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Classification of Ni Levels for Determination Cut-Off Grade in Region X

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ABSTRACTS

The need for ore with levels above 1.8% presents the author's initiative to conduct research to produce ore products with the required levels. The aim is to find out the lowest grade of ore that can be mined and used as a cut-off grade in area x. The research method used is the blending method. Some of the data needed include the drill point coordinates, the borehole's depth, the borehole, the slope of the borehole, lithology, and the value of Ni content. The distribution of nickel in the x region is dominated by ore which has a grade of 1 to 2% with a total volume of 140,100 Bcm, and there is a small amount of nickel that has a rate above 2% with an importance of 15,650 Bcm. The mining sequence has been divided into three to three stages, where the tonnage obtained from each location is 8,9937 tons, 442361 tons, and 100,554 tons. The simulation of blending steps was carried out starting from the classification of nickel with the highest grade, namely nickel with the lowest rate of 1.8% with an average rise of 2.07%, to the last stage, which produces a middle grade of 1.9%, namely in the classification of nickel with rates above 1.6 %. From the results of the blending simulation that has been carried out, it can be concluded that the lowest grade that can be used as a cut-off grade in area x is ore with a Ni content of 1.6%.

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INTRODUCTION

A mineral resource is a concentration or occurrence of material that has economic value on or above the earth's crust, with a certain shape, quality, and quantity that has reasonable prospects for eventually being economically extracted (Sukandarrumidi, 2007). Nickel laterite is one type of natural resource that cannot be renewed, this is because the formation of nickel laterite requires a process that takes millions of years(Thamsi, Jafar, and Fauzie 2021a; Yogi Pranata et al. 2017).

Some of the factors that form nickel include rock of origin, climate, chemical reagents and vegetation, structure, topography, and time (Waheed, 2002; Hardyanto 2016; Hasria et al. 2021; Yogi Pranata et al. 2017). The need for high-grade mills causes ore, ore itself is a valuable mineral that is sought and then extracted in mining activities with the hope (although not always achieved) to gain benefits for miners and for the community (Taylor, 1986). Low-grade ore will lose the selling price and will be categorized as waste because it cannot be processed at the factory (Habibie et al., 2019). This condition certainly requires proper handling so that low-grade ore is not wasted and the volume of reserves increases(Azizi et al., 2019; Ilyas et al., 2022; Sufriadin et al., 2012; Thamsi, 2017).

One of the unresolved problems in Region X is the determination of the cut-off grade. Region X itself has low levels or can be said to be incompatible with the products targeted by the company. The product targeted by the company is an ore which has a Ni content of 1.8%. Cut off grade or limit grade where the grade below has metal or mineral content in rock that does not meet economic requirements (Heriyawan et al, 2005(Anshariah, 2016; Syah et al., 2018; Thamsi et al., 2021).

There are not many studies related to the classification of Ni levels for determining the cut-off grade, so researchers are interested in conducting this research. The aim is to find out the lowest grade of ore that can be mined and used as a cut-off grade in area x.

METHODS

This research was conducted using several activity approaches, namely field orientation, data collection, data processing, and data analysis. The data was processed using X software using a database including collar data, survey data, assay data, and geology data to model Ni sediment and distribution, determine mining stages, and simulate ore blending stages.

RESULTS AND DISCUSSION

Distribution of Ni in Region X

The nickel distribution picture shows the distribution of nickel with levels represented by several colors, including blue, light blue, green, light green, yellow and red. The red color in the figure represents nickel with the highest grade of 2.5 – 3%, with the least volume in Region X. In addition to red, nickel with a high grade is also represented by yellow with a content of 2 – 2.5%, total volume nickel represented by red and yellow is 15,650 Bcm.

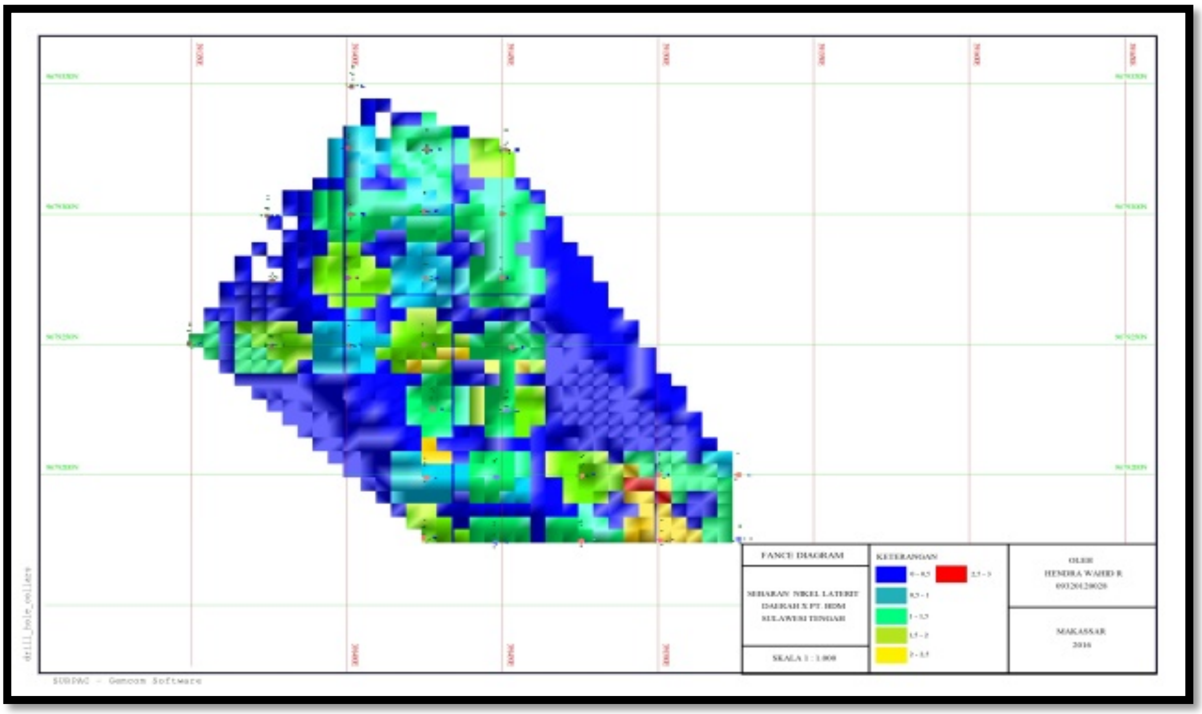

Figure 1. Distribution of Ni in Region X.

Other colors shown in the picture are green and light green. The green color in the picture above represents nickel with levels of 1 - 1.5%, while the light green color represents nickel with levels of 1.5 - 2%; these two colors dominate Region X because Region X is the area with the highest nickel content is 1-2 % total volume is 140,100 Bcm (Figure 1). Nickel with the lowest levels in Region X is shown in blue and light blue, i.e., 0-1%. Nickel with levels below 1% is considered waste or material that is considered waste and is not recommended for mining.

Mining Stage

The mining sequence carried out in Region X is carried out in stages, starting from the part with less waste material and more material containing nickel with levels above 1%. The mining sequence in Region X is divided into 3 stages. gradually, nickel grades above 1% are 89,936 tons, 442,359 tons, and 100,558 tons.

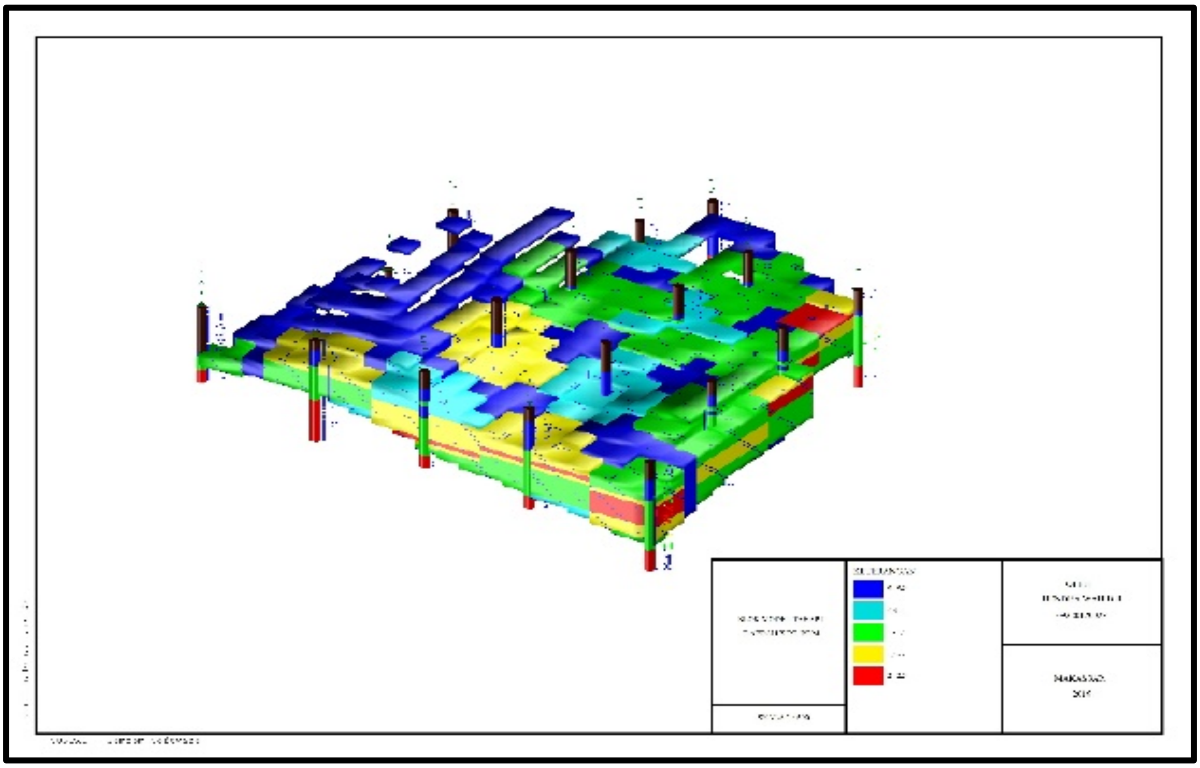

Figure 2. Ore model stage 1

In the first stage of the ore model block, nickel with levels above 1.5% dominates the area. In the first stage, the resulting ore tones are 89,937 tons, and the details can be seen in the following table.

Table 1. Details of ore at stage 1

If seen briefly in Figure 2, the ore with high levels is not very visible on the surface; this is

No.	Ni Class (%)		Volume	Tonnage	Average
	From	To	(BCM)	(tons)	Ni Content (%)
1	1	1.19	20375	29544	1.1
2	1.2	1.39	20725	30051	1.3
3	1.4	1.59	8900	12905	1.5
4	1.6	1.79	4675	6779	1.7
5	1.8	1.99	4825	6996	1.9
6	2	2.19	1675	2429	2.1
7	2.2	2.39	850	1233	2.3
8	2.4	2.59	0	0	0
9	2.6	2.9	0	0	0

because, in the second area, there is only a little more with high levels, which can be seen clearly in table 2 below.

From the results of the classification of levels of Ni at the last stage, nickel with the highest grade that can be obtained is nickel with a grade of 2.6 – 2.8% but with a very small tonnage of 979 tons with an average grade of 2.7% (Figure 3 and Table 3).

After calculating the formula for determining the total volume, average grade, and tonnage in each classification, the results obtained from these calculations can be seen in Table 4

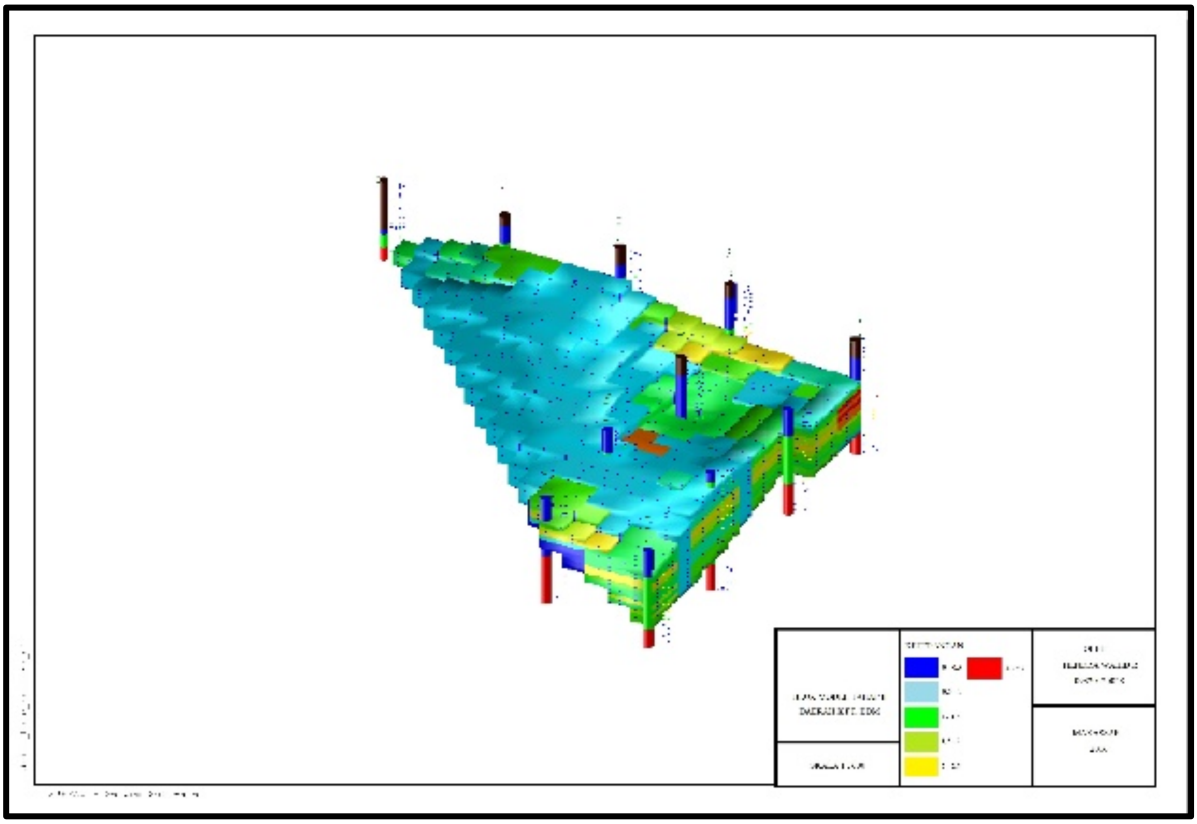

Figure 2. Model ore stage 2

Table 2. Details of ore at stage 2

No.	Ni Class (%)		Volume	Tonnage	Average
	From	To	(BCM)	(tons)	Ni Content (%)
1	1	1.19	41900	60755	1.1
2	1.2	1.39	39200	56840	1.3
3	1.4	1.59	25625	37175	1.5
4	1.6	1.79	21175	30704	1.7
5	1.8	1.99	12200	17691	1.9
6	2	2.19	8200	11890	2.1
7	2.2	2.39	5725	8301	2.3
8	2.4	2.59	1025	1486	2.4
9	2.6	2.9	700	1015	2.7

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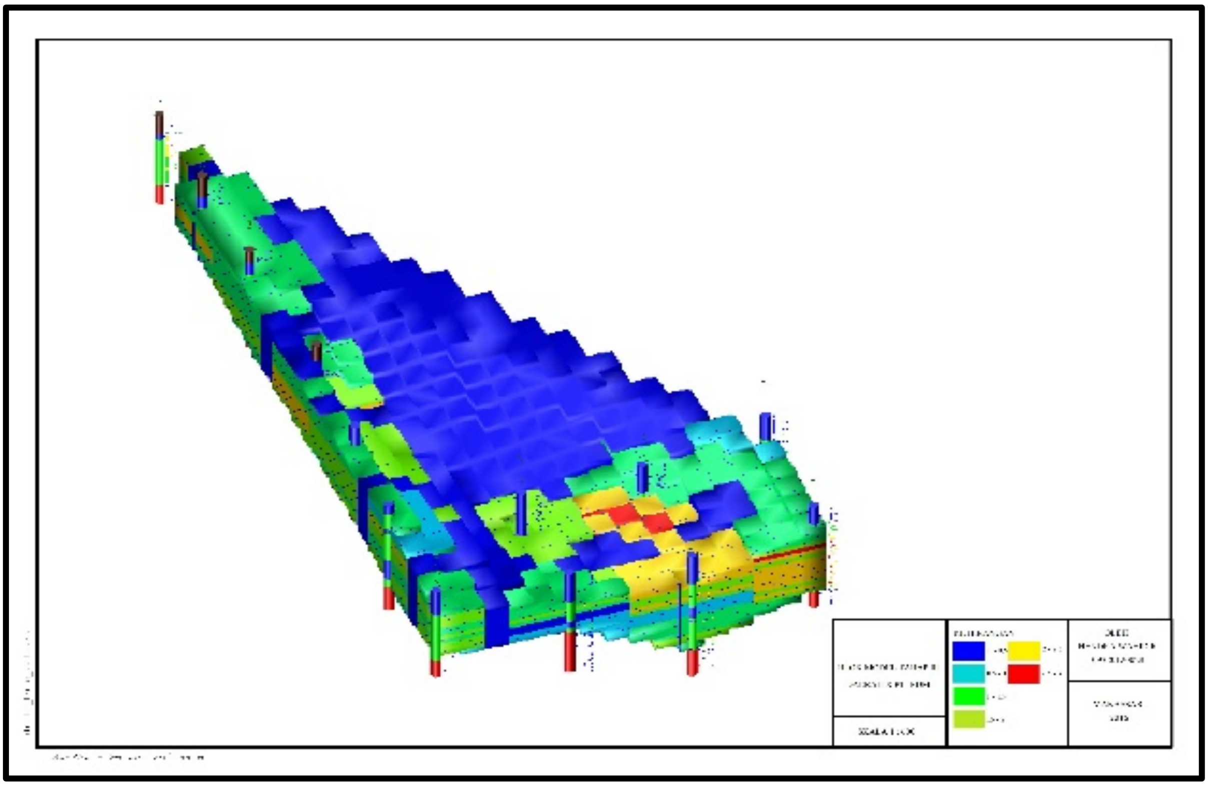

Figure 3. Model ore stage 3

Table 3. Details of ore at stage 3

No.	Ni Class (%)		Volume	Tonnage	Average
	From	To	(BCM)	(tons)	Ni Content (%)
1	1	1.19	41900	60755	1.1
2	1.2	1.39	39200	56840	1.3
3	1.4	1.59	25625	37175	1.5
4	1.6	1.79	21175	30704	1.7
5	1.8	1.99	12200	17691	1.9
6	2	2.19	8200	11890	2.1
7	2.2	2.39	5725	8301	2.3
8	2.4	2.59	1025	1486	2.4
9	2.6	2.9	700	1015	2.7

Table 4. Total area 1, 2, and 3

No.	Ni Class (%)		Volume	Tonnage	Average
	From	To	(BCM)	(tons)	Ni Content (%)
1	1	1.19	18325	26571	1.1
2	1.2	1.39	12775	18524	1.3
3	1.4	1.59	11800	17110	1.5
4	1.6	1.79	11525	16711	1.7
5	1.8	1.99	3700	5365	1.9
6	2	2.19	4650	6743	2.1
7	2.2	2.39	4925	7141	2.3
8	2.4	2.59	975	1414	2.4
9	2.6	2.9	675	979	2.7

Blending Stage Simulation

Blending is mixing materials of different quality and quantities to obtain an appropriate mixture. In the blending process, it must meet the specific ore needs of the processing plant (Musnajam, 2012). In the blending process, it must meet the specific ore needs of the processing plant, where the factory requires ore with a Ni content of 1.8%.

It can be done with the formula Average content to calculate the average level of blending ore results on the stockpile.

Formula:

$$\text{Average Ni Content} = \frac{(\text{V1xNi}) + \cdots + (\text{Vn x Ni n})}{\text{V total}}$$

Table 5. Simulation of blending stages

Stage	Classification		Volume	Tonnage	Ni	Average
	From	To	(BCM)	(Ton)	(%)	Ni Content (%)
1	2.2	2.39	5725	8301	2.3	2.07
	2.4	2.59	1025	1486	2.4	
	2.6	2.79	700	1015	2.7	
	2	2.19	8200	11890	2.1	
	1.8	1.99	12200	17691	1.9	
	Total		27850	40383		
2	1.8	2.39	27850	40383	2.07	1.9
	1.6	1.79	21175	30704	1.7	
	Total		49025	71086		

CONCLUSION

From the results of the discussion described previously, it can be concluded that the cut-off grade used in area X is 1.6, with a total tonnage of 71,086 tons by blending ore to optimize nickel with low grades.

From the above calculation results, the blending carried out in the first stage by mixing all ores with a high content of 1.8% and above resulted in a relatively high average content of 2.07%. This means that the lower grade can still be mined, so it is necessary to re-mix it with nickel with a lower grade classification. The results of the calculation of the average grade are possible to be used as a benchmark for determining the cut-off grade, namely the Ni classification, which has a grade above 1.6% with an average grade of 1.9%, and the total tonnage of ore that can be mined is 71.086 tons. This is proven in the calculation of the third stage of the simulation.

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