of the operation. These will be further investigated as part of the Feasibility Study.

18.2.1 Tailings and Return Water Pipelines

The tailings pipeline and the tailings return water pipeline would occupy the same corridor.

Major components of the mine site pump station are transfer sump and main line centrifugal pumps. The main line pumps would be horizontal centrifugal type with two pumps operating in series (one operating train and one standby train). The tailings would be distributed by spigots on distribution headers around the impoundment areas.

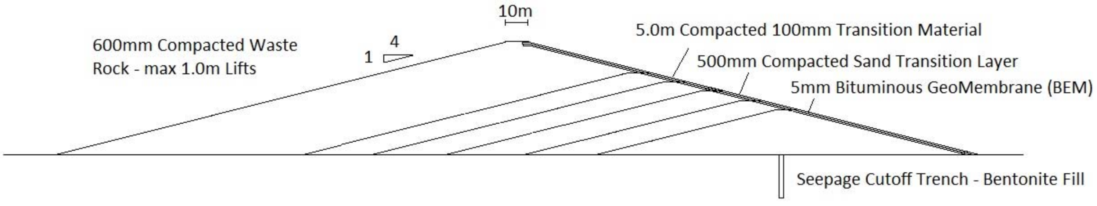
Optimisation of a return water pipeline diameter is based on balancing increasing capital cost of larger pipelines with increasing operating cost of smaller pipelines due to friction losses. Lowest net present cost for return water pipeline is typically found at around 1 m/s line velocity. Major components of the tailings return water pump station would be barge pumps, water head tank and main line centrifugal pumps.

Both pipelines would be buried for security with a minimum 1m depth of cover over top of pipe for most of the route and 2m depth of cover for water and road crossings. Leak detection would be provided.

18.2.2 Impoundment Design

Under the PFS, the basic design of the embankment is an earth construction, consisting of a low permeability core with rock shoulders. Seepage would be managed via an upstream liner and the core. Sand filters are also installed for the liner and the core, to manage against piping failure. Proposed dimensions and relationship of materials is illustrated in Figure 18.2.

Figure 18.2 Schematic of Embankment Construction



Acknowledging the seismic nature of the area, downstream lifts are preferred in preference to upstream lifts which rely upon the stability of tailings, which have the potential risk of liquefaction during significant seismic events.

It has been assumed that suitable fill is available from hills nearby the facility or from within the storage area of the facility itself.

18.2.3 Management of Acid-Producing Tailings

Tailings are expected to be net acid producing due to the pyrite content. Two management options have been identified for tailings with the potential to be acid producing - either storage within excavated cells or a water cover of the entire facility.

Engineered, permanent water cover has been proposed as the preferred option to manage the acid mine drainage potential of tailings as this controls exposure to air and prevents the oxidation process. Detailed design will need to be carefully engineered to ensure water cover remains as a legacy landform feature.

Water cover and fresh water inflow are expected to maintain a reasonable water quality within the storage; however, this remains a key part of scope for further design in the Feasibility Study.

18.3 Access Roads

The proposed option for the main access road from the Lae township to the process plant and mine infrastructure is a combination of upgraded existing roads and development of new sections of road.

A number of secondary "spur" roads from the main access road would be required to access each facility, including:

- Process Plant Access Road
- Overland Conveyor Maintenance Track
- Portal Access Road
- Wafi Access Link Road
- Watut River Access Road
- Spoils Dump Access Road
- TSF Access Road
- Vent Shafts Access Road
- Watut Portal Access road
- Watut Refrigeration Plant Access Road

In general, the design criteria adopted for project roads in the PFS includes two-lane, unsealed and with a maximum speed of 80 km/h. In sections of hilly terrain where 80 km/h is impractical, the design speed would be reduced. The roads would have a maximum gradient of 10% and be designed for standard load semi-trailers. The climatic and unknown ground conditions will impact long term pavement performance, requiring regular maintenance to deal with potholes and pavement damage. Allowance has been made in the PFS to install sprayed seal surface on the steeper sections of the roads.

18.4 Power Supply

As there is no existing infrastructure in Morobe or the adjacent Provinces to supply the expected power demand, the project scope involves establishing a power supply delivering up to 150 MW for mine operations.

A range of options have been considered for power generation, including coal steam, gas and hydropower. Despite its large capital requirement it was found that a hydro scheme with either HFO or LNG back-up would deliver the lowest levelised cost of energy.

In broad terms there are two types of hydropower stations: run-of-river, with no storage, and reservoir type, where water storage increases gravitational head and, in some circumstances, may also moderate flow to the power station. Hydropower developments (particularly run–of-river) also require thermal power supply as back-up during periods of low water flow.

Given the long lead time and complexity, both technical and social, of developing a hydropower scheme, a portfolio approach has been adopted in the PFS. This involves establishing initial generating capacity for the project start-up based on a heavy fuel oil generated power supply.

18.5 Water Management

Management of the water generated, collected and used by the project will be critical to the ongoing success of the project. Water will be re-used where possible to minimise raw water consumption, discharge of waste water to the environment and water transport energy costs. Provisions have been made in the PFS for water treatment facilities, along with erosion and sediment control structures, to treat excess water generated from the underground mine and general site run-off.

The main surface water management objectives are to:

- prevent possible downstream pollution of existing rivers, creeks and streams;
- provide facilities for the drainage, storage, treatment and disposal of low quality water; and
- manage runoff from the plant site for reuse, or when not practical to do so, delivery to the TSF.

Several significant diversions are expected to be required around some of the project infrastructure due to the presence of substantial upstream catchments. Given the PNG climate, local drainage will require careful consideration and design.

Under the PFS, the concentrator bulk earthworks are designed to create a flat terraced area encompassing the plant site. The pad will be graded with a fall to a sloping drain, which discharges to the process plant sediment pond. The sediment pond is designed to contain the run-off from a 1-in-25 year rainfall event. The pond is provided with floating pontoon pumps that discharge into the process-water tank and/or the TSF, via the tailings slurry transfer station.

The crushed ore stockpile pad is also graded to allow rainfall run-off to drain to the same process plant sediment pond.

18.6 Accommodation

A permanent accommodation facility would be required for on-going project operations. A potential site has been identified that can be developed for a permanent accommodation facility to support up to 3,000 beds.

A site has also been identified for a 2,000 bed temporary construction camp for the early works, approximately 5km north of the Watut portal.

A second 2,000 bed temporary camp will also be required at the mine site, with a 500 room camp at Lae and 20 houses at the Nine Mile WGJV complex during construction.

18.7 Buildings

In addition to accommodation for the construction and permanent workforces, numerous buildings will be required.

Buildings and facilities within the main Mine Infrastructure Area, adjacent to the Watut portal include:

- Security/guard house
- Male and female bath houses
- Laundry
- Muster room
- Operations building
- First aid room
- Heavy vehicle workshop
- Tyre change shop
- Light vehicle workshop
- General workshop and pump repair shop
- Refuelling bay and fuel storage depot
- Gas storage facility
- Water treatment plant
- Sewage treatment plant
- General warehouse and storage yard
- Vehicle wash
- Cap lamp building

The following buildings and offices would be provided to service the concentrator area:

- Administration office
- Plant offices
- Change-house and messing
- Workshop and warehouse
- Security and gatehouse
- First-aid
- Laboratory
- Reagents storage
- Control room

The buildings associated with the port facility would typically include:

- Administration
- Workshop
- Warehouse
- Reagent store
- Security and gatehouse
- Filter control room
- Shift-change room with kitchen facilities

19 MARKET STUDIES AND CONTRACTS

An assessment of the likely future copper concentrate market was undertaken as part of the PFS. The assessment looked at long-term contracts between major producers and Asian smelters, the likely market, given their proximity to PNG and comparatively short shipping routes. The assessment also considered the forecast changes to mine output and smelter capacities. The forecast indicates that the copper concentrate market is expected to return to surplus as new mine production outstrips smelting capacity, resulting in concentrate quality being an important factor in securing favourable marketing terms.

Regionally, Golpu will face competition from a number of large mines in Australasia and Oceania. These include Grasberg, Batu Hijau, Boddington and Ok Tedi. However, with a copper concentrate grade of around 30% copper and containing between 10g/t and 20g/t gold with low concentrations of deleterious elements, the quality of the Golpu concentrate is relatively high compared to many of its competitors.

The assessment also found that for a standard grade for copper concentrate (25% to 35% Cu), the direct smelter treatment charges over the past ten years have varied from US$42 to US$110 per tonne of concentrate, and refining charges from US¢4.2 to US¢11.0 per pound payable copper.

A long-term forecast of US$80.00/dmt for treatment charges and US¢8.00/lb for refining charges has been adopted for the PFS. This compares with current market rates for treatment charges of about US$60.00/dmt and refining charges of about US¢6.00/lb.

Price participation has been forecast to return to the market in 2015 at a rate of 10% above spot copper prices of US$1.50/lb and has been included in the financial model.

The quantity of gold payable by a smelter can vary widely. However, for Asian smelters a standard scale of gold metal deductions has emerged. This scale varies from no gold payable if the gold content is below 1 g/t, up to 97–97.5% of the gold payable if the gold content exceeds 20 g/t in the concentrate. Further engagement of smelters and early negotiations of terms will be pursued during the Feasibility Study phase.

20 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

Wafi-Golpu is located on the north side of the main dividing range of PNG, generally within the zone of foothills below 1,000m above sea level where the western edge of a densely forested rugged, steep mountain range meets the foothills of the Watut River valley.

20.1 Environmental Studies

The Project has been the subject of a number of environmental and social investigation studies since the Wafi and Golpu deposits were discovered in 1979 and 1990.

20.1.1 Hydrology and Meteorology

Meteorological data has been collected since November 2003 at an automatic weather station on Mount Golpu, located immediately above the Wafi Camp. The automatic weather station currently operating at Mount Golpu was installed in December 2008. In addition to this, manual rainfall records were recorded at the Wafi Camp from 1990 to 2006.

The following meteorological data are recorded:

- Temperature
- Humidity
- Rainfall
- Solar radiation
- Wind speed and wind direction

Hydrology data has been collected within the Project site sporadically since 1980. Flow data was recorded at the Sunshine stream gauging station on Watut River from January 1980 to July 1994. The Sunshine stream gauging station lies approximately 60 km upstream of the confluence of the Watut and Wafi rivers.

Supplementing this data are flow, turbidity, pH, electrical conductivity and temperature data collected from three stream gauging stations, which were installed on the Wafi River at Pekumbe, the Watut River at Pekumbe (downstream of its confluence with the Wafi River) and the Waime River at Gingen in 2005.

20.1.2 Mine Materials Geochemistry

Mining activities can expose sulphide mineralization to atmospheric oxygen and so have the potential to generate acidic mine drainage (AMD).

Geochemical testwork has been undertaken for the Wafi and Golpu projects over the last 16 years. Approximately 36 waste rock samples from around the Golpu deposit, three tailings samples and three run of mine (ROM) ore samples were assessed for acid forming potential.

In 2011, a geochemical assessment of 105 drill core samples in the approximate vicinity of the proposed alignment of the Watut decline was conducted. Also in 2011, a further geochemical assessment program commenced, which involved testwork on two

Golpu drill cores (70 samples) and a fourth tailings sample. Based on the outcomes of this testwork, samples were classified in terms of AMD potential as follows:

- Non-acid–forming (NAF) — although sulphides may be present in such samples, the inherent ANC should be sufficient to neutralise any acid that might be produced by sulphide oxidation
- Potentially acid-forming (PAF) — the exposure of such a material to atmospheric conditions is likely to result in sulphide oxidation, which in turn could result in acidification
- Uncertain (UC) — when there is a disparity between the NAPP and NAG results. The conservative approach is to assume that these samples are PAF

Some samples were also selected for more detailed analysis to clarify sulphide reactivity, acid buffering characteristics and elemental enrichments.

Results from the testwork programs indicate that the majority of the Watut decline material is likely to be NAF until the decline reaches the vicinity of the Golpu deposit.

Testwork from the Golpu deposit indicates sharp transition from the oxide gold cap zone into underlying high sulphur (up to 20% S and an average of approximately 10% S) fresh PAF rock. This suggests that fresh sulphidic rock may generate AMD.

Based upon the current knowledge of the Golpu ore body, the tailings facility will need to be designed to manage this PAF material such as by store and release or water covers.

20.1.3 Air and Noise

Air quality and noise monitoring was undertaken in May 2011 at villages proximal to the project (Bavaga, Seraf, Wongkins and Mazim) in order to characterise the existing air and noise environments.

Air monitoring results from 24-hour sampling showed the air quality did not exceed relevant international assessment criteria (WHO, 2006). This was expected as Golpu is remote from any major industrial sources of air pollution.

20.1.4 Water and Sediment Quality

Water and sediment quality monitoring programs were established in the project area in 2005. In 2010, the water and sediment quality-monitoring program was expanded from 17 sites to 38 sites, and is currently ongoing with sampling undertaken on a monthly basis contributing to the formation of a dataset for establishing background conditions in the project area.

Sampling sites have been established in catchments that may potentially be affected by the development of Golpu, with a particular focus on the Watut, Wafi and Markham Rivers and selected tributaries, and at control sites.

Samples have been analysed for the following parameters:

- Metals
- Total suspended solids (TSS)
- Electrical conductivity
- Total cyanide
- Major ions
- Total alkalinity as calcium carbonate (CaCO3)
- Nutrients
- Bacteria (total coliforms and Escherichia coli (E. coli))
- Oil and grease
- Total petroleum hydrocarbons (TPHs) and polyaromatic hydrocarbons (PAHs)

20.1.5 Terrestrial Ecology

Terrestrial flora, vegetation and fauna studies were completed in 2011. The terrestrial flora and vegetation studies assessed the floristic values and potential impacts of a range of proposed infrastructure components for the project. The terrestrial fauna studies assessed the species composition and faunal habitats in the same areas of the flora studies.

20.1.6 Aquatic Ecology

Numerous aquatic ecology surveys of the Watut River system have been undertaken over the last three decades, primarily for the Hidden Valley Mine EIS and for subsequent permitting requirements. There have been no substantial surveys completed on the Wafi River or smaller streams within the project area. These studies will be undertaken during the FS and reported in the EIS.

20.1.7 Cultural Heritage and Archaeology

Two cultural heritage surveys have been conducted around the project area. The 2007 survey focussed on the near-mine areas, whilst the 2011 survey focussed on the proposed Markham Gap area. Both surveys were conducted with the help of local informants from the Yanta, Hengambu and Babuaf groups.

20.1.8 Socio-economic Baseline

There is limited demographic and socio-economic information available for the project area. It is expected that the 2011 PNG census will provide some information specific to the project area, much of the remaining data is only available at provincial, district or local government level. Accordingly, several studies have been undertaken over the past 10 years to determine the socio-economic circumstances of the communities in the project area.

These studies generally cover villages that are close to the Wafi and Golpu deposits and do not extend over proposed infrastructure that is distant from the deposits. The baseline studies will be updated and extended geographically as part of the FS process.

20.2 Plans for Waste Disposal, Monitoring, Water Management

There are two main types of mine waste that will be produced during operation of the Project, tailings from ore processing and waste rock from mine development.

20.2.1 Tailings

The proposed copper concentrator will produce tailings as a waste product. Up to 22 Mt/y of tailings will be produced. A comprehensive options assessment has been completed for a range of terrestrial tailings storage facilities (TSFs). The options assessment looked at various criteria including:

- Capacity
- Constructability
- Operating costs
- Impacts to the environment – operating and closure periods
- Impacts on communities

Several potentially suitable sites for an on-land tailings storage facility were identified, all of which are within 15 to 20 km of the mine site. Further site investigations are planned as part of the feasibility study.

20.2.2 Waste Rock

Waste rock and overburden material will be generated during the initial development of the access declines as well as earthworks activities during the construction phase. This waste rock will be disposed within engineered dumps. Several waste rock dump sites have been identified within 15 to 20 km of the mine site. Further site investigations are planned as part the feasibility study.

20.3 Permitting Requirements

The permitting and licensing aspects of the Golpu Project will be regulated primarily under the Mining Act 1992, Mining (Safety) Act 1977 and Environment Act 2000. The requirements for leases, permits and agreements are outlined in these Acts.

20.3.1 Permits and Licenses – Existing and Under Application

The WGJV is the registered holder of two exploration licences (ELs), EL440 (Mt Wanion) and EL1105 (Mount Watut). The PFS proposes mining the Golpu copper-gold deposit within the area of EL440 through a decline constructed from Lower Watut River valley on EL1105. These ELs are required to be renewed biennially. WGJV also holds four permits under the Environment Act. Two environment permits are held for drilling activities, one permit for road construction activities between Bavaga Village and the Lower Watut River flats and one to allow pump tests around the Golpu deposit. The license details are listed below.

- WE-L2A (63) Water Extraction Permit
- WD-L2A (84) Water Discharge Permit
- WD-L2B (314) Water Discharge Permit for construction of a new national road
- WI-L2A (14) Water Investigation Permit

WGJV is also applying to the Department of Environment and Conservation to amend its road construction permit WD-L2B (314) to include the construction of a 2,000 person camp on the Watut flats. This permit is currently in draft form.

20.3.2 Project Permitting Strategy

Newcrest and Harmony as owners of the project have engaged with the PNG Government to ensure a clear alignment on the objectives and requirements for the project development. This engagement will include the permitting strategy which will be necessary for the development of the Golpu deposit.

20.3.3 Environment Permitting

Environmental permits are required for a variety of activities associated with ongoing exploration at Golpu. A PFS recommendation is to embark on advanced exploration works to accelerate data collection as part of the feasibility study. Aspects of the advanced exploration works will require approvals under the PNG Environment Act 2000. These approvals will be applied for at the appropriate time in accordance with the project schedule. A full EIS for the development of Golpu will be undertaken as part of the Feasibility Study.

20.3.4 Compensation and Community Participation Agreements

The Project currently has a compensation agreement in place with the Yanta and Hengambu Clans covering exploration activities on the 50:50 land at Wafi (50:50 refers to a court ruling on the ownership of this land between these parties). A Compensation Agreement has been negotiated with the Babuaf Clan in relation to the new construction camp on the Watut flats.

A series of village-based Community Participation Agreements have been proposed to commit the Golpu project to specific community development activities as an interim arrangement until the project's Memorandum of Agreement is in place, which is expected to be required prior to the commencement of any mining activities.

20.4 Social and Community Requirements

Negotiations with communities with respect to the development phase of the project are in their early stages. While agreements are currently in place for exploration activities, additional community agreements for land access and compensation will be expected to be put in place for the increased disturbance associated with aspects of the development phase of the project.

Landowner boundaries around Golpu have not been formally determined. The responsibility for determining landowner boundaries remains with the State and this process has been underway for some time and there is no immediate indication that formal landowner boundaries will be determined in the immediate future. This is not expected to cause any delay to the commencement of the advanced exploration works.

Inward migration to the project area is occurring and is expected to continue, mitigation and management measures for which will be further developed as part of the Feasibility Study. A household survey/census was conducted in 2007 and identified 100 households in two villages in the potential footprint of the currently envisaged mining operation.

20.5 Mine Closure Requirements

A conceptual closure framework exists for closure planning which identifies the expected main issues with closure and the key objectives for closure. The level of detail is consistent with this stage of the project development. A more detailed closure plan will be developed during the Feasibility Study.

Detailed mine closure planning will be an ongoing process over the life of the mine, estimated to be in excess of 25 years. Key principles essential for successful closure include development of:

- a closure framework, including closure objectives, criteria and indicators
- consideration of closure within the design process
- ongoing consultation with key landowners and stakeholders
- progressive rehabilitation, maintenance and decommissioning plans
- sustainable communities plans including health, education, infrastructure, human capital development, law and order ,and business development
- a strategy for unforeseen circumstances such as unplanned closure.

20.5.1 Legislation and Policy

The guiding principles of mine closure planning within PNG are described in the Mine Closure Policy and Guidelines prepared by the Department of Mining and the Office of Environment and Conservation (DOM/OEC, 2005) which is still in draft form. The policy states that a conceptual closure plan must provide a suitable basis for identifying the risks that arise and ensuring the appropriate performance of environmental closure.

21 CAPITAL AND OPERATING COSTS

21.1 Capital Cost Estimate

The capital cost estimate relates to the PFS Reserve Case comprising Lifts 1 and 2 of the Golpu project only, and has been categorised by major phase of project development as follows:

- Phase 1 - pre execution expenditure from 1 July 2012 to 31 December 2014 (includes studies and advanced exploration works);
- Phase 2 - other pre-production expenditure through to first commercial production (being 2019 in the PFS Reserve Case); and
- Phase 3 - post first commercial production capital expenditure.

The estimate of initial capital cost encompasses Phases 1 and 2, and covers all expenditure required to conduct studies; secure project approvals; design, construct and commission the mine, materials handling system and operating facility at the designated initial level of output and quality. This includes project management, technical support, temporary works, construction services, start-up commissioning and pre-production operating costs.

Sustaining capital is the capital required to maintain capital works at the designated level of output and quality post completion of Phase 2. This includes replacement of equipment and other assets as they reach the end of their effective life. Sustaining capital costs are described in Section 21.2 and Table 21.3.

Working capital includes the value of stores and inventories on-hand, cash in bank and trade debtors, less the amount of trade creditors, payables and any overdraft facilities. Working capital is not explicitly included in the estimate of capital costs, though its existence has been reflected in the cash flow estimate and financial model.

The capital cost estimate is presented in January 2012 United States dollars in real terms and is built up with regard to the categories summarised in Table 21.1.

Table 21.1 Capital Cost Estimate Categories

Capital cost estimate category	Description
Mining	Mine access Ventilation Lift development Materials handling Mine mobile equipment Other mine infrastructure
Treatment plant	Stockpile conveyors Concentrators Concentrate pipeline Tailings dam and pipelines
Treatment plant services & utilities	Site development Buildings and facilities Major utilities Mobile equipment
Regional infrastructure	Access roads Concentrate drying, storage & outloading Power generation & high voltage distribution Other infrastructure
Project indirects	Temporary works Construction support services Project overheads, management and other costs

21.2 Estimate Development for Capital Cost

The capital cost estimate has been developed based on preliminary layout drawings and general arrangement drawings for all major facilities. Major equipment and components were identified and sized for the required mine capacity and ore characteristics. Estimate values were generally calculated on a first principles basis, with works quantified to a PFS level and cost rates applied for both supply and install elements representative of market conditions prevailing at the time of the estimate.

Bulk materials (mainly structural concrete and steel work) have been quantified using developed layout drawings and preliminary engineering data drawn from similar projects globally.

Pricing for major equipment has been based on market quotes obtained over the past 12 months. Material and installation costs are based on extrapolations from similar projects and benchmarked against PNG project data available to the project team.

Indirect project costs such as temporary works, construction support services, engineering, procurement and construction management have been extrapolated from the direct costs based on similar projects in PNG as available to the project team.

Other capitalised costs have been estimated through a combination of detailed bottom-up estimates and allowances, having regard to similar projects known to the project team.

Allowance for contingency has been provided in the estimate of each capital cost category. The project capital cost estimate (including contingency) is consistent with PFS level estimates with an accuracy range of +/- 25%.

Capital cost estimates have been developed over a period of time in which economic conditions, particularly as they related to resource projects, were more buoyant than is currently the case. Current market conditions have resulted in both capital and operating costs being generally more favourable than they were at the time of generating cost estimates. PFS Reserve Case capital cost estimates do not reflect these recent changes and therefore represent a significant optimisation opportunity during the Feasibility Study (hence described as “un-optimised”).

The capital cost estimate developed for the PFS Reserve Case is presented in Table 21.2.

Table 21.2 Life-of-Mine Capital Expenditure*

Capital Profile (USD Million, 100% Basis)				
	Phase 1	Phase 2	Phase 3	Total
	FY13 - 1H FY15	2H FY15 - 1H FY19	2H FY19 - EOM	
Direct Costs				
Mine	207	761	2,709	3,676
Process Plant	0	652	422	1,074
Infrastructure	18	540	4	562
Power Supply	0	472	0	472
Total Direct Cost	**224**	**2,425**	**3,135**	**5,784**
Indirect Costs				
Project Management	173	507	250	929
Owners Costs	106	529	314	949
Drilling & Studies	249	196	0	444
Total Indirect Costs	**527**	**1,232**	**564**	**2,323**
Contingency	54	383	555	993
Sustaining Capital			668	668
Total Capital Cost	**806**	**4,039**	**4,922**	**9,767**

**Based on un-optimised PFS*

Total initial capital to first commercial production (Phases 1 and 2) is estimated in the PFS Reserve Case to be US$4,845M.

As mentioned, working capital is not explicitly included in the capital cost estimate but is included in the cash flow estimate and financial model used for economic analysis.

Estimates for sustaining capital have generally been developed having regard to the frequency of equipment and infrastructure replacement experienced in PNG, as known to the project team. Table 21.3 contains a more detailed breakdown of the estimated sustaining capital requirements shown in Table 21.2.

Table 21.3 Sustaining Capital

Category	US$M
Allowance for post-commissioning optimisation – concentrator and power station	14
Compliance	220
Power station major rebuilds/upgrades	23
Mobile equipment replacement (mine)	221
Mobile equipment replacement (non-mine)	75
Building replacements/refurbishment	90
IT and communications upgrades	25
Total	**668**

The capital cost estimate is based on the following assumptions:

- Site conditions (location, geotechnical, topographical, climate, access, etc.) at the time of the expenditure are not significantly different from that currently assessed to be the case;
- The basic port facility is established by third parties at no capital cost to the project and the project pays commercial rates for use;
- A 100MW power station is included in the capital cost estimate to supply initial power requirements. The longer term power supply will be sourced from a combination of third party power, provided at commercial rates, and the 100MW power station;
- Any upgrades to public roads, bridges and associated infrastructure are effected by third parties; and
- Materials for engineered fills, pavements and concrete production are available locally at commercial rates.

21.3 Operating Cost Estimate

The operating cost estimate covers all operating expenditures for mining and processing activities for the Golpu project through to the loading of concentrate onto vessels for export to customers. Operating costs commence with initial post-commissioning ore delivery to the process plant. For the PFS Reserve Case, production is estimated to ramp up to a 15Mtpa production rate over a five year period while development of Lift 2 proceeds. Production is estimated to increase to an annual production rate of 22Mtpa by Operating Year 11 (financial year 2029).

The operating cost estimates have been developed on a financial year basis and are presented in January 2012 United States dollars in real terms.

Operating costs have been categorised as presented in Table 21.4.

Table 21.4 Operating Cost Categories

Name	Description
Mining	Includes all mine operation and maintenance functions associated with mine drainage and dewatering, underground operations, fixed surface facilities and materials handling systems through to the process plant stockpile discharge, technical and engineering support.
Process Plant	Includes all operation and maintenance of the process plant, concentrate slurry and dewatering plant, tailings disposal system to pipeline discharge point and return water line, plant site infrastructure, technical and engineering support.
Infrastructure	Includes operation and maintenance of the Lae Tidal Basin port facilities, 100MW power station and supply systems, high voltage distribution and switchyards, permanent accommodation, off-site support facilities, roads and civil maintenance, raw water supply, waste water treatment, tailings dam and communications.
General and Admin (G&A)	Includes executive management, administration, health, safety, environment and community, human resources, commercial, legal and finance functions, and other operating overheads.

21.4 Estimate Development for Operating Cost

Operating cost estimates exclude royalties, product refining and transport charges which are offset against revenues in the financial model used for the economic analysis. Corporate taxes are not depicted in operating costs though are included in the cash flow estimate and financial model.

Manning schedules have been developed to estimate total workforce requirements by operating period and classify labour by source and roster cycle. Labour rates applied to the manning schedules have been estimated using present day terms. Travel, site accommodation and meals have been calculated based on manning schedules and costed at current rates applicable for the location.

The estimated unit cost per employee includes personnel related expenses such as recruitment, mobilisation costs, local transport costs, personal protective equipment, safety supplies, training programs, and medical services. Experience with the Hidden Valley operations assisted the basis for estimation.

Other costs were also estimated having regard to Hidden Valley operations data. These include general freight between Lae and the project sites, IT/computing, communications, supply of small equipment (<$2,000), office supplies, cleaning, local government and community costs, donations and sponsorships, regulatory body approval fees, and consultants. Security and emergency response services assume owner operation and are included in labour schedule estimates.

Power consumption estimates have been developed using engineering data available to the project team. The operating cost estimate assumes power is supplied initially from the 100MW power station, and subsequently from both the 100MW power station and third party power supplier.

Cost estimates include the supply cost of equipment spare parts, maintenance materials and consumables necessary to maintain facilities and mobile equipment.

Annual consumption rates for major equipment have been estimated using a range of manufacturer specifications provided to the project team. Total fuel usage has been calculated based on the estimated operating demand per unit of equipment.

Annual cost rates applied to installed units of equipment have been developed based on manufacturer recommendations and comparable operating experience available to the project team. Cost estimates include scheduled maintenance replacement parts, lubricants, filters and grease, tyres, tracks, and ground engaging tools. An allowance for unscheduled repairs has been made.

Process plant operating consumables include grinding and filter media. Cost estimates have been based on consumption rates estimated using comparable operating experience available to the project team.

Chemical and reagents required for ore processing and other chemical supplies used for tailings, potable water and waste water treatment have been costed using consumption rates estimated with reference to comparable operating experience available to the project team.

The operating cost estimates have been developed over a period of time in which economic conditions, particularly as they related to resource projects, were higher than is currently the case. The PFS Reserve Case operating cost estimates do not reflect recent changes and therefore represent an opportunity during the Feasibility Study to optimise. Costs generally correlate with commodity prices but have not, in this economic analysis, been reduced in line with the declining metal price assumptions.

The operating cost estimate is consistent with a PFS estimate with an accuracy range of +/- 25%.

Average life-of-mine unit operating costs are presented in Table 21.5.

Table 21.5 Average Life-of-Mine Operating Cost Estimate

Area	**PFS Reserve Case (US$/t processed) (Life-of-Project)**
Mining	8.64
Processing	7.39
Infrastructure	1.61
G&A	5.01
Total Operating Cost	**22.65**

22 ECONOMIC ANALYSIS

22.1 Description of Newcrest Economic Analysis

This section contains Newcrest's economic analysis of the PFS Reserve Case. A real discount rate of 5% has been used.

The PFS Reserve Case does not reflect the potential that exists to enhance project outcomes and economics through identified opportunities including lower capital costs, improved metallurgical recoveries, accelerated production ramp-up, establishment of a further mining lift at depth and continued exploration success. Refer to sub-section 22.9 for more detail regarding optimisation of the project that will be pursued during the Feasibility Study.

22.2 Key Assumptions

The Golpu project will produce a copper and gold concentrate. The PFS Reserve Case long term gold and copper prices, applied from 2029, are presented in Table 22.1. Costs have not been reduced in line with the reduction in long term prices.

Table 22.1 Long-term Metal Price Assumptions

Commodity	Unit	Price
Gold	US$/oz	1,250
Copper	US$/lb	3.10

Treatment, refining and transport costs included in the financial model have been estimated having regard to market rates and outlook at the time of the estimate and the location of the Golpu project. The charges used in the economic analysis are summarised in Table 22.2.

Table 22.2 Treatment, Refinery and Transport Costs

Item	Unit	Cost or Charge
Ocean Freight	US$/wmt	40
Treatment Cost	US$/dmt	80
Refining Charge	USc/lb	8

A corporate tax rate for PNG entities of 30% has been adopted for the financial analysis. Construction capital expenditure is depreciated at a rate of 25% using the diminishing value method.

Allowance has been made for a royalty of 2% of net smelter revenue payable to the PNG Government.

22.3 Production Scenarios

The PFS Reserve Case production schedule is based on the Mineral Reserve estimate. Ore production is forecast to commence in FY19. The production schedule of the Golpu project adopted for the PFS Reserve Case is presented in Table 22.3.

Table 22.3 Golpu PFS Reserve Case Production Schedule

	Unit	LOM	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31-EOM
PFS Reserve Case															
Ore Mined & Treated	Mt	**450**	0.4	2.9	6.7	10.2	15	15	18	18	20	22	22	22	278
Au grade	g/t	**0.86**	0.79	0.89	0.80	0.72	0.61	0.58	0.84	1.1	1.1	1.2	1.1	1.1	0.79
Cu grade	%	**1.2**	1.3	1.5	1.3	1.2	1.0	1.0	1.2	1.3	1.4	1.4	1.5	1.5	1.1
Au Recovery	%	**61**	63	62	61	60	57	55	54	59	63	67	67	67	61
Cu Recovery	%	**93**	94	94	92	92	91	90	88	91	92	95	96	96	92
Au Produced	koz	**7,741**	6	51	103	139	167	155	281	406	469	557	538	531	4,337
Cu Produced	kt	**5,051**	4	41	80	110	142	139	195	219	250	298	315	312	2,944
Concentrate Grade	% Cu	**27**	28	28	27	27	26	26	26	26	26	28	29	29	27

Based on un-optimised PFS

The production profile presented in Table 22.3 reflects an un-optimised transition of production from Lift 1 to Lift 2. This optimisation will be addressed in the Feasibility Study. Refer to sub-section 22.9. Higher grades in Lift 1 from recent drilling have not been considered in this analysis.

22.4 Capital Costs

The Life-of-Mine capital cost estimated for the Golpu PFS Reserve Case of US$9.767B is shown by phase in Table 22.4.

Table 22.4 Life-of-Mine Capital Expenditure

Capital Profile (USD Million, 100% Basis)				
	Phase 1	**Phase 2**	**Phase 3**	**Total**
	FY13 - 1H FY15	**2H FY15 - 1H FY19**	**2H FY19 - EOM**	
Direct Costs				
Mine	207	761	2,709	3,676
Process Plant	0	652	422	1,074
Infrastructure	18	540	4	562
Power Supply	0	472	0	472
Total Direct Cost	**224**	**2,425**	**3,135**	**5,784**
Indirect Costs				
Project Management	173	507	250	929
Owners Costs	106	529	314	949
Drilling & Studies	249	196	0	444
Total Indirect Costs	**527**	**1,232**	**564**	**2,323**
Contingency	54	383	555	993
Sustaining Capital			668	668
Total Capital Cost	**806**	**4,039**	**4,922**	**9,767**

Capital cost estimates have been developed with reference to economic conditions prevailing over the past 12 months. Recent market developments have resulted in capital costs beginning to decline from recent levels. PFS Reserve Case capital cost estimates do not reflect these recent changes but will be optimised in the Feasibility Study.

22.5 Operating Costs

Total Life-of-Mine operating costs estimated in the PFS Reserve Case are US$10.2B over the approximately 26 year production life of the project. The operating cost estimate is consistent with PFS level estimates with an accuracy range of +/- 25%.

Average life-of-mine unit operating costs estimated in the PFS Reserve Case are presented in Table 22.5.

Table 22.5 Average Life-of-Mine Operating Cost Estimate

Area	PFS Reserve Case (US$/t processed) (Life-of-Project)
Mining	8.64
Processing	7.39
Infrastructure	1.61
G&A	5.01
Total Operating Cost	**22.65**

Operating cost estimates have been developed with reference to economic conditions prevailing over the past 12 months. Recent market developments have resulted in operating costs beginning to decline from recent levels. Costs also generally correlate with commodity prices but have not been reduced in this economic analysis in line with the declining metal price assumptions. The PFS Reserve Case operating cost estimates will be optimised in the Feasibility Study.

22.6 Other Items

Mine closure costs (estimated at US$200M) and initial working capital (estimated at US$60M) are not included in the capital or operating cost estimates as discussed earlier in this document. They have been included in the cash flow estimate and the financial model.

22.7 Results of the Newcrest Economic Analysis

Key parameters of the PFS Reserve Case are shown in Table 22.6.

Table 22.6 PFS Reserve Case Parameters

Case Parameter	PFS Reserve Case
Lift 1	Probable Ore Reserve
Lift 2	Probable Ore Reserve
Lift 3	N/A
Mill throughput	22Mtpa
Ramp up	Standard
Metallurgical recovery	Un-optimised

Newcrest's estimates of Net Present Value (NPV), Internal Rate of Return (IRR) and Payback Period for the PFS Reserve Case are shown in Table 22.7. NPV is calculated on mid-period cash flows with a reference date of July 2012.

Table 22.7 Newcrest's Economic Analysis of the PFS Reserve Case

Parameter	Unit	PFS Reserve Case (100% basis)
Net cash flow	US$M	12,139
NPV@ 5%	US$M	2,504
IRR of US$ NPV	%	8.4%
Payback period	Years	16
Discounted payback period	Years	19

Based on un-optimised PFS

The PFS Reserve Case has not been optimised to refine the production profile, optimise the capital or operating costs or incorporate factors identified in the PFS with the potential to impact production, grade and metal recoveries for the Golpu development. These include higher grades and recovery in Lift 1, optimised metallurgical recoveries for gold, accelerated production ramp up and increased long-term production rate and the potential for a third mining lift (Lift 3) immediately below Lift 2. Refer to sub-section 22.9.

Net cash flows estimated in the Newcrest economic analysis of the Golpu PFS Reserve Case are presented in Table 22.8.

Table 22.8 Newcrest's Economic Analysis of the Annual Cash Flows*

		LOM	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21
Operating Cost	US$M	**-10,191**	0	0	0	0	0	0	-125	-244	-291
Capital Cost	US$M	**-9,767**	-223	-426	-320	-406	-1,144	-1,641	-1,142	-548	-268
Taxes & Royalties	US$M	**-6,269**	0	0	0	0	0	0	-1	-7	-14
Net Revenue	US$M	**38,664**	0	0	0	0	0	0	40	357	695
Other [1]	US$M	**-297**	18	17	-8	8	61	43	-86	-67	-46
Net Cash Flow	US$M	**12,139**	-205	-409	-328	-399	-1,082	-1,598	-1,314	-510	77

		FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31- EOM
Operating Cost	US$M	-340	-383	-380	-410	-407	-429	-443	-445	-446	-5,847
Capital Cost	US$M	-546	-673	-630	-428	-221	-192	-176	-102	-96	-582
Taxes & Royalties	US$M	-19	-24	-23	-33	-145	-296	-423	-451	-471	-4,363
Revenue	US$M	935	1,169	1,111	1,625	1,906	2,123	2,425	2,400	2,373	21,504
Other [1]	US$M	7	-5	1	-56	-41	-21	-27	-8	-2	-88
Net Cash Flow	US$M	37	84	79	699	1,092	1,185	1,355	1,394	1,359	10,624

1. Includes working capital, accounts payable and receivable and mine closure costs

**Based on un-optimised PFS.*

22.8 Further Optimisation Potential to be Addressed in Feasibility Study

The PFS also identified several factors with the potential to improve production, grade and metal recoveries for a Golpu development beyond that assumed and modelled for the PFS Reserve Case including:

- Higher Grade and Recovery in Lift 1: A further three holes recently drilled into the upper section of the Golpu deposit returned high grade intercepts within the Lift 1 envelope. This drilling has revealed that the volume of high grade porphyry has the potential to be greater than that currently modelled in the PFS reserve case in the upper section (Lift 1) of the Golpu deposit, supporting higher grades and higher metal recoveries in Lift 1.

- Optimised Metallurgical Recovery for Gold: Metallurgical recoveries are yet to be optimised. Future test work programs are planned during the Feasibility Study with the objective of improving gold recovery and enhancing the metallurgical performance of the concentrator.

- Ramp up and Production Rate: The PFS Reserve Case adopts moderate assumptions regarding ramp up and sustainable production rates. The Feasibility Study will assess the opportunity and impact of accelerating the ramp up in production and sustaining higher mining and processing rates than considered in the PFS Reserve Case.

- Additional Mining Lift: Holes drilled at depth beneath Lift 2 (lower horizon of the Probable Ore Reserve) have returned the highest grade drill intercepts so far recorded at Golpu. These indicate potential for a third mining lift beneath the current base of the Golpu Probable Ore Reserve. The Feasibility Study will assess the opportunity and impact of a third mining lift at Golpu.

It should be noted that this upside potential has not been included in the Newcrest economic analysis.

22.9 Sensitivity Analysis

Outcomes of Newcrest's economic analysis of the PFS Reserve Case are sensitive to commodity prices, grade, capital and operating costs and metallurgical recoveries. The impact of each of these factor are shown on a 100% in Tables 22.9 – 22.13.

Table 22.9 Metal Price Sensitivity Cases

Gold Price	**Long Term (US$/oz)**	**NPV (US$M)**	**IRR (%)**
-10%	1,125	2,222	8.1%
PFS Reserve Case	1,250	2,504	8.4%
+10%	1,375	2,786	8.8%
Spot Price	1,750	3,381	9.4%
Copper Price	**Long Term (US$/lb)**	**NPV (US$M)**	**IRR (%)**
-10%	2.80	1,623	7.3%
PFS Reserve Case	3.10	2,504	8.4%
+10%	3.40	3,380	9.5%
Spot Price	3.70	3,700	9.7%
Gold & Copper Prices	**Long Term**	**NPV (US$M)**	**IRR (%)**
Spot Prices – Gold & Copper	US$1,750/oz US$3.70/lb	4,574	10.5%

Table 22.10 Grade Sensitivity Cases

Gold Grade	LOM (g/t)	NPV (US$M)	IRR (%)
-15%	0.77	2,082	7.9%
PFS Reserve Case	0.86	2,504	8.4%
+15%	0.94	2,924	8.9%
Copper Grade	**LOM (%)**	**NPV (US$M)**	**IRR (%)**
-15%	1.09%	1,245	6.8%
PFS Reserve Case	1.21%	2,504	8.4%
+15%	1.33%	3,752	9.9%

Table 22.11 Operating Costs Sensitivity Cases

Direct Operating Costs	LOM (US$/t)	NPV (US$M)	IRR (%)
-10%	20.39	2,808	8.8%
PFS Reserve Case	22.65	2,504	8.4%
+10%	24.92	2,199	8.0%

Table 22.12 Capital Cost Sensitivity Cases

Project Capital	LOM (US$M)	NPV (US$M)	IRR (%)
-20%	7,815	3,609	10.6%
-10%	8,791	3,058	9.5%
PFS Reserve Case	9,767	2,504	8.4%
+10%	10,743	1,945	7.5%

Table 22.13 Average Metallurgical Recovery Sensitivity Cases

Recovery Cases	Au %	Cu %	NPV (US$M)	IRR (%)
PFS Reserve Case	61%	93%	2,504	8.4%
Increased gold recovery	71%	93%	2,964	9.0%
Increased gold and copper recovery	75%	95%	3,391	9.5%

The sensitivities shown above are discrete as they relate to each variable. It is possible that a combination of different variables eventuates, compared with the PFS Reserve Case, producing a different economic outcome. For example, Table 22.14 below illustrates the sensitivity to a variation in metal prices and recoveries.

Table 22.14 Illustrative Combined Sensitivity Cases

Recovery Cases	Long Term Metal Price		Metallurgical Recoveries			
	Gold (US$/oz)	Copper (US$/lb)	Au %	Cu %	NPV (US$M)	IRR (%)
PFS Reserve Case	1,250	3.10	61%	93%	2,504	8.4%
Illustrative Combined Sensitivity Case*	1,750	3.70	75%	95%	5,692	11.5%

* Sensitivity based on spot metal prices combined with higher metallurgical recovery shown in “Increased gold and copper recovery” sensitivity in table 22.13.

23 ADJACENT PROPERTIES

The MMJV operates the Hidden Valley mining and treatment operation about 70 km south-southeast of Wafi-Golpu. Hidden Valley consists of two open pits mining epithermal gold mineralization and a gold treatment plant.

24 OTHER RELEVANT DATA AND INFORMATION

All relevant data and information is included in other sections of this report.

25 INTERPRETATION AND CONCLUSIONS

The Wafi-Golpu project was initially identified in 1977 with the discovery of the Wafi epithermal gold mineralization leading to the discovery of the copper-gold porphyry mineralization at Golpu in 1990.

A PFS was completed in 2007 and in 2010 the WGJV began a PFS which incorporated further drilling of the Golpu mineralization. A revised Mineral Resource estimate for Golpu was reported in July 2011 and the PFS for the Golpu deposit was completed in August 2012. A revised Mineral Reserve estimate was reported for the Golpu deposit in August 2012.

The Golpu PFS demonstrated the potential of the Golpu deposit to support the development of a major underground mining operation with associated processing facilities and infrastructure on a scale that would rank Golpu as the largest mining development in PNG to date.

The Golpu project is not yet in the Feasibility Study phase. Newcrest and Harmony are engaging with key stakeholders (including the PNG and provincial governments, landholders and community representatives) to ensure clear alignment on the objectives and requirements for the project development and key elements of the next phase of work. It is anticipated that, subject to satisfactory resolution on these outstanding matters, Newcrest and Harmony will progress the Golpu project into the Feasibility Study phase during the first half of calendar 2013.

In addition, capital and operating costs which have been estimated to PFS level are now being closely evaluated to assess what opportunities exist to further refine them given the continuing weaker global economic conditions.

The PFS also identified several factors with the potential to impact production, grade and metal recoveries for a Golpu development beyond that assumed and modelled for the PFS Reserve Case. These include higher grade and recovery in Lift 1, optimised metallurgical recovery for gold, production ramp up and production rate enhancements and opportunity for an additional mining lift immediately below Lift 2.

There is a number of early stage exploration porphyry targets located along the entire length of the Wafi Transfer Zone, and drilling conducted to date has confirmed the presence of porphyry related mineralisation. In the years ahead, exploration will continue in the Wafi Transfer Zone.

26 RECOMMENDATIONS

The Golpu PFS was completed in August 2012 and it is expected that a Feasibility Study will follow. The Golpu project is not yet in the Feasibility Study phase. Newcrest and Harmony are engaging with key stakeholders (including the PNG and provincial governments, landholders and community representatives) to ensure clear alignment on the objectives and requirements for the project development and key elements of the next phase of work. It is anticipated that, subject to satisfactory resolution on these outstanding matters, Newcrest and Harmony will progress the Golpu project into the Feasibility Study phase during the first half of calendar 2013.

It is recommended that capital and operating costs which have been estimated to PFS level are closely evaluated to assess what opportunities exist to further refine them, particularly given the continuing weaker global economic conditions.

It is recommended that opportunities with the potential to impact production, grade and metal recoveries for a Golpu development beyond that assumed and modelled for the PFS Reserve Case be fully investigated during Feasibility Study phase. These include higher grade and recovery in Lift 1, optimised metallurgical recovery for gold, production ramp up and production rate enhancements and opportunity for an additional mining lift immediately below Lift 2.

It is recommended that exploration activities within the Wafi-Golpu Property continue whilst the Golpu deposit progresses through the Feasibility Study phase and the Wafi deposit progresses to the PFS phase.

The Feasibility Study is estimated to take two years to complete. Pre-Execution Phase expenditure for the period 1 July 2012 to 31 December 2014 is estimated at approximately US$800 million (100% terms). The majority of this spend comprises resource definition drilling and studies (approximately US$250 million), access decline and advanced exploration works (approximately US$200 million) and EPCM and owners' costs (approximately US$250 million).

27 REFERENCES

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28 QUALIFIED PERSON'S CERTIFICATE

Colin Moorhead
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MELBOURNE VIC 3004

1. I, Colin Moorhead, do hereby certify that I am Executive General Manager, Minerals, Newcrest Mining Limited.
2. I am a graduate of the University of Melbourne and hold a Bachelor of Science (Hons.) in Geology with a geophysics major.
3. I am a Fellow of the Australasian Institute of Mining and Metallurgy.
4. I have worked as a geologist for a total of 25 years since my graduation from university. My relevant experience includes 16 years fulfilling the roles of exploration geologist, mine geologist, geology manager and technical services manager at Newcrest's Australian open pit and underground mining operations, two years as geology manager at Newcrest's Indonesian mining operation, two years as General Manager Technical Services responsible for technical excellence and resources and reserves governance and four years in the role of Executive General Manager, Minerals responsible for exploration, mine geology and resources and reserves governance throughout Newcrest.
5. I have read the definition of 'Qualified Person' set out in National Instrument 43 101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfil the requirements to be a 'Qualified Person' for the purposes of NI 43-101.
6. I am responsible for the preparation of all Sections of the Technical Report titled Technical Report on the Wafi-Golpu Property, dated 29 August 2012 (the Report). I visited the Wafi-Golpu Project on 15 May 2012.
7. I have had prior involvement with the Property that is the subject of the Report. This involvement is via my role as Executive General Manager, Minerals with Newcrest where I am the executive responsible for exploration, mine geology and resource and reserves governance throughout Newcrest.
8. I am not independent of the issuer applying all of the tests in Section 1.5 of National Instrument 43-101.
9. I have read National Instrument 43-101 and Form 43-101F1, and the Report has been prepared in compliance with that instrument and form.
10. As of the effective date of the Report, to the best of my information, knowledge and belief, the part(s) of the Report for which I am responsible contains all scientific and technical information that is required to be disclosed to make the Report not misleading.

29 August 2012

Original signed by

Colin Moorhead