J E M T
Journal of Earth and Marine Technology
homepage URL: ejurnal.itats.ac.id/jemt

Laterite Nickel Mine Sequence Modeling Based on Total Reserve at Block 5A, "Bonus" Pit by Surpac 6.3.2 at PT Bintang Delapan Mineral in Bahodopi District, Morowali Regency, Central Sulawesi

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DOI: j.jemt.2021.v2i1.1725

Article info
Received:
February 17, 2021
Revised:
February 27, 2021
Accepted:
March 5, 2021
Published:
March 31, 2021

Keywords:
modeling, reserves, nickel, mine sequence, surpac 6.3.2

Abstract
PT. Bintang Delapan Mineral is an active nickel mine company that produces 300,000 tons of nickel per month by open pit method. During the mine operation, the company needs to calculate the reserves periodically due to decreasing nickel reserves in the long time period. Mineral reserves estimation is a process to determine and define the grade and boundary of a mineral deposit. Reserves estimation can be done manually using several methods. One method is called block modeling which presents the estimation process in block model type by applying a mining software, called Surpac 6.3.2. It was able to present the progress of mine site activity (pushback). The result of nickel reserves estimation by Surpac 6.3.2 block modeling is 48730 m3 or equal to 73096 tons. The nickel reserves have an average grade of 1.64%. By this reserve estimation, mine sequences could be created into 7 sequences in considering bench height. Bench model specifications are bench high 4 m, berm 2 m, and 60º slope.

1. Introduction

The potential availability of mineral resources in Indonesia is quite abundant and almost spread throughout the archipelago. This is one of the capitals for development activities, proven in the rich sphere of Indonesian expenditure due to mineral resources that generate substantial revenues for taxes and royalties annually.

The abundance of mineral resources owned by Indonesia consists of various types, ranging from mineral rocks such as limestones and coal, nonmetallic minerals such as, and metallic minerals such as gold, copper, silver, iron, and nickel. With various types of minerals, one of the minerals that have long-term prospects and promising that until now still be one of the largest foreign exchange earning commodity for the country is nickel.

Nickel is one of the highly reactive metallic mineral minerals with oxygen so nickel in nature will be found in compound form. Although nickel is reactive to oxygen, nickel is not corrosive, making this mineral an important role in the steel industry as one component of stainless steel. Due to the increasing use of nickel metal in various industrial sectors as supporting the fulfillment of human needs and also the availability is quite abundant then the investors both from within and outside the country are encouraged to invest in the form of a mining company.

One of the nickel mining companies still operating today is PT. Bintang Eight Minerals located in District Bahodopi, Morowali District, Central Sulawesi Province. In operation, of course, nickel reserves available at mining sites in the company began to experience a reduction during the mining process took place. Therefore, it is necessary to calculate the reserve periodically at the company.

The process of estimating the reserves is a step taken to determine the level, extent, and so forth from a precipitate of mineral deposits. The calculation of reserves can be done manually by using several methods, one of which is the model block model with the help of software such as Surpac 6.3.2 which later the estimation results can be modeled in the model block view to see the progress of the mine (pushback) at the mine site.

2. Methodology

The purpose of this research is to know the value of laterite nickel deposit and to model the progress of mine on block 5A pit bonus using block model (pushback) method in software Surpac 6.3.2.

In this study, the steps taken by the methodology of prioritizing the utilization of natural resources are:

1. Collar data collecting includes the name of the drill point (hole_id), drill point coordinates (X, Y), drill point elevation (Z), drill bit depth (max_depth), the thickness of the nickel layer obtained from the drill log.
2. Collect zonation data from the depth of each nickel laterite layer zone consisting of OB (Overburden), LGL (Low-Grade Limonite), MGL (Medium Grade Limonite), LGSO (Low-Grade Saprolite), MGSO (Medium Grade Saprolite) HGSO (High-Grade Saprolite), WS (Waste).
3. Assay data includes the name of the drill point (hole_id), the depth of the deposition layer of nickel from (depth_from), to (depth_to), the type of rock/lithology of the nickel layer (rock type), the level of elements contained in each layer Nickel (Ni), Cobalt (Co), Ferrum (Fe), Silicate (SiO_2), Magnesium (MgO), ore thickness, are test results in the laboratory.
4. Preparation of topographic map and drill point distribution map.
5. Estimation of reserves using block modeling method in Surpac 6.3.2 software.
6. Design the progress of the mine on block 5A pit bonus using the block model (pushback) method in Surpac 6.3.2 software. Consistency testing shows the level of trust in the method used.

3. Results

Based on the data that has been obtained on the block 5A pit bonus, it can be generated database as follows (Fig.1).

Figure 1. Display database (left) Database overall on block 5A pit bonus (right)

The database above shows the depth and depth of the ore in a single drill point, in a single point of drill there is OB (overburden), ore divided into LGL (Low-grade limonite), MGL (Medium grade limonite), LGSO (Low-grade saprolite), MGSO (Medium grade saprolite), HGSO (High-grade saprolite) and also WS (Waste / no grade).

After the database appears, then correlate each database from ore (LGL, MGL, LGSO, MGSO, HGSO) which has been in the form as shown below (Figs.2).

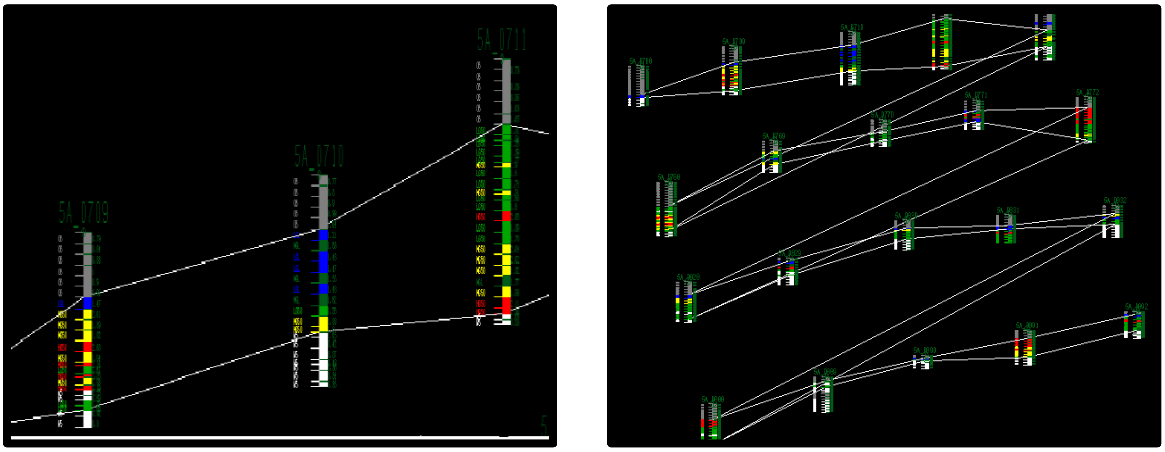


Figure 2. Correlation between databases (left) & Database overall correlation (right)

From the database correlation that has been formed, it can be in the form of the orebody, overburden, and also waste/bedrock in accordance with the depth of each point.

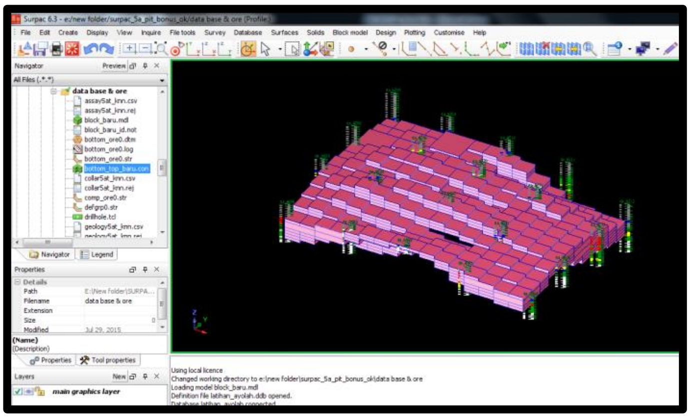


Figure 3. Ore view in block model form

Fig.3 above shows the ore view in block model on block 5A pit bonus with total volume 48730.47 m^3, tonnage 73095.70 ton, and also the average grade of Ni 1.64%.

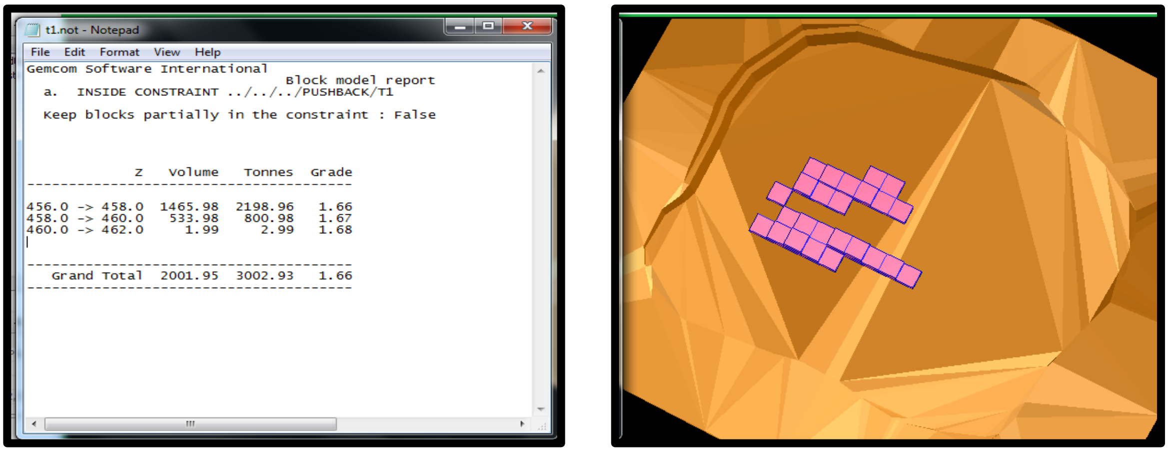
The 3D overburden model is a combination of two DTMs, namely top overburden and bottom overburden which are the boundaries of the seed and overburden zones. The combination of these two constraints forms a 3D overburden constraint with a block size of 25 meters and a sub-block of 12.5 meters.

From the model block that has been formed, then done the design/pit design on the ore, so from the design can be determined the progress of the mine block 5A Pit Bonus.

3.1 Mine Advance on Block 5A Pit Bonus

The progress of the mine is designed to be able to describe or determine the amount of volume that will be exposed in each phase of mining, in this case, the company mines from a pit based on the height of the bench. The height of the bench in this pit is 4 m, beam 2 m, and 60^0 slopes [1]. To know the volume of the ore we are using a database command statement in the block model. Here is the mine progress stage design that has been created using the block model:

1. In the first mine progress design, mining is carried out from the highest elevation of 460 m up to 456 m elevations, with an uncovered ore volume of 2001.95 m3 (see Fig.1).



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Gemcom Software International

Block model report

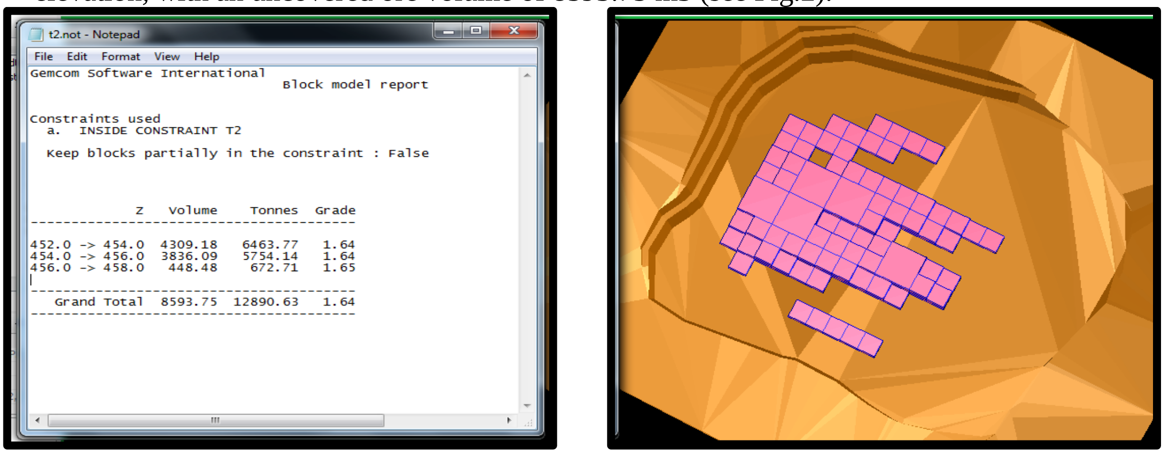
a. INSIDE CONSTRAINT ../../../PUSHBACK/T1

Keep blocks partially in the constraint : False

Z	Volume	Tonnes	Grade
456.0 -> 458.0	1465.98	2198.96	1.66
458.0 -> 460.0	533.98	800.98	1.67
460.0 -> 462.0	1.99	2.99	1.68
Grand Total	2001.95	3002.93	1.66

Figure 4. Progress Mine 1 - ore volume (left) ore block model (right)

2. In the second mine progress design, mining is carried out from a 456 m elevation to a 452 m elevation, with an uncovered ore volume of 8593.75 m3 (see Fig.2).



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Block model report

Constraints used

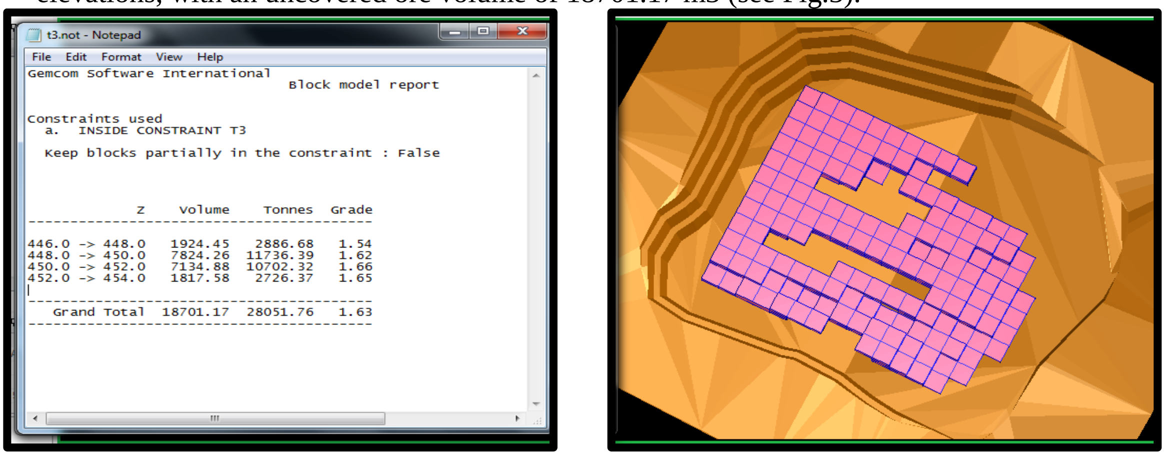
a. INSIDE CONSTRAINT T2

Keep blocks partially in the constraint : False

Z	Volume	Tonnes	Grade
452.0 -> 454.0	4309.18	6463.77	1.64
454.0 -> 456.0	3836.09	5754.14	1.64
456.0 -> 458.0	448.48	672.71	1.65
Grand Total	8593.75	12890.63	1.64

Figure 5. Progress Mine 2 - ore volume (left) ore block model (right)

3. Design of the progress of the third mine, mining is carried out from 452 m elevation to 448 m elevations, with an uncovered ore volume of 18701.17 m3 (see Fig.3).



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Gemcom Software International

Block model report

Constraints used

a. INSIDE CONSTRAINT T3

Keep blocks partially in the constraint : False

Z	Volume	Tonnes	Grade
446.0 -> 448.0	1924.45	2886.68	1.54
448.0 -> 450.0	7824.26	11736.39	1.62
450.0 -> 452.0	7134.88	10702.32	1.66
452.0 -> 454.0	1817.58	2726.37	1.65
Grand Total	18701.17	28051.76	1.63

Figure 6. Progress Mine 3 - ore volume (left) ore block model (right)

4. Design of the progress of the third mine, mining is carried out from a 448 m elevation to a 444 m elevation, with an unloaded ore volume of 11621.09 m3 (see Fig.4).

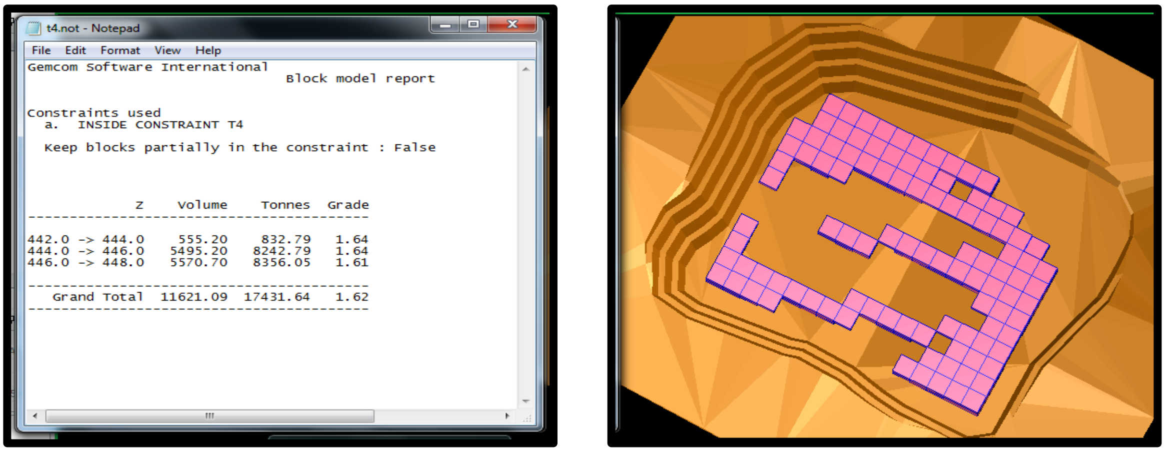

Figure 7. Progress Mine 4 - ore volume (left) ore block model (right)

5. Design of the progress of the fifth mine, mining carried out from elevation 444 m up to 440 m elevations, with unloaded ore volume of 4687.50 m3 (see Fig.5).

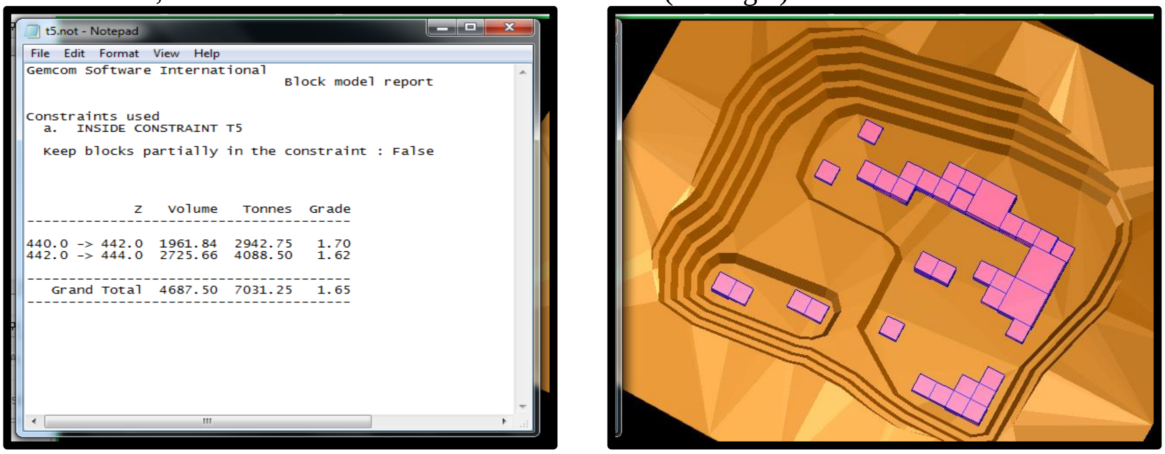

Figure 8. Progress Mine 5 - ore volume (left) ore block model (right)

6. Design of progress of the fifth mine, mining carried out from elevation 440 m up to 436 m elevations, with unloaded ore volume equal to 2197.27 m3 (see Fig.6).

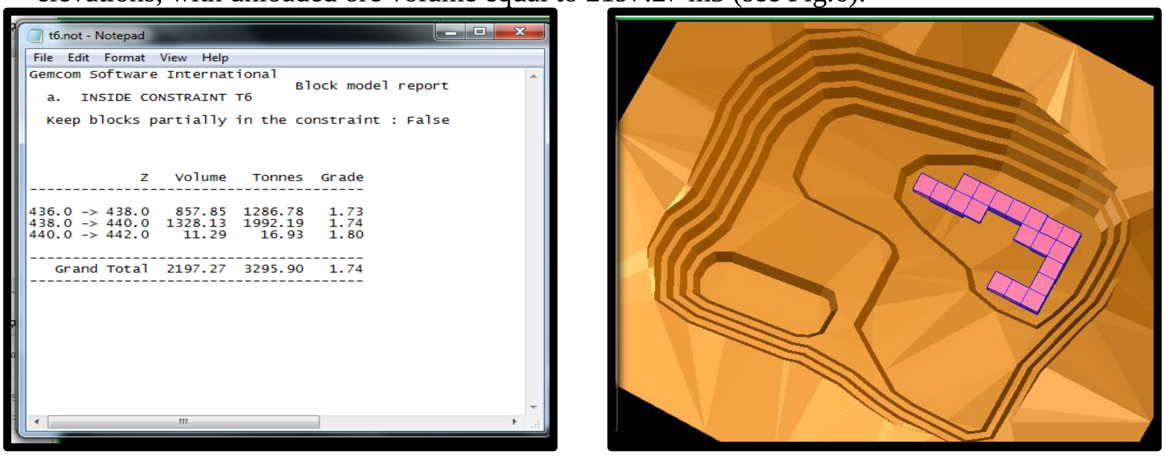

Figure 9. Progress Mine 6 - ore volume (left) ore block model (right)

7. Design of progress of the fifth mine, mining carried out from elevation 436 m to 432 m elevations, with ore uncovered volume of 927.73 m3 (see Fig.7).

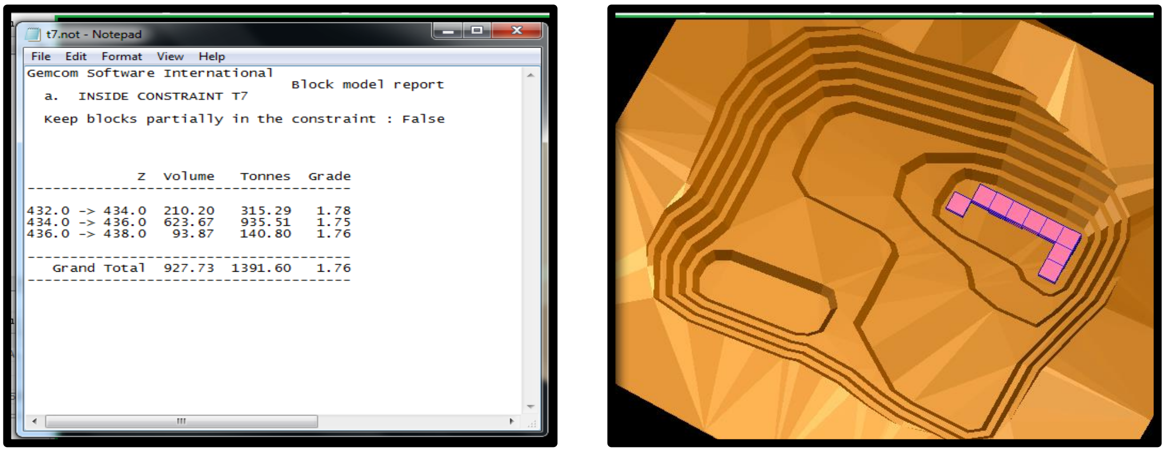

Figure 10. Progress Mine 7 - ore volume (left) ore block model (right)

With the arrival of mining at the lowest part or the lowest elevation of the ore, the ending of the mining can also be forwarded on block 5A of this bonus pit. The total of all the mined ore volume can be seen in

Table 1 Plan design progress of mine on block 5A pit bonus

Rencana design tahapan kemajuan tambang	Elevasi from (m)	Elevasi to (m)	Volume terbongkar (m^3)	Tonase (ton)	Grade (%)
1	460	456	2001.95	3002.93	1.66
2	456	452	8593.75	12890.6	1.64
3	452	448	18701.17	28051.8	1.63
4	448	444	11621.09	17431.6	1.62
5	444	440	4687.5	7031.25	1.65
6	440	436	2197.27	3295.91	1.74
7	436	432	927.73	1391.6	1.76
Total			48730.46	73095.7	

3.2 the 3D modeling of block model of ore appearance on block 5A pit bonus

By according to [2]–[5], here is the 3D modeling of Overburden, Core (HGL, MGL, LGSO, MGSO, HGSO), waste/bedrock appearance in block 5A pit bonus using block model, with 25 x 25 x 5 m cell size.

After the modeling is done, they can count the volume of each zone using the report command from the block model. The result of the volume calculation as follows (Table. 2).

Table 2 Total overall volume

	Total Volume (m^3)	Grade (%)
Overburden	36816,41	0,89
Ore	48730,47	1,64
Waste/no grade	22558.59	0,60

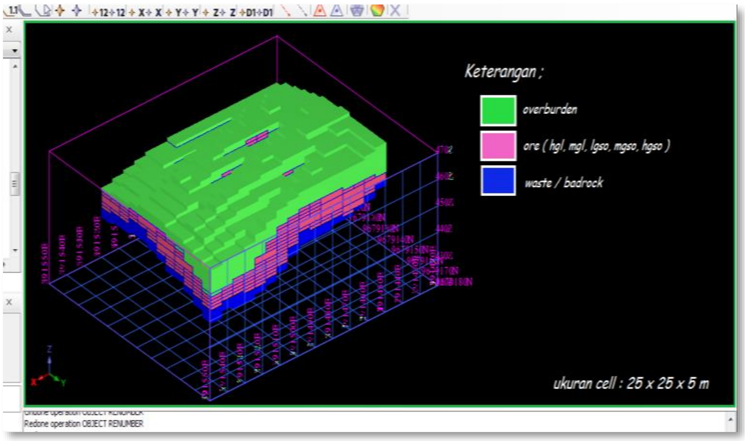

Figure 11. Overburden, Ore, and waste at the study site

4. Conclusion

Based on research conducted on block 5A PT pit bonus. Bintangdelapan Mineral, Bahodopi District, Morowali District, Central Sulawesi, the following conclusions are obtained:

1. The estimation of the reserve at the research location using the block model method in software surpac 6.3.2 produces a total volume equal to 48730.47 m3, tonnage 73095.70 ton and the average grade is 1.64%.
2. The progress of the mine at the research site is modeled into 7 stages. Where for each mining stage at the research site is mined based on the height of the bench. The height of the bench is modeled 4 m, berm 2 m, and slope 60^0.

5. Acknowledgment

The authors sincerely thank the PT. BintangDelapan Mineral for permission to use the mining location and laboratory equipment is given so that this research can be completed properly.

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