The use of RTK GPS in Open Pit Survey – A Case study at Gold Fields Ghana Limited, Tarkwa, Ghana.

by

MENSAH Francis, MPhil student & Chief Surveyor, GGL
DUNCAN Edward Eric, MSc (Glasgow) BSc (Kumasi) Lecturer

Introduction

- GPS is being used for Planimetric controls, detailing as well as a wide variety of engineering applications.
- Goldfields Ghana Limited (GGL) currently operates 10 active mine pits with pit locations being at a maximum distance of 6km apart. GGL management took the bold decision of purchasing some GPS equipment to help facilitate the surveying process and enhancing the map-making process of the company.

History of the Mine

- Mining in the Tarkwa area started as far back as 1800. Around 1877, Skarchley visited Tarkwa and there were about 600 natives engaged in gold production by digging pits to depth of about 24 m or more.
- The Tarkwa mines started around 1878 by a French company under the management of Bonnet until the mine closed down in early 19 century.
- In line with the Ghana Government economic recovery programme, a memorandum of agreement of incorporating the project development was signed on the 26th May 1993, in which GGL acquired 85% shares and took over the operations of the mine on 1st July 1993.

Location, Climate and Topography

- The project area falls within the equatorial climatic zone.
- The topography of the lease area comprises rugged ridges with peaks of 335 m above mean sea level in some areas, interspersed by undulating valley bottoms.

GPS Survey at Gold Fields Ghana Limited

- RTK survey was introduced to GGL in December 2004 to augment the fleet of Sokkia Total Stations being used on the mine.
- The RTK survey system at GGL comprises of 1 R5700 Trimble unit as the main base, 1 R 5800 mobile base, and 5 R 5800 Trimble receivers.

Cont'
Weighted Ambiguity Vector Estimate (WAVE) provided statistics to evaluate the quality of a baseline solution. The statistics in table 2 are the default values indicating good baselines.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Default Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference variance</td>
<td>=1</td>
</tr>
<tr>
<td>Ratio</td>
<td>&gt;1.5</td>
</tr>
<tr>
<td>Root Mean Square (RMS)</td>
<td>&lt;15mm</td>
</tr>
<tr>
<td>PDOP</td>
<td>&lt;7</td>
</tr>
<tr>
<td>Residual Plots</td>
<td>±15mm</td>
</tr>
</tbody>
</table>

From the results above, the RMS values were all within the acceptable limit of <15mm, the PDOP were within acceptable limits of 3 as used in the Trimble Survey Controller. A horizontal precision of 8mm and vertical precision of 14mm were achieved.

The known coordinate of the main base station on WGS-84, Ghana National Grid and GGL Grid was generated and tabulated in table 3.

In other to ascertain the accuracy of the RTK operations, a comparison between conventional survey using Total Station measurement and RTK GPS measurement was performed and the outcome of the survey were as follows:
Table 4: RTK and Total station Survey Analysis

<table>
<thead>
<tr>
<th>WESTING</th>
<th>NORTHING</th>
<th>ELEVATION</th>
<th>WESTING</th>
<th>NORTHING</th>
<th>ELEVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>504.77</td>
<td>500.035</td>
<td>122.31</td>
<td>504.77</td>
<td>500.035</td>
<td>122.31</td>
</tr>
<tr>
<td>504.77</td>
<td>500.035</td>
<td>122.31</td>
<td>504.77</td>
<td>500.035</td>
<td>122.31</td>
</tr>
<tr>
<td>504.77</td>
<td>500.035</td>
<td>122.31</td>
<td>504.77</td>
<td>500.035</td>
<td>122.31</td>
</tr>
<tr>
<td>504.77</td>
<td>500.035</td>
<td>122.31</td>
<td>504.77</td>
<td>500.035</td>
<td>122.31</td>
</tr>
<tr>
<td>504.77</td>
<td>500.035</td>
<td>122.31</td>
<td>504.77</td>
<td>500.035</td>
<td>122.31</td>
</tr>
</tbody>
</table>

The results between the two techniques compared very well with the distance closures ranging from 8mm to 59mm, with an average closure of 33mm and a standard deviation of 1mm.

The Usage

- Currently, RTK GPS is being used at GGL for the following surveys:
  - Road survey
  - Topographical survey (Pit floor pick ups.)
  - Stakeout survey (grade control, mine design pegs, blast pattern layout)
  - Stockpile survey

RTK GPS Usage

- Bench Mark
- Grade control pegs demarcation

RTK GPS Survey

- Road Survey Plot

Grade Conrol markout

- Grade control pegs demarcation
Problems associated with RTK usage.

- The basic problem currently been experienced is the erratic radio link in some areas of the mine due to the topography of the operational area as enumerated under topography and drainage in the relevant information about the mine and high PDOP in some pits with high walls thereby restraining surveyors from achieving higher productivity as compared to others.
- It was also observed in the course of the year that when satellite availability exceeds 8 radio data link becomes difficult due to the volume of data that needs to be broadcast through the repeater stations.

Advantages

- RTK survey at GGL have reduced man hours by approximately 40 - 50%, a surveyor is able to demarcate 100 grade control pegs within an hour and half with RTK which other wise could have been achieved at the fastest period of 3 hours by means of Total Station method. There is no need for a surveyor to wait for fog to clear before starting a survey, bad weather is now a thing of the past.

Efficiency

- In order to ascertain the efficiency of the system, control points were installed in 6 out of the 10 Pits currently in operations and monitored over a one week period which yielded the results in table 5.

Accuracy test on RTK positions

Cont'

- From the data above, it could be observed that the partial differences are all less than 10 cm even though the presence of human error due to improper leveling could not be over ruled. This test proved that the RTK GPS is accurate and efficient.

Conclusions and recommendations

- The introduction of RTK GPS has generally enhanced mapping operations at GGL thereby reducing the mapping process by 30%.
- Responses for mapping services by other departments are being met on time and with utmost efficiency. The use of RTK in setting out blast patterns has also improved floor conditions due to accurate drilling depth especially on design ramps.
- For mining purposes the accuracies obtained using GPS were very reliable and of high quality.
- We wish to recommend to Trimble to improve upon the memory battery life of the TSCe which for now does not last for the eight hours guarantee to last.
- To other Mining companies who have not yet tried the technology, we will encourage them to put their money in it for they will never regret they did.
• THANK YOU

• Question Time