GLOBAL JOURNAL OF ENGINEERING, DESIGN & TECHNOLOGY
(Published By: Global Institute for Research & Education)
www.gifre.org

ORIENTATION STUDY OF THE EFFICIENCY OF BULK LEACH EXTRACTABLE GOLD (BLEG) ASSAY METHOD ON HWINIBUTRE AND BENSO ORE SAMPLES AT GOLDEN STAR RESOURCES

Al-Hassan S*. & Abusah R. K.**
*University of Mines and Technology, Tarkwa, Ghana
**Golden Star Resources, Ghana

Abstract

The Hwini-Butre and Benso (HBB) concessions were acquired by Golden Star Resources (GSR) as part of their takeover of St. Jude Resources (SJR). Originally exploration samples (RC and DD) were analysed by 50g Fire assay method. The low repeatability of fire assay data from Hwinibutre and Benso deposits has created a great concern as it could severely impact on resource estimates. Considering an alternative method to improve the analytical reproducibility of assay data, GSR wishes to resort to analyzing 1000g of sub-samples by Bulk Leach Extractable Gold (BLEG) assay method. One challenge is that GSR is not sure about the efficiency of the BLEG method on the samples.

In an attempt to verify the suitability and efficiency of the BLEG analytical method based on the accelerated cyanide leach extraction, 1kg each of RC samples and duplicates representing 10% of the Benso and Hwinibutre drill sample populations were subjected to BLEG orientation study to investigate for theleachability and efficiency of the BLEG method on the Hwinibutre and Benso ore samples. Furthermore, BLEG and fire assay analysis were carried out on selected samples and duplicates to investigate the Au grade reproducibility of the assay methods on ore samples.

The Bulk leach orientation study revealed that their ore samples were leachable with gold recovery levels ranging between 96% and 99.6% for leach time between 8 and 12 hours. The study also indicated that the BLEG assay method was a more suitable method for the Hwinibutre and Benso ore samples than the fire assay method. The cost of the BLEG assay per sample is lower than that for fire assay. It is therefore recommended that, for better reproducibility and assurance in reliability of Hwinibutre and Benso samples, the BLEG method should be preferable.

.

Introduction

Evaluation of a mineral Resource and its economic viability are critically dependent on the quality of assay data as it is this data that defines the grade of the resource. Often the procedures of sampling and chemical analysis used to generate such data are neglected or given little consideration. (Roden and Smith, 2001).

Preliminary metallurgical test results of theHwini-Butre and Benso (HBB) rocks indicate good kinetics to cyanide leaching with no refractory indications (Watts et al, 2002). Quality control data from the traditional or conventional Fire assay (FA) with 50g charge revealed low Au reproducibility and creating a great concern as it could severely impact on the accuracy and reliability of resource estimates.

Recognising this as a potential source of error it was prudent to verify the applicability of other alternative methods such as the Bulk leach extractable gold (BLEG) assay method. Assay data from bulk leached samples have been used for gold successfully elsewhere in Ghana (Al-Hassan and Danuor, 2010)

Location of Deposits

The Hwini-Butre and Benso deposits are located in the Western Region of Ghana (Fig. 1). The Benso concessions are north-northwest of Takoradi and approximately 40 kilometers (straight line distance) south-southwest of the Wassa gold mine. The three land parcels that comprise the concessions include

Subriso, Amantin and Chichiwele. The Hwini-Butre concession is located 30 kilometers south of

The BensoSubriso deposits and east of the town of Mpohor, which is 20 kilometers northwest of Takoradi.

Fig 1 Location Map of the Deposits

Geology

The HBB concessions lie along the southeastern flank of the Birimian-aged (lower Proterozoic) Ashanti Belt, along the same structure as Wassa. The southwestern part of the Hwini-Butre concession covers Mpohor Complex, a syn-volcanic mafic intrusive that is bound to the east and north by the Butre volcanic sequence. The Mpohor Complex is a

polyphase intrusion with compositions ranging from gabbroic to granophyric, with intermediate phases such as diorite and granodiorite. The Butre volcanic sequence, which also underlies the South Benso concession further north, mostly comprises volcanic flows with minor meta-sediment horizons.(Watts, et al., 2002).

Mineralisation

Mineralization on the Hwini-Butre concession is typically associated with shallow east-dipping narrow quartz veins and their associated sericitic alteration halos, with coarse free gold associated with sulfides and as specks within the quartz veins and altered host rocks (Anon, 2006).

Data Collection and Analysis

Data for this work consists of Reverse Circulation (RC) drill samples taken from Hwini-butre and Benso concessions. These samples were selected from field reject RC samples from drill holes with mineralised intersections, originally analysed by the fire assay method. A total of 146 and 246 field samples and duplicates, representing 10% of samples from the Hwinibutre and Benso respectively, were selected for this research. The data was divided into two parts. The first set of data of eight (8) test samples from Hwini-butre and Benso were used to evaluate the efficiency of the Bulk Leach Extractable Gold on the deposit types. The second set of data evaluated the Analytical (Assay) reproducibility of BLEG and fire assay methods...

Sample weight of 3.0 kg were dried in trays and pulverized in a pulverizing mill, to a nominal 85% passing 75µm. Approximately 1kg of sub-sample was taken away for assay and the pulverized residue retained in a plastic bag as laboratory rejects. All preparation equipment were flushed with barren material prior to the commencement of the job to eliminate sample contamination.

A 1000 cm^3 of 0.1% cyanide concentrationwas added to the sample and some definite amount of lime was also added to the sample. The purpose of the lime was to raise the pH of the solution above 8.5. Gold extraction is quite effective between pH value of 8.5 and 11 depending on the type of ore with the agitated leach; the bottle is placed on revolving bars and allowed to roll for a period of time to obtain the optimum leach point. An orientation study is carried out to evaluate leaching characteristics.

The mixture is allowed to be rolled for about 24 hrs. After specified hour intervals, the following were carried out.

1. The bottle is shaken and 50 cc of slurry is decanted into a measuring flask
2. The bottle is closed and allowed to roll for the next specified hour when the procedure was repeated.

50 cc of slurry was allowed to settle till the surface liquor was clear; a volume of 25cc was carefully decanted and extracted into an organic solution DIBK and determined by flame AAS. Detection limit was 0.01ppm.The remaining solid fraction was dried and analyzed for gold byfire assay method. Data was obtained for 1 to 24 hours and it was used to prepareleachability or metal dissolution curves. Resident gold in the tails may indicate whether optimum leach time had been achieved or not. It may also indicate robbing of gold by graphite or clays.

The absolute grade of the ore material is given by equation (1):

Gold in liquor + Gold in tails = Grade (1)

The metal dissolution curve demonstrates the measure of the efficiency of gold recovery by the BLEG method. The recovery is obtained by equation (2)

$$\text{Percentage Recovery} = \left(\frac{\text{Gold in liqour}}{\text{Gold in liqour} + \text{Tail grade}}\right)\times 100\% \quad (2)$$

Where the *Gold in liquor* is the ultimate gold extractions realised by BLEG and *Tail grade* is the residual grade, obtained by fire assay method. Figs 2 and 3 show someleachability curves on Hwinibutre and Benso ore samples respectively. A summary of the extracted grades, optimum recovery levels and time taken to attain the optimum recovery levels are all captured in Table 1

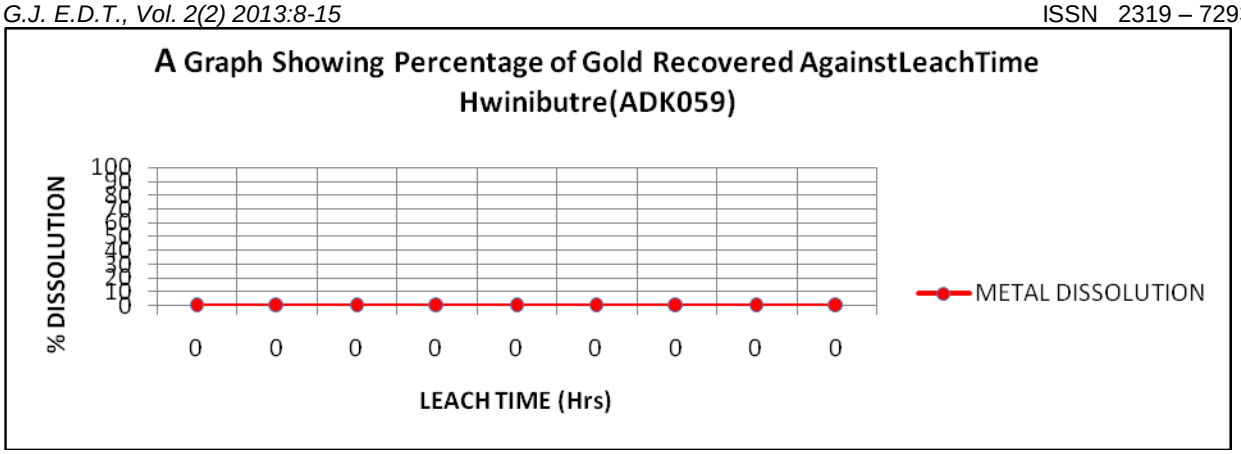

Fig. 2 Gold dissolution curve for the Hwini-Butre ore

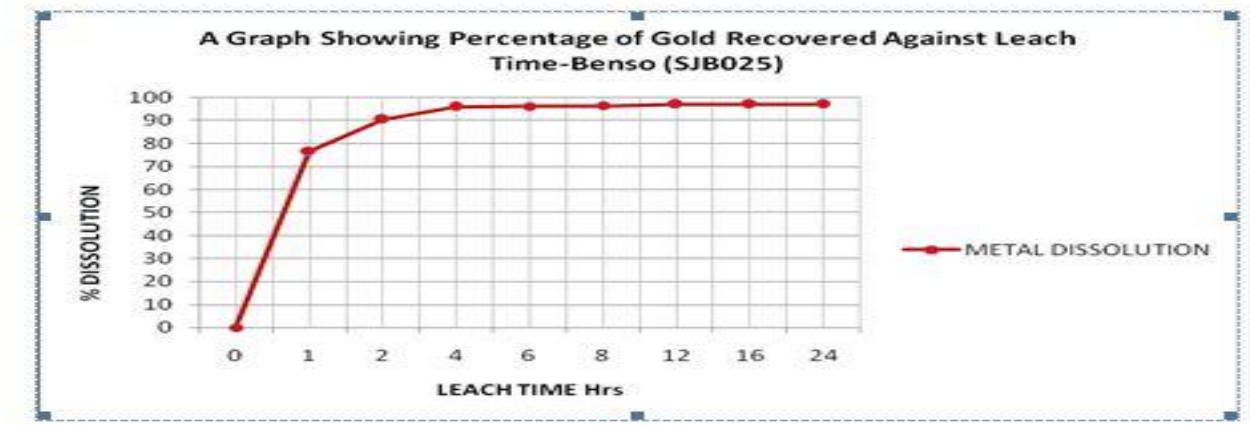

Fig. 3 Gold dissolution curve for the Hwini-Butre and Benso ore

Table 1summary of the leaching behavior of Hwini-Butre and Benso ore samples

Prospect	Sample ID	Extracted grade (g/t)	Residue grade (g/t)	Total gold (g/t)	Percentage Recovery	Optimum leach time (hr)	Ore type
Hwini-Butre	8611	39.88	1.59	41.47	96.2%	8	Fresh
	8612	21.04	0.90	21.94	95.9%	8	Oxide
	8613	33.09	0.78	33.87	97.7%	12	Fresh
	8614	25.44	0.10	25.54	99.6%	12	Oxide
Benso	8615	9.85	0.23	10.08	97.7%	6	Fresh
	8616	40.18	0.38	40.56	99.1%	8	Oxide
	8617	9.53	0.20	9.73	97.9%	6	Oxide
	8618	29.34	0.87	30.21	97.1%	12	Fresh

Percentage Recovery Analysis

As part of the orientation study to investigate the robustness of the BLEG method, ore samples with Au grades from Hwinibutre and Benso were subjected for cyanide leach for 12 hours.71 samples from Hwinibutre and 121 samples from Benso were analysed.

Plots of percentage gold recovered are shown in Figs 4 and 5.

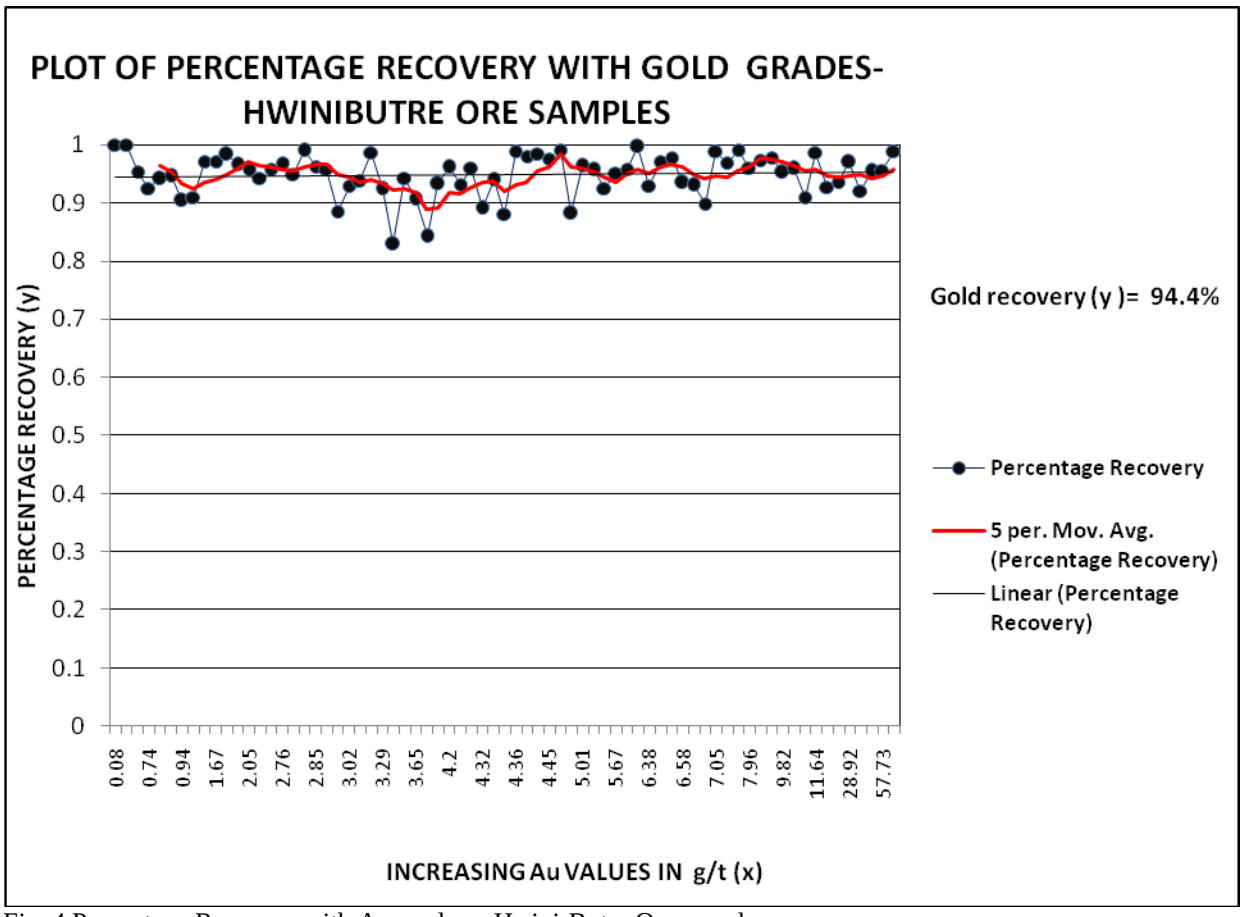

Fig. 4 Percentage Recovery with Au grades – Hwini-Butre Ore samples

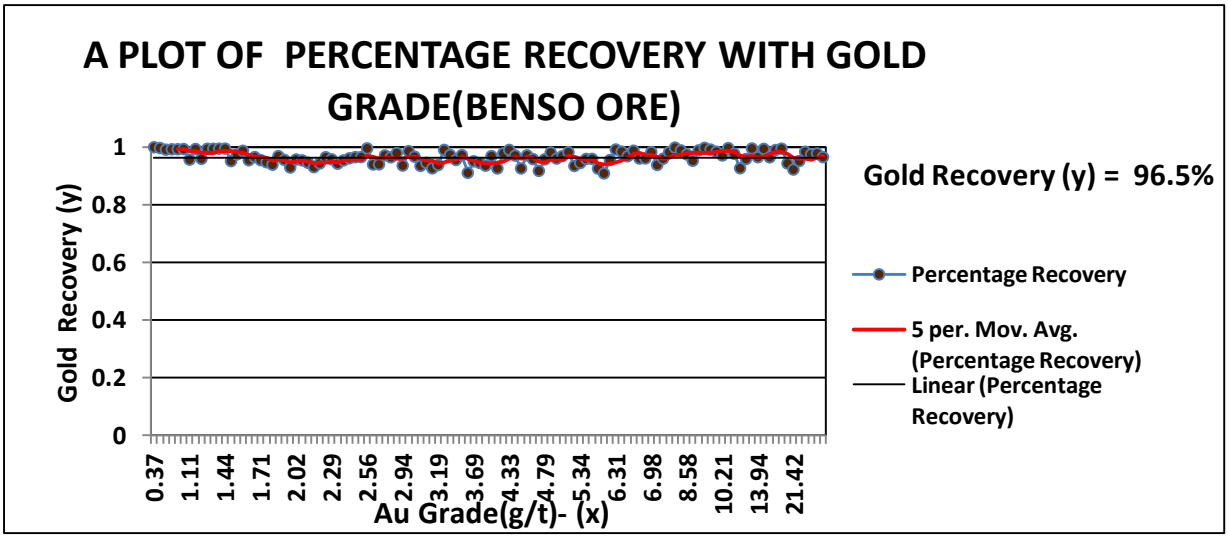

Fig. 5 Percentage recovery of Au grades – Benso ore

Assay repeatability of BLEG on Benso and Hwinibutre ore samples

To investigate assay repeatability, BLEG assay results of field samples and duplicates from Hwinibutre and Benso were analysed using the Half Absolute Relative Deviation plots (HARD).

HARD is expressed as the ratio of the absolute difference between the paired assays relative to the sum of the assay pair and it is expressed as a percentage.

$$\text{HARD} = \left[\frac{|A-B|}{|A+B|}\right] \times 100\%$$

Where:
A = Assay value of the field sample

B = Assay value of the field duplicate sample

Figs 6 and 7 show the HARD plots on Benso RC field duplicates; and Tables 2 and 3 show the analytical precision levels with their associated sample populations under study.

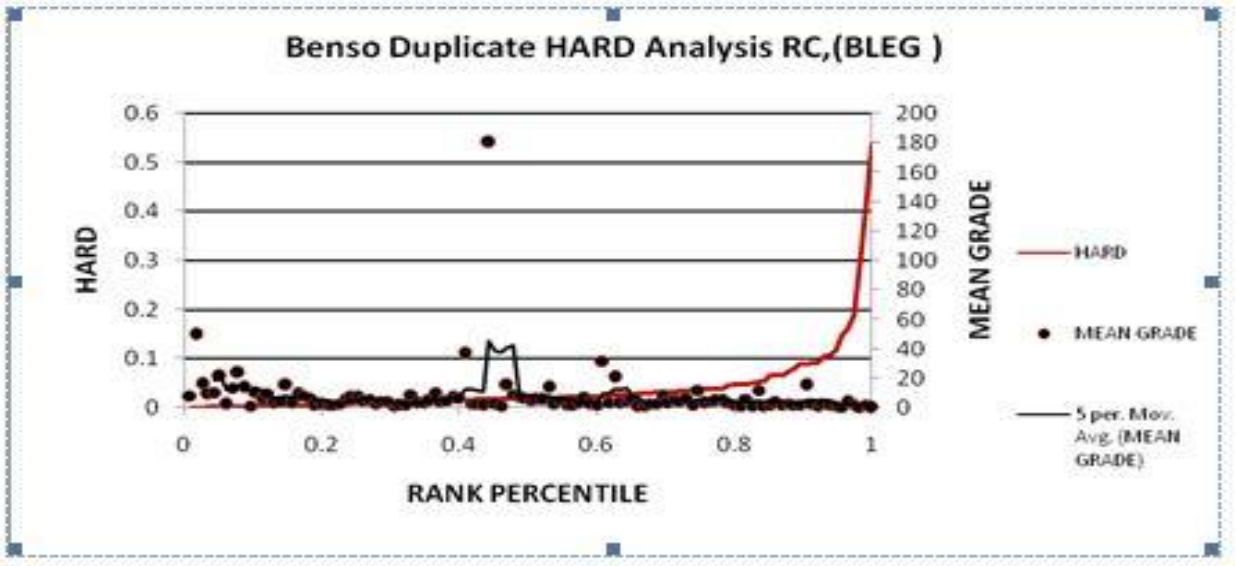

Fig. 6 HARD Analysis of Benso samples and Duplicates

Table 2

PRECISION LEVEL	Percentage of population showing strong Au repeatability
10% HARD	92%
15% HARD	96%

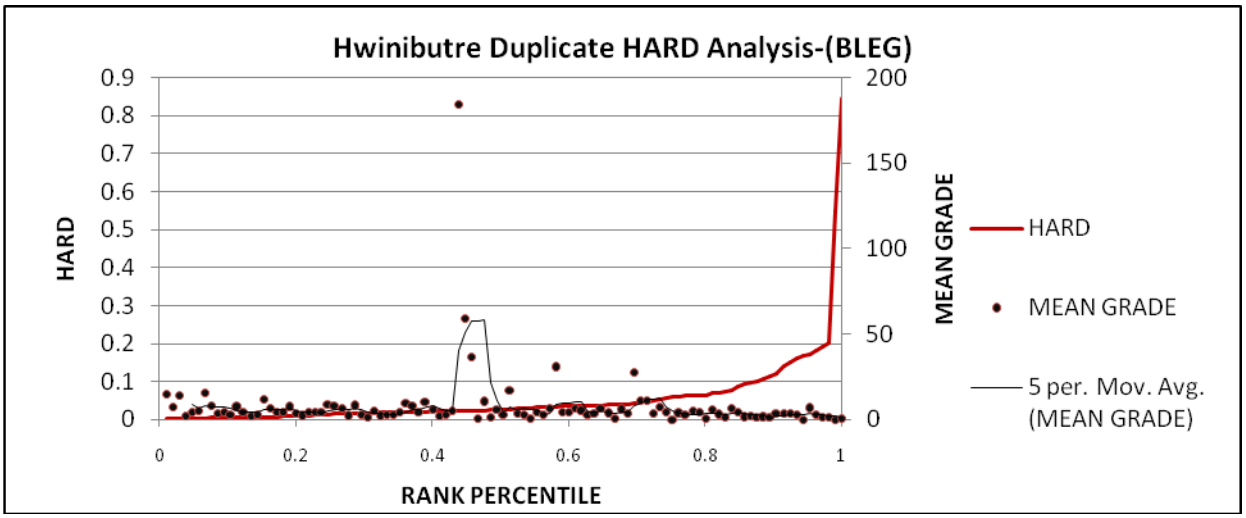

Fig. 7 HARD Analysis of Hwinibutre Duplicate Samples

Table 3

PRECISION LEVEL	Percentage of population showing strong Au repeatability
10% HARD	88%
15% HARD	92%

Assay repeatability of Fire assay method on Benso and Hwinibutre ore samples

Table 4 shows the summary of Au reproducibility of BLEG and Fire Assay on Hwinibutre and Benso samples.

Table 4 Reproducibility of BLEG and Fire Assay on Hwini-butre and Benso samples.

Location	Analytical Method	Precision Level	Percentage Population showing strong Au repeatability
Benso	**BLEG**	10% HARD	92%
		15% HARD	96%
	Fire Assay	10% HARD	58%
		15% HARD	77%
Hwinibutre	**BLEG**	10% HARD	80%
		15% HARD	92%
	Fire Assay	10% HARD	51%
		15% HARD	66%

Cost of Assays

The sample preparation and analytical cost for 50g charge Fire assay is about $9.70 per sample whilst that cost of preparation and analysis for 100g BLEG is about $7.55 per sample (SGS, 2012 rates)

Observations and Discussions

From the analysis of the BLEG orientation study, the following observations were made:

- Hwinibutre and Benso samples were leachable
- Hwinibutre ore samples had recovery levels ranging between 96% and 99.6% with an average recovery of 97.5% with optimum leach time ranging between 8 and 12 hours.
- Benso ore samples had recovery levels ranging between 97% and 99% with an average of 98% within 6 and 12 hours.
- Gold recoveries using the BLEG method were fairly consistent with grade. Average recovery levels were 94% for Hwinibutre ore samples and 96% for BensoHwinibutre and Benso samples respectively.
- BLEG method exhibited stronger Au reproducibility than Fire assay. for all the samples
- The sample preparation and analytical cost for 1000g BLEG was $ 7.55 per sample, which was much lower than $ 9.7 per sample for fire assay (SGS quotes, 2012)

Conclusion

From The studies it can be concluded that:

- Hwinibutre and Benso samples are leachable.

- The BLEG method is relatively cheaper than the Fire assay method, and can practically be implemented.
- The gold variability between the sample pairs observed in the fire assay results is significantly reduced using the BLEG method.
- The total pulverizing of large volume of samples by the BLEG method also helps to homogenize the samples thereby giving it a more realistic and reliable Au grade estimate of samples than fire assay...
- The BLEG is an appropriate analytical method for treating samples with erratic gold distribution.

Recommendations

- It is therefore recommended that for better reproducibility and assurance of reliability of assay results for Hwinibutre and Benso samples, the BLEG method should be used.
- Bulk leaching for 12 hours is recommended for optimum gold recovery.
- Total pulverizing is recommended for all sub samples from Hwinibutre and Benso before subjecting them to BLEG analysis. In this way more representative sample would be achieved.

References

1. Al-Hassan, S. & Danuor, H. K. (2010) "Assessment of Quality of Assay Data on Drill Samples from Golden Star Resources (Prestea/Bogoso) Ltd." Ghana Mining Journal, Vol. 12, December 2010, pp 24 – 31.
2. Roden, S and Smith, T ,2001, " Sampling and Analysis Protocols and Their Role in Mineral Exploration and New Resource Development, in Mineral Resources and Ore Reserve Estimation"- The AusIMM Guide to Good practice (Ed: A.C Edwards), pp73-78.
3. Anon, (2006) "Gold Exploration for problematic ores" (http://www.alsglobal.com/mineral/ALScontent.alsx)
4. Watts, Griffis and McQuat, (2002) www.crewdev.com/default-v-doc-id-761.html