Geological Reconciliation Study: Estimated Remaining Overburden Material and Reserve at Sibanyis Quarry, Kuching, Sarawak

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Abstract:
This study presents the estimated remaining quantity of overburden material (topsoil, completely to highly weathered rock) and remaining geological reserve at Sibanyis Quarry, Kuching after the quarry has been operated for years. Desktop study including literature search was carried out prior field investigation. Three boreholes together with latest topographical and detail survey was conducted to obtain the latest data at Sibanyis Quarry, Kuching. Based on this Geological Reconciliation Study, the estimated total remaining geological rock reserve is 40,022,767 metric tons, and the weathered rock and top soil are 2,159,688 BCM and 1,247,697 BCM respectively. The assumptions that are taken into consideration are top soil thickness of 11m, weathered rock thickness of 15m and rock density of 2.64 mt/m3.

Keywords: Quarry Reserve Estimation, Microtonalite

1.0. Introduction:
Sibanyis Quarry is located 2.4 km north-east of the intersection of Mile 15 Kuching-Serian Road and the Kuching Outer Ring Road (Figure 1). This study presents the estimated remaining quantity of overburden material (topsoil, completely to highly weathered rock) and remaining geological reserve at Sibanyis Quarry, Kuching, Sarawak.

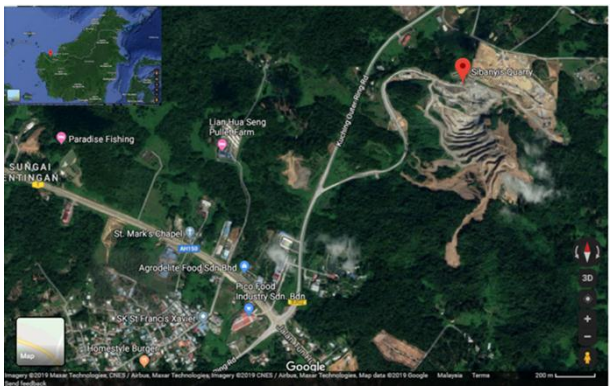

Figure 1: Locality map of the Sibanyis Quarry, Kuching.

The scope of work includes:

a) Review of the existing geological literature

b) Review of the site investigation data based on the SI report.

c) Calculate the remaining overburden (topsoil, weathered rock) and remaining rock reserves

2.0. General Geology of Study Area
Gunung Sibanyis forms an irregular-shaped hill rising to a height about 200m from a ground level of about 22m. It consists of microtonalite which form during the intrusion of Miocene into the country rock of Retian Member of the Serian Volcanic aged Late Triassic [1]. The Retian Member is mainly consisting of volcanic sandstone with some tuff or breccia. However, volcanic conglomerate with pebble to cobble size can be observed at Sibanyis Quarry. Columnar joint is common within the microtonalite body of this quarry with orientation of dipping into south or vertical.

3.0. Method of Investigation
3.1. Field Method
Desktop study including literature search was carried out prior field investigation by referring to previous documented works in the area. The coring work was carried out from 16.04.2019 to 22.06.2019 with 1 unit of rotary wash boring machine (YBM-05) by Watima Testing Sdn Bhd. Three boreholes were proposed at different location, NMLC core barrel is used in this coring operation to retrieve 54mm diameter core samples [2]. The topographical and detail survey was conducted by Survey Solutions in March 2019 and Drone (model: DJI Phantom 4 Pro) surveyed topographic data on August 2019 to obtain the latest profile at Sibanyis Quarry, Kuching. Site investigation especially at the existing outcrops with exposed rock face was carried out to confirm the rock type and the geology with respect to the fracture planes, strata dip and strikes using Brunton compass. GPS instrument is used to determine the rock face and confirmed the boundary of the quarry site.

3.2. Topsoil, Overburden and Reserve Determination
The potential volume of overburden in the area is interpreted based on the information obtained from topographical and detail survey conducted by Drone (model: DJI Phantom 4 Pro) surveyed topographic data on August 2019 and boreholes data from soil investigation report produced [3]. The overburden material defines as overlying soils and the completely to highly weathered rock. The boundary and the height of the interested area are interpreted based on the topographic survey. The volumes of the stone are calculated using windows contouring and 3D surface mapping software known as Surfer. The Positive Volume [Cut] is considered as an estimate reserve volume.

4.0. Site Visit
The study area is underlain by microtonalite (Figure 2). Most of the vegetation on the Gunung Sibanyis has been cleared and the hill has been cut into benches. The investigation was concentrated on microtonalite which is the rock of interest. The rock is jointed with nearly vertically orientated (Figure 3), 25cm to 55cm wide spacing. It is recognized as columnar joints. Highly weathered microtonalite can be easily been found at the upper section (RL 154 to RL180) of the hill with yellow-brownish colored iron-stain on the surface of the rock. Excavator is removing the top soil and trimming the slope at the top

of the hill (Figure 3) before it reaches the hard level and ready for drill and blast operation (Figure 4).

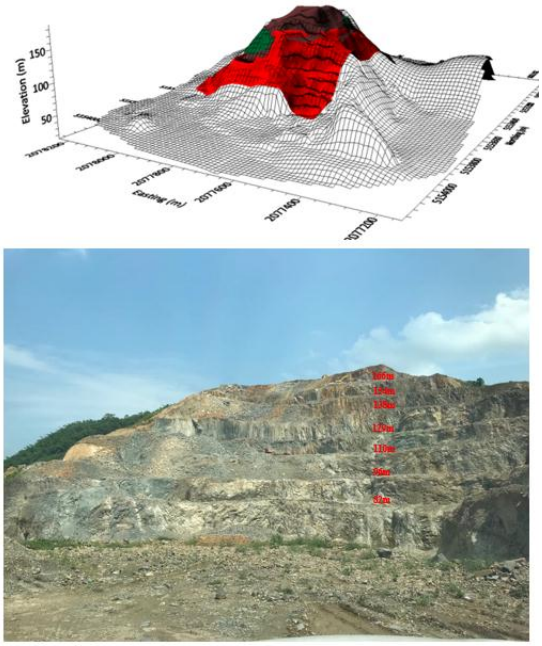

Figure 2: 3D model and site photo of Gunung Sibanyis, Kuching

Figure 3: Jointed weathered rock at upper section of the hill (~RL170).

Figure 4: Top soil excavation and slope trimming in progress.

Figure 5: Drilling operation for blasting work at the top of hill.

5.0. Site Investigation

The coring work was carried out from 16.04.2019 to 22.06.2019 with 1 unit of rotary wash boring machine (YBM-05) by Watima Testing Sdn Bhd. Three boreholes were proposed at different location (Table 1), NMLC core barrel is used in this coring operation to retrieve 54mm diameter core samples.

Table 1: Boreholes location.

Borehole	Easting (m)	Nothing (m)	Termination Depth (below ground level)
BH1	2077752	5153426	30.1m
BH2	2077761	5153397	35.2m
BH3	2077791	5153470	35.4m

Generally, the overburden in area ranges from 18.3m to 31m, comprising orange, and brown to light grey highly weathered microtonalite before reaching slightly weathered microtonalite. Total Core Recovery (TCR) of the core samples remain high which indicates no core loss. Generally, the Rock Quality Designation,RQD of the fresh rock at Gunung Sibanyis is high >75% however, RQD value of highly weathered rock (normally at the upper section of the core samples) remain very poor <25%. Low RQD indicates the rock is highly fractured. Based on observation, this could be due to mechanically fracture or naturally. The texture of the sample normally aphanitic groundmass with phenocrysts comprise of white plagioclase and hornblende (black needle shaped).

6.0. Estimated Topsoil, Overburden and Reserve

The estimated remaining overburden volume is computed based on different in August 2019 topography grid file and interpreted weathered surface grid file based on borehole data within the proposed quarry reserve pit boundary (Figure 2). Surface mapping software – Surfer 15 was used to create a grid file based on the topographic map. This file is made up of location (x and y coordinates) and heights (z coordinate) of many points within the areas delineated for stone reserve estimation. The reserve estimation assumes that the area is all underlain by intrusive rock. However, the computed volume will be considered as remaining reserve after subtracting away the estimated amount of overburden by considering the presence of highly to completely weathered material (~15 m), topsoil (~11m) and irregular topography.

The remaining stone reserves were estimated for five z values corresponding to contour level 180m, 166m, 154m, 138m, 129m, 110m, 96m, 82m, 68m, 54m, 40m and 26m the levels down to which quarrying may be finally taken. These reserves maybe considered as remaining "geological reserve". The actual remaining "workable reserve' i.e. reserves that may be practically exploited as rock aggregates, would be the "geological reserve" minus the amount that may not be practically quarried or used, this being allowance made mainly for highly jointed or weathered rocks occurring at depth, haulage roads, and slope stability. Potential remaining "workable reserve" were calculated for 90%, 80% and 70% of the remaining 'geological reserve" (Table 2). If the intended annual production were 500,000MT, the corresponding quarry life may then be determined; the quarry life was also calculated for annual production of 2,200,000MT (Table 3). The total in-situ reserve of proposed area is estimated based on the specific gravity of 2.64 for microtonalite.

It is estimated that 1,247,697 BCM of the top soil is remaining based on August 2019 topography data while the remaining weathered rock is 2,159,688 BCM. If quarrying were to be taken down to the 26m contour level, the potential remaining stone reserve or remaining "geological reserve" of the proposed quarry site would be 40,022,767MT. Assuming that 90% of this reserve may be practically exploited, the remaining "geological reserve" would be 36,020,490MT; this amount would be able to sustain quarry operation for about 72.0 years at an annual production of 500,000MT. If the annual production were to be 2,200,000MT, then the potential remaining quarry life would be about 16.4 years.

7.0. Comparisons

Based on Sibangis Quarry Master Plan, the estimated total geological rock reserve is 47,509,462 metric tons, and the weathered rock and top soil are 422,524 BCM and 1,533,781 BCM respectively. The assumptions that are taken into consideration are overburden thickness of 9m, weathered rock thickness of 2m and rock density of 2.64 mt/m3. Based on this Geological Reconciliation Study, the estimated total remaining geological rock reserve is 40,022,767 metric tons, and the weathered rock and top soil are 2,159,688 BCM and 1,247,697 BCM respectively. The assumptions that are taken into consideration are top soil thickness of 11m, weathered rock thickness of 15m and rock density of 2.64 mt/m3. The summary of geological reconciliation study quantity and master plan quantity is presented in Table 2.

Table 2: Comparison of quantity between this study and Master Plan Quantity.

Geological Reconciliation Study Quantity		Master Plan Quantity
1,247,697 BCM	**Top Soil**	1,533,781 BCM
2,159,688 BCM	**Weathered Rock**	422,524 BCM

40,022,767 MT	**Geological Reserve**	47,509,462 MT

Table 3: Remaining Life of Proposed Quarry.

Contour Level from top reserve contour (after deduct estimate overburden) down to which quarrying is taken	Potential Remaining 'Geological Reserve" (MT)	Potential Remaining "Workable Reserve"		Potential Remaining Quarry Life (Years)	
		Percentage of "Geological Reserve"	Metric Ton (MT)	If Annual Production is 500,000 MT	If Annual Production is 2,200,000 MT
Top Reserve Contour Level to 180m	0	100%	0	0.0	0.0
		90%	0	0.0	0.0
		80%	0	0.0	0.0
		70%	0	0.1	0.0
Top Reserve Contour Level to 166m	48,212	100%	48,212	0.0	0.0
		90%	43,391	0.1	0.0
		80%	38,569	0.1	0.0
		70%	33,748	0.1	0.0
Top Reserve Contour Level to 154m	387,026	100%	387,026	0.8	0.2
		90%	348,323	0.7	0.2
		80%	309,621	0.6	0.1
		70%	270,918	0.5	0.1
Top Reserve Contour Level to 138m	1,867,094	100%	1,867,094	3.7	0.8
		90%	1,680,385	3.4	0.8
		80%	1,493,675	3.0	0.7
		70%	1,306,966	2.6	0.6
Top Reserve Contour Level to 129m	3,040,475	100%	3,040,475	6.1	1.4
		90%	2,736,427	5.5	1.2
		80%	2,432,380	4.9	1.1
		70%	2,128,332	4.3	1.0
Top Reserve Contour Level to 110m	6,287,835	100%	6,287,835	12.6	2.9
		90%	5,659,051	11.3	2.6
		80%	5,030,268	10.1	2.3
		70%	4,401,484	8.8	2.0
Top Reserve Contour Level to 96m	9,541,826	100%	9,541,826	19.1	4.3
		90%	8,587,643	17.2	3.9
		80%	7,633,461	15.3	3.5
		70%	6,679,278	13.4	3.0
Top Reserve Contour Level to 82m	13,721,656	100%	13,721,656	27.4	6.2
		90%	12,349,490	24.7	5.6
		80%	10,977,325	22.0	5.0
		70%	9,605,159	19.2	4.4
Top Reserve Contour Level to 68m	18,998,730	100%	18,998,730	38.0	8.6
		90%	17,098,857	34.2	7.8
		80%	15,198,984	30.4	6.9
		70%	13,299,111	26.6	6.0
Top Reserve Contour Level to 54m	25,243,290	100%	25,243,290	50.5	11.5
		90%	22,718,961	45.4	10.3

		80%	20,194,632	40.4	9.2
		70%	17,670,303	35.3	8.0
Top Reserve Contour Level to 40m	32,179,616	100%	32,179,616	64.4	14.6
		90%	28,961,654	57.9	13.2
		80%	25,743,693	51.5	11.7
		70%	22,525,731	45.1	10.2
Top Reserve Contour Level to 26m	**40,022,767**	100%	40,022,767	80.0	18.2
		90%	**36,020,490**	**72.0**	**16.4**
		80%	32,018,213	64.0	14.6
		70%	28,015,937	56.0	12.7

8.0. Conclusions and Recommendation

a) Based on the latest quarry site condition and latest coring data conducted in year 2019, the estimated overlying soils and the completely to highly weathered rock is 11m and 15m respectively. The values are more than average thickness (overburden = 9m; weathered rock = 2m) which has been estimated by previous geologist.

b) Based on this geological reconciliation study, the estimated topsoil and weathered rock 1,247,697 BCM and 2,159,688 BCM respectively.

c) If quarrying were to be taken down to the 26m contour level, remaining stone reserve or remaining "geological reserve" of the proposed quarry site would be 40,022,767MT. Assuming that 90% of this reserve may be practically exploited, the potential remaining "geological reserve" would be 36,020,490MT; this amount would be able to sustain quarry operation for about 72.0 years at an annual production of 500,000MT. If the annual production were to be 2,200,000MT, then the potential remaining quarry life would be about 16.4 years.

9.0. Acknowledgement

The authors bear no responsible to the losses for any third parties who use the reserve data for economic purposes.

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