THE USE OF RTK GPS IN BLAST OPTIMIZATION “THE CASE OF GOLD FIELDS GHANA LTD, TARKWA”

BY
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EILAT 2009, FIG WORKING WEEK

PRESENTATION OUTLINE

INTRODUCTION

BACKGROUND

PROBLEM STATEMENT

OBJECTIVES

GPS APPLICATION

CONCLUSIONS

THE USE OF RTK GPS IN BLAST OPTIMIZATION

WE DELIVER
Tarkwa Gold Mine is owned by Gold Fields Ghana, IAMGOLD and the Government of the Republic of Ghana in a 71%, 19% and 10% ratio.

Tarkwa is a large, low-grade open pit gold mining operation being operated by Gold Fields Ghana Limited (GGL).

Annual production average is 110 million tonnes.

Tarkwa Mine is located in Southern Ghana between Latitude 5° 15’N – 5° 30’N and Longitude 1° 50’W – 2° 05’W.

The concession covers an area of approximately 295 km² extending from the town of Tarkwa in the south for a distance of 25 km to Huni Valley in the northeast limit.
**BACKGROUND**

**Mine Geology**

- The producing section of the concession is in two ridges which extend over a strike length of 12km and are perpendicular to each other. The gold bearing reefs of the area are called conglomerate and are focused in the lower part of the Tarkwaian System.

- Due to the alternating nature of the reef/waste layers within the ore body, selective mining is practiced at Tarkwa. This allows the mine to achieve planned grades by separating the ore from waste in a way that minimizes dilution and minimizes ore loss.

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**THE USE OF RTK GPS IN BLAST OPTIMIZATION**

If blast fragmentation is poor, conditions will not allow select mining to be optimised (the planned dilution will not be respected) and the grade reconciliation can be poor as a result.
**BACKGROUND**

<table>
<thead>
<tr>
<th>Machine Type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liebherr 984 Excavators</td>
<td>4</td>
</tr>
<tr>
<td>Liebherr 994_200 Excavators</td>
<td>4</td>
</tr>
<tr>
<td>Liebherr 9250 Excavators</td>
<td>1</td>
</tr>
<tr>
<td>Liebherr 994B Excavators</td>
<td>2</td>
</tr>
<tr>
<td>Liebherr 994B Face Shovel</td>
<td>1</td>
</tr>
<tr>
<td>O&amp;K RH120 Excavator</td>
<td>3</td>
</tr>
<tr>
<td>Caterpillar 785C Trucks</td>
<td>44</td>
</tr>
<tr>
<td>Tamrock Pantera 1500 Drill Rigs</td>
<td>22</td>
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</table>

**STATEMENT OF PROBLEM**

- Before the introduction of RTK GPS into the blasting process at Gold Fields Ghana limited (GGL), blast fragmentation was resulting in sub-optimal feed size to crushers on the Mine and an unfriendly floor conditions resulting in excessive sheeting of digging floor to prevent tyre damage.
- Using RTK GPS to improve blast fragmentation through accurate drill depth and design pattern in order to achieve a constant throughput.
- Increase pit loading efficiency.
- Decrease rock breaker hours.
- Reduce equipment damage.
- Reduce in-pit sheeting costs respectively.
The primary objectives of the blast optimization are:

- To maximize crusher throughput.
- To minimize loading times.
- To minimize cycle times.

GPS APPLICATION

RTK GPS Set-up at GGL

- The system is made up of
- 1 R 5700 Trimble unit
- 1 R 5800 mobile base unit
- 10 R 5800 receivers (Rovers)

A calibration survey was performed on 8 known control points to establish the base station with the following results:
Current RTK GPS application include:
- Planimetric control points survey
- Pit excavation volume survey
- Mine plan design survey
- Grade control mark-out survey
- Drill pattern design mark-out

Calibration Results

<table>
<thead>
<tr>
<th>From-To</th>
<th># of Satellites</th>
<th>RMS (m)</th>
<th>Slope Distance (m)</th>
<th>Horizontal Precision (m)</th>
<th>Vertical Precision (m)</th>
<th>PDOP (m)</th>
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</thead>
<tbody>
<tr>
<td>Base-PT6</td>
<td>7</td>
<td>0.005</td>
<td>3481.582</td>
<td>0.010</td>
<td>0.016</td>
<td>1.305</td>
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<tr>
<td>Base-PT9</td>
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<td>0.004</td>
<td>2418.006</td>
<td>0.010</td>
<td>0.017</td>
<td>1.652</td>
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<tr>
<td>Base-PS3</td>
<td>6</td>
<td>0.004</td>
<td>1835.020</td>
<td>0.007</td>
<td>0.017</td>
<td>2.096</td>
</tr>
<tr>
<td>Base-TEB1</td>
<td>7</td>
<td>0.003</td>
<td>2927.499</td>
<td>0.006</td>
<td>0.012</td>
<td>1.888</td>
</tr>
<tr>
<td>Base-GFID13</td>
<td>10</td>
<td>0.006</td>
<td>5296.384</td>
<td>0.010</td>
<td>0.017</td>
<td>1.524</td>
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<td>Base-AKE5</td>
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<td>0.003</td>
<td>1468.594</td>
<td>0.006</td>
<td>0.011</td>
<td>2.395</td>
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<tr>
<td>Base-AKE3</td>
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<td>0.012</td>
<td>1.124</td>
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<td>Base-KOT3</td>
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<td>0.006</td>
<td>4412.562</td>
<td>0.007</td>
<td>0.012</td>
<td>1.135</td>
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</table>
GPS APPLICATION

Accuracy Test on RTK GPS Positions

- Periodic accuracy test is conducted on the system to ascertain its reliability and one of such exercise is tabulated on the next slide.
- Six control points were established at different locations and monitored at different times of the day when satellite availability differs significantly.
- The overall error margins were less than 10cm in both axes which is an indication of good quality RTK operation.

<table>
<thead>
<tr>
<th>STATION</th>
<th>EASTING</th>
<th>NORTHING</th>
<th>ELEVATION</th>
<th>DATE</th>
<th>dE</th>
<th>dN</th>
<th>dZ</th>
<th>MISCLOSE VECTOR</th>
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</thead>
<tbody>
<tr>
<td>MK1</td>
<td>9983.53</td>
<td>11241.00</td>
<td>212.65</td>
<td>31/12/2008</td>
<td>-0.01</td>
<td>0.03</td>
<td>0.00</td>
<td>0.03</td>
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<tr>
<td>MK2</td>
<td>9866.60</td>
<td>11513.59</td>
<td>211.97</td>
<td>0.01</td>
<td>0.09</td>
<td>-0.01</td>
<td>0.09</td>
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<tr>
<td>MK3</td>
<td>9813.33</td>
<td>11826.45</td>
<td>208.25</td>
<td>0.08</td>
<td>0.00</td>
<td>0.01</td>
<td>0.08</td>
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<tr>
<td>CW1</td>
<td>9235.97</td>
<td>9783.92</td>
<td>187.59</td>
<td>-0.05</td>
<td>-0.01</td>
<td>-0.03</td>
<td>0.05</td>
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<tr>
<td>CW2</td>
<td>9130.80</td>
<td>9748.52</td>
<td>186.02</td>
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<td>0.00</td>
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</tbody>
</table>

WE DELIVER
GPS APPLICATION

Data Acquisition, Processing & Transfer

- Data required for the survey work is normally produced by the drill & blast engineer
- The blast pattern is based on the orientation of the ore body, road network & other geological factors

Block Pattern Layout on Geological data
Pattern Points

THE USE OF RTK GPS IN BLAST OPTIMIZATION

RTK GPS Initialization

THE USE OF RTK GPS IN BLAST OPTIMIZATION

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THE USE OF RTK GPS IN BLAST OPTIMIZATION

Mark-out hole with GPS

Drilling in Operation

Hole Checkers at Work

Implementation of the flags based system in Akontan Ridge, week 37

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GPS APPLICATION

Benefits of RTK GPS Implementation
- improved blast to design boundaries
- Good fragmentation
- Low rock breaker hours

% Blast to Design

THE USE OF RTK GPS IN BLAST OPTIMIZATION

RESULTS

Blast to Design Before Implementation

Blast to Design After Implementation

THE USE OF RTK GPS IN BLAST OPTIMIZATION

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RESULTS

THE USE OF RTK GPS IN BLAST OPTIMIZATION

Fragmentation

Rock size Passing 750mm

<table>
<thead>
<tr>
<th>Month</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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</thead>
<tbody>
<tr>
<td>3.6</td>
<td>3.7</td>
<td>3.8</td>
<td>3.9</td>
<td>4.0</td>
<td>4.1</td>
<td>4.2</td>
<td>4.3</td>
<td>3.6</td>
<td>3.7</td>
<td>3.8</td>
<td>3.9</td>
<td>4.0</td>
<td>4.1</td>
<td>4.2</td>
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</table>

RESULTS

Loading Times

<table>
<thead>
<tr>
<th>Month</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>3.7</td>
<td>3.8</td>
<td>3.9</td>
<td>4.0</td>
<td>4.1</td>
<td>4.2</td>
<td>4.3</td>
<td>3.6</td>
<td>3.7</td>
<td>3.8</td>
<td>3.9</td>
<td>4.0</td>
<td>4.1</td>
<td>4.2</td>
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</table>

WE DELIVER
RESULTS

COST BENEFITS

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Jan-08</th>
<th>Feb-08</th>
<th>Mar-08</th>
<th>Apr-08</th>
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<tbody>
<tr>
<td>Additional gold revenue</td>
<td>1,106,947.91</td>
<td>1,012,933.72</td>
<td>1,810,617.34</td>
<td>2,363,474.46</td>
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<tr>
<td>Reduced equip damages</td>
<td>50,000.00</td>
<td>50,000.00</td>
<td>50,000.00</td>
<td>50,000.00</td>
</tr>
<tr>
<td>Reduced R/Breaker hrs</td>
<td>8,450.26</td>
<td>9,756.04</td>
<td>-10,164.41</td>
<td>-10,222.39</td>
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<tr>
<td>Explosives savings</td>
<td>0.00</td>
<td>4,623.09</td>
<td>31,111.00</td>
<td>76,898.23</td>
</tr>
<tr>
<td>Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drilling flags</td>
<td>750.00</td>
<td>750.00</td>
<td>750.00</td>
<td>750.00</td>
</tr>
<tr>
<td>Tulip</td>
<td>0.00</td>
<td>3,715.00</td>
<td>25,000.00</td>
<td>46,127.50</td>
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<tr>
<td>Net Profit</td>
<td>1,164,648.17</td>
<td>1,072,847.85</td>
<td>1,655,813.93</td>
<td>2,433,272.80</td>
</tr>
</tbody>
</table>

Net Profit

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CONCLUSION

- RTK GPS is less labor intensive and saves cost
- Reduced significantly pit floor sheeting as a result of good floor
- Increased tonnage throughput
- Reduced rock breaker hours
- Improved digger loading times
- Improved truck cycle times

QUESTION TIME

THANK YOU

QUESTIONS

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