OPTIMISATION OF THE
PROMINENT HILL
FLOTATION CIRCUIT

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CONTENTS

• Introduction
• Reagent Scheme Optimisation
• Cell Design Optimisation
• Process Control Optimisation
• Conclusion
Prominent Hill is located:

- 650 km north-northwest of Adelaide and 150 km northwest of Roxby Downs (Olympic Dam) in South Australia.
• Iron oxide hosted copper-gold (IOCG) deposit- chalcocite, bornite and chalcopyrite with additional “gold only” ores

• Mining started 2006, process plant commissioned early 2009

• Total reserves currently 69.8Mt with 1.1% Cu and 0.60g/t Au (as at June 2012)

• Extension study underway to increase mine life
INTRODUCTION

Process Flowsheet

CRUSHING AND STOCKPILE
- Gyratory Crusher
- Crushed Ore

From Mine

GRINDING
- SAG Mill
- Screen
- Primary Cyclones
- Ball Mill

FLOTATION
- Rougher Flotation
- Regrind Cyclones
- Regrind Mill
- Cleaner Flotation 1
- Cleaner Flotation 2
- Cleaner Flotation 3
- Jameson Cell

CONCENTRATE DEWATERING AND STORAGE
- Concentrate Thickener
- Pressure Filter
- Concentrate Loadout
- Concentrate Storage

TAILINGS
- Tailings Thickening
- Tailings Storage Facility
INTRODUCTION
Flotation Circuit
INTRODUCTION
Regrind Mill (IsaMill)
INTRODUCTION
Jameson Cell
**PROCESS OPTIMISATION**

**Flotation Optimisation Objectives**

- **Copper Sulphide Recovery**
  - Increased revenue

- **Gold Recovery**
  - Smelter credits

- **Throughput**
  - Through improved flotation of coarse materials

- **Consumables Costs**
  - Reagents

*Ongoing diagnostic and mineralogy testwork to determine potential improvements*
### PROCESS OPTIMISATION

**Design Predictions**

- Throughput design is 8Mtpa
- Maximum predicted recovery for a single ore type is 88% for copper and 77% for gold
- Actual recovery would be expected to be lower with blending

<table>
<thead>
<tr>
<th>Ore Type</th>
<th>Predicted Concentrate Grade</th>
<th>Predicted Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cu %</td>
<td>Cu %</td>
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<tr>
<td>Chalcocite-Bornite</td>
<td>54</td>
<td>88</td>
</tr>
<tr>
<td>Chalcopyrite-Pyrite</td>
<td>25</td>
<td>83</td>
</tr>
<tr>
<td>Bornite-Chalcopyrite</td>
<td>34</td>
<td>80</td>
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REAGENT SCHEME OPTIMISATION
Implementation Process

- Laboratory flotation tests
- Plant trial
- Statistical analysis via paired t-tests
## REAGENT SCHEME OPTIMISATION
### Statistical Analysis

- Test pairs randomly generated to create an “on/off” trial

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<th>Test Status</th>
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</tr>
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</table>
### REAGENT SCHEME OPTIMISATION

#### Statistical Analysis

- Test pairs randomly generated to create an “on/off” trial
- t-test to compare two means (1 sided)
- The P-value provides the level of confidence with which we can say there is an improvement
- The difference between the mean recoveries provides the best estimate of what that improvement is

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<td>13/07/2011</td>
<td>Day 404 Off</td>
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</table>
Thionocarbamate

CMS 2500® and SEX showed an average of 1.1% copper recovery improvement at 98.8% confidence compared to SEX alone

Permanently added to the ball mill feed
• CMS 2500® used in conjunction with SEX is able to improve flotation of copper sulphide minerals

• Xanthate will tend to form multi-layers around the mineral particles at the more active sites contributing to extreme hydrophobicity and froth instability

• The thionocarbamate reacts at the most active sites but forms mono-layers, leaving SEX to react at less active sites, providing a more uniform collector coverage and stable froth
• Permanently incorporated into the concentrator reagent scheme via the existing ‘Test Reagent’ ring main infrastructure

• Minor changes to the existing setup which was similar to the xanthate ring main

• Control of dosage from the DCS
Dithiophosphate

Aero 404® showed an average of 1.68% gold recovery improvement at 95.9% confidence compared to the existing scheme (SEX and CMS 2500®)

Permanently added to the rougher feed and Jameson Cell tailings
Dosed from a self bunded tank

Two small pumps send to the two dosing points

Power source for pumps set to trip with the SAG Mill
DSP 110® showed an average of 0.35% copper recovery improvement at 95.0% confidence compared to the existing scheme (SEX, CMS 2500® and Aero 404®).

- Permanently added to the rougher feed
- Thionocarbamate
<table>
<thead>
<tr>
<th>Collector</th>
<th>Type</th>
<th>Addition Points</th>
<th>Dosage (g/t)</th>
<th>Purpose</th>
<th>Recovery Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Ethyl Xanthate (SEX)</td>
<td>Xanthate</td>
<td>Primary hydrocyclone feed hopper</td>
<td>10-30</td>
<td>Selective sulphide collector</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rougher circuit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jameson Cell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>First cleaner circuit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interfroth CMS2500®</td>
<td>Thionocarbamate</td>
<td>Ball mill</td>
<td>1.5-3.5</td>
<td>Copper recovery</td>
<td>1.10% Cu</td>
</tr>
<tr>
<td>Cytec Aero 404®</td>
<td>Dithiophosphate</td>
<td>Rougher circuit head</td>
<td>3</td>
<td>Gold recovery</td>
<td>1.68% Au</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cleaner circuit head</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orica DSP110®</td>
<td>Thionocarbamate</td>
<td>Rougher circuit head</td>
<td>0.25</td>
<td>Copper recovery</td>
<td>0.35% Cu</td>
</tr>
</tbody>
</table>

- Sodium ethyl xanthate as the main collector
- Additional collectors proven to aid in recovery
- Currently no activators or depressants employed
Mineralogical test work showed that rougher losses occurred in coarse (>100µm) and fine (<C5) fractions.

These losses could be targeted by retrofitted designs intended to enhance mixing and suspension.

Installations were completed in stages during planned shut down periods.

Cell Design Optimisation
Rotor-Stator Design (Outotec FloatForce®)

- Replaced MultiMix® design with half length stators
- Allows increased slurry circulation
- Allows improved mixing efficiency at higher air rates
• Bi-directional pitch-blade turbine on shaft exerts downwards force
• Enhances mixing in large cells such as the 150m³ OK-150s
• Improves coarse particle mixing and recovery
• Installed in cells 1 to 3 in December 2010 and 4 to 6 in March 2012
CELL DESIGN OPTIMISATION
Improved Coarse Particle Suspension

- $P_{80}$ measured before and after pitch blade installation
- Samples taken at four cell depths
- Demonstrates improved coarse particle suspension
## Results Summary – 2010 and 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>&gt;106</th>
<th>106-C1</th>
<th>C1-C4</th>
<th>C4-C5</th>
<th>&lt;C5</th>
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<tbody>
<tr>
<td>2010</td>
<td>4.3</td>
<td>2.1</td>
<td>0.8</td>
<td>0.2</td>
<td>2.3</td>
</tr>
<tr>
<td>2011</td>
<td>3.3</td>
<td>1.4</td>
<td>0.8</td>
<td>0.2</td>
<td>1.6</td>
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<tr>
<td>Total reduction</td>
<td>1.0</td>
<td>0.7</td>
<td>0.0</td>
<td>0.0</td>
<td>0.7</td>
</tr>
</tbody>
</table>

- Both fine and coarse fraction losses were reduced across this period.
- Increased coarse recovery allows greater feed $P_{80}$ and therefore greater throughput (9.9Mtpa in 2011).
- From mineralogy reports, total copper and gold rougher losses reduced by 2.4% and 1.0% respectively.
**PROCESS CONTROL OPTIMISATION**

**Mintek FloatStar® (Level Stabilisation)**

- Multi-variable feed forward control system
- Applied to cell and intermediate hopper level controllers
- Limits propagation of disturbances downstream

• Metallurgist sets mass pull and operator controls air settings on cells
• Flow Optimiser controls relative mass pull of each cell using the level controls
• Consistent feed to concentrate pump ensuring stable flow downstream

CONCLUSIONS

• Increased throughput in 2011 of 9.9Mtpa (24% above design capacity of 8Mtpa)

• Improved copper recovery in 2011 of 90.5% (design maximum of 88%)

• Rigorous approach to reagent trials using statistical analysis

• Improved coarse particle recovery

• Improved circuit stability due to expert process control systems