JGE (Jurnal Geofisika Eksplorasi)
Vol. 10 No. 01, Maret 2024 (16-23) https://doi.org/10.23960/jge.v9i2.305

# MODEL OF LATERITE NICKEL DEPOSITS BASED ON LGSO AND HGSO VALUES PT MITRA KARYA AGUNG LESTARI

# *MODEL ENDAPAN NIKEL LATERIT BERDASARKAN NILAI LSGO DAN HGSO PT MITRA KARYA AGUNG LESTARI*

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Received: 2023, July 24th
Accepted: 2024, February 5th

**Keywords:**
HGSO;
IDW;
LGSO;
Nickel Laterite;
PT MKAL.

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**How to cite this article**:

Asmiani, N., Thamsi, A.B., Nompo, S., Bakri, S., Tukloy, M.Y.A., & Harmitun (2024). Model of Laterite Nickel Deposits Based on LGSO and HGSO Values PT Mitra Karya Agung Lestari. *JGE (Jurnal Geofisika Eksplorasi),* 10(01), 16-23.

**Abstract.** The laterite nickel deposit model provides information about the form of laterite nickel deposits below the surface, which can be used as one of the considerations in the implementation of mining activities. The purpose of conducting this research is to determine the distribution model of nickel laterite deposits in 3 dimensions (3D) and to determine the amount of nickel laterite reserves based on high-grade saprolite ore (HGSO) and low-grade saprolite ore (LGSO) values in the DH Block. In this research, Inverse Distance Weighted (IDW) is used to estimate nickel laterite resources, which are applied using mining software Surpac 6.3.2 to produce a model in 3D form. The data used are laterite nickel content data (assay), x, y, and z coordinate data (collar), survey data, and lithology data. Based on IDW estimation results with a Cut Off Grade (COG) value of 1.3 in the DH Block of PT Mitra Karya Agung Lestari, High-Grade Saprolite Ore (HGSO) values were obtained at Ni content > 1.7 and Low-Grade Saprolite Ore (LGSO) at Ni content > 1.3, with a tonnage value of 111.994 tons of HGSO and 371.044 tons of LGSO.

***Abstrak.*** *Model endapan nikel laterit dibuat untuk memberikan informasi tentang bentuk endapan nikel laterit di bawah permukaan, yang dapat dijadikan sebagai salah satu pertimbangan dalam pelaksanaan kegiatan penambangan. Tujuan dari pelaksanaan penelitian ini untuk mengetahui model persebaran endapan nikel laterit dalam bentuk 3 dimensi (3D) dan mengetahui jumlah cadangan nikel laterit berdasarkan nilai high grade saprolite ore (HGSO) dan low grade saprolite ore (LGSO) pada Blok DH. Dalam penelitian ini, Inverse Distance Weighted (IDW) digunakan sebagai metode untuk mengestimasi sumber daya nikel laterit yang diaplikasikan menggunakan software pertambangan Surpac 6.3.2 untuk menghasilkan suatu model dalam bentuk 3D. Data yang digunakan yaitu data kadar nikel laterit (assay), data koordinat x, y dan z (collar), data survey, dan data litologi. Berdasarkan hasil estimasi IDW dengan nilai Cut Off Grade (COG)1,3 Blok DH PT Mitra Karya Agung Lestari, didapatkan nilai High Grade Saprolite Ore (HGSO) pada kadar Ni > 1,7 dan Low Grade Saprolite*

*Ore (LGSO) pada kadar Ni > 1,3, dengan nilai tonase HGSO sebesar 111.994 Ton dan LGSO sebesar 371.044 Ton.*

## 1. INTRODUCTION

Indonesia is a country rich in natural resources, especially mining materials, which are non-renewable natural resources. One example of a very important natural resource is nickel. Nickel is a natural resource with many benefits, such as making rust-proof metal, a mixture for making stainless steel, and various other goods. This uniformity also makes nickel very valuable and has a high selling value on the world market. Since at least 1950, demand for nickel has increased by an average of 4% every year, and it is estimated that the next ten years will continue to increase (Dalvi et al., 2004).

The Eastern Indonesia region, especially the Central Sulawesi region, has potential mineral resources of nickel laterite deposits in Wituponda District, Morowali Regency.

The inverse distance weighting method is a way to estimate the average value of a block, which is the weighted average value of drill hole data around the block. This method is often used in the mining industry because the interpolation characteristics can be controlled by limiting the input points used in the interpolation process (Passerby, 2012).

Accurate information and data from drilling activities need to be visualized as a block model so that mining planning can be carried out as fully as possible (Hardyanto et al., 2016). By estimating nickel laterite resources using the IDW method, a model of the distribution of nickel, average grade, and tonnage can be identified. Based on the data from PT Mitra Karya Agung Lestari's drilling results, the authors conducted a study to determine the laterite nickel deposit and tonnage model based on LGSO and HGSO values.

## 2. LITERATURE REVIEW

Hall and Wilson (2000) explain that Sulawesi Island is divided into 4 (four) main lithotectonic belts, namely (1) western Sulawesi, which is a Tertiary magmatic arc associated with sedimentary rocks; (2) central Sulawesi, which is an arc of metamorphic rocks, (3) Eastern Sulawesi which is an ophiolite complex or also known by another term, namely East mandala, and (4) continental fragments of Banggai Sula Tukang Besi. Physiographically, the research area is included in the East Sulawesi ophiolite complex. The southern part of the research area is near the left strike-slip fault (Matano fault).

Nickel laterite is genesis formed due to the degree of weathering, both chemically and mechanically, in ultramafic and serpentinite igneous rocks (Marsh, 2010). In general, Brand et al. (1998) divided 2 (two) ultramafic rock classes that have economic value for nickel laterite deposits, namely type 1 (one) dunite, peridotite, harzburgite, and wehrlite in the ophiolite lane. The research area based on the Geological Map of the Bench Sheet is categorized in type 1 (one). Then, type 2 (two) olivine dominant komatiites and mafic-ultramafic layered Nickel laterite are genesis formed due to the degree of weathering, both chemically and mechanically, in ultramafic and serpentinite igneous rocks (Marsh et al., 2010). Elias (2002) explained that several factors support the lateralization process in nickel laterite deposits. These factors will affect the profile zone of nickel laterite deposits, such as differences in thickness, chemical composition, and mineralogy of each division of the laterite zone.

Sediment modeling aims to provide an overview of geological conditions and sediment geometry characteristics (Anas et al., 2020). So, it is necessary to analyze the ore body model to determine the mining method. Resource or reserve estimation is also carried out to determine the quantity of a deposit that is considered economical to mine. So, at the resource or reserve estimation stage, a method is needed that can provide an approach to the amount of existing resource or reserves.

The method itself is determined based on theoretical considerations. The variables or parameters that form the basis for estimating resources or reserves include volume, tonnage, grade, and quality of minerals (Thamsi et al., 2023; Liu et al., 2019). There are two estimation methods commonly used, namely conventional and non-conventional methods. With the development of technology, the estimation of resources or reserves with various methods is commonly used in computerized form using software assistance.

Resource estimation is an estimate of the potential of ore mineral deposits located on the earth's surface to determine whether these deposits are feasible to proceed to the mining process and then the calculation of reserves (Guntara et al., 2021). This study aims to determine the resource potential of lateritic nickel ore deposits and the mineral deposit's thickness, the drill point depth, and the topography of the estimated area. The data needed in this study are assay, collar, lithology, and survey data, where this data will be calculated using the Inverse Distance Weighted method.

**Table 1.** Rate Ni Block DH PT MKAL.

| Hole ID | From | To | Ni (%) | Description |
|---|---|---|---|---|
| | 0.00 | 1.00 | 1.00 | Waste |
| | 1.00 | 2.00 | 1.02 | Waste |
| | 2.00 | 3.00 | 1.29 | Waste |
| | 3.00 | 4.00 | 1.91 | Ore |
| | 4.00 | 5.00 | 1.97 | Ore |
| | 5.00 | 6.00 | 2.47 | Ore |
| | 6.00 | 7.00 | 2.23 | Ore |
| | 7.00 | 8.00 | 2.30 | Ore |
| **MKAL_DH.06** | 8.00 | 9.00 | 2.22 | Ore |
| | 9.00 | 10.00 | 2.11 | Ore |
| | 10.00 | 11.00 | 1.73 | Ore |
| | 11.00 | 12.00 | 1.92 | Ore |
| | 12.00 | 13.00 | 1.79 | Ore |
| | 13.00 | 14.00 | 1.81 | Ore |
| | 14.00 | 15.00 | 1.02 | Waste |
| | 15.00 | 16.00 | 0.50 | Waste |
| | 16.00 | 17.00 | 0.50 | Waste |

## 3. METHODS

The research implementation used the subsurface geological data collection method through drilling activities to obtain subsurface geological information vertically and rock/lithology samples in the study area. The results of the drilling in the form of rock samples and subsurface geological data were then analyzed in the laboratory and evaluated using Surpac software with a statistical approach in the form of the Inverse Distance Weighting (IDW) method so that modeling data would be generated from the distribution of nickel laterite deposits in the study area. Based on the stages, the research methods used in this study include:

### *3.1. Preliminary Stage*

The initial stage carried out in the research was the preparatory stage. At this stage, activities include preliminary activities such as administration of research permits, literature studies to study literature, and literature relevant to the conditions of the research area, both in the form of journals and research reports.

### *3.2. Data Collection Stage*

Data collection includes observations of surface geological conditions and geomorphology of the research area, data collection on 23 points of drilling activities, sampling and documentation of research activities, and creating a database of the geological data obtained. The data collection method uses drilling activities using the grid method with a spacing between drill holes of 50 x 50 meters.

### *3.3. Data Processing and Analysis Stage*

This stage begins at the laboratory analysis stage. Laboratory analysis is carried out by conducting chemical tests on samples from the drilling results that have been obtained to obtain grade data called assay data.

This is done to evaluate and separate data groups, including collar, lithology, survey, and assay data. The data is then processed using the IDW method to construct a block model of nickel deposits and calculate estimates of laterite nickel deposit resources in the study area.

The primary and secondary data used in this research are primary and secondary. Data collected from the research location is then processed with the help of Surpac 6.3.2 software for processing data.

The general formula of Inverse Distance Weighted (IDW) (Ramadhan et al., 2022; Annels, 1991):

$$Z^* = \frac{\sum_{i=1}^{n} \frac{1}{d_1^k} X\, Zi}{\sum_{i=1}^{n} \frac{1}{d_i^k}} z \quad (1)$$

Information:

$Z^*$ : The estimate rate
N : The amount of data
*i* : The rate to *i* (*i* = 1……n)
$d_i$ : The distance between the estimated point and the *i*-point that is estimated
Z : The original rate
K : The power parameter

## 4. RESULTS AND DISCUSSION

Based on PT MKAL's topography, the area's topography is more dominantly sloping; this can be seen from the shape of the slope arrangement which is not too steep. The DH block area seen based on the topography and actual conditions in the field has relatively loose contour lines, which characterizes the area as quite sloping.

Based on the analysis carried out, the determination of the follow-up of nickel resources will be weighed based on the exploration results carried out in the mining business managed by PT Mitra Karya Agung Lestari. The data is in the form of drill point data obtained from drilling. From the coring drilling results, the data obtained includes hole ID, (Ni) content, easting, northing, elevation, and depth. The data for these levels were obtained after analysis in the laboratory. The drill point data used in this study was 23 points, and the data rate used *was 347.*

### *4.1. Borehole Distribution*

In the research area, drilling activities are carried out within 50 meters between the drill holes. Thus, the drill points in the study area are considered feasible enough to be used as a basis for estimating laterite nickel resources/reserves. A map of the distribution of drill points can be seen in **Figure 1**.

### *4.2. Laterite Nickel Deposit Model Block*

Modeling laterite nickel deposits aims to provide an overview of the subsurface deposits' geological conditions and geometric characteristics. Therefore, an analysis of the ore body model is needed to determine the mining method. The block model is a medium for displaying the data generated from the geological database to know the results, values, or models that will be made later to estimate the number of resources/reserves of a predetermined level.

The manufacture of block models is based on the company's standard Cut Off Grade (COG). This block model uses a size of 5x5x1 using the inverse distance method to estimate the reserve value. Model blocks are made by dividing an ore deposit into smaller units or blocks with a certain length, width, and height. Each block has attributes such as density, lithology, and grade. An overview of the appearance of the laterite nickel deposit model block, based on the results of data processing using the Surpac 6.3.2 program, can be seen in **Figure 2**.

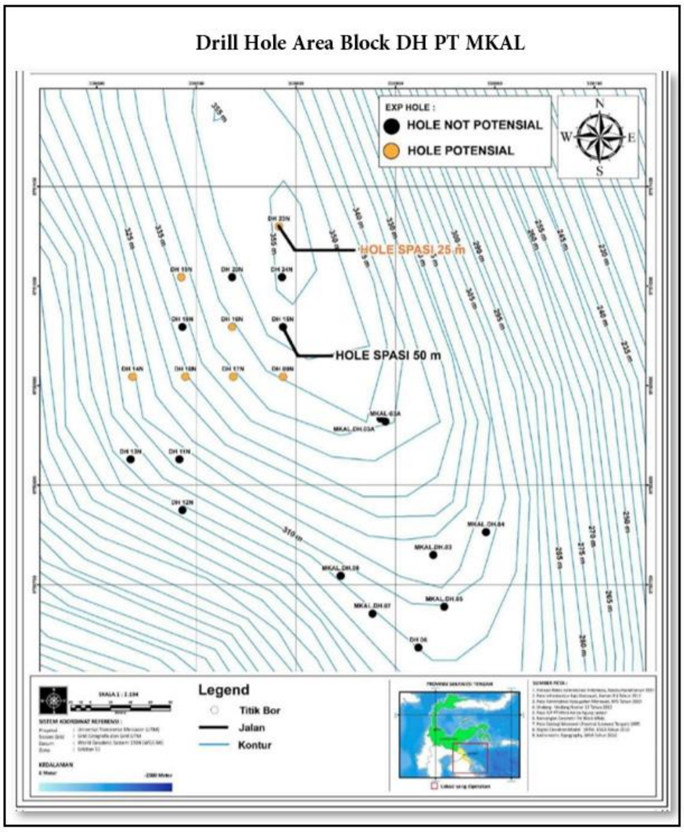


**Figure 1.** Drill Points Distribution.

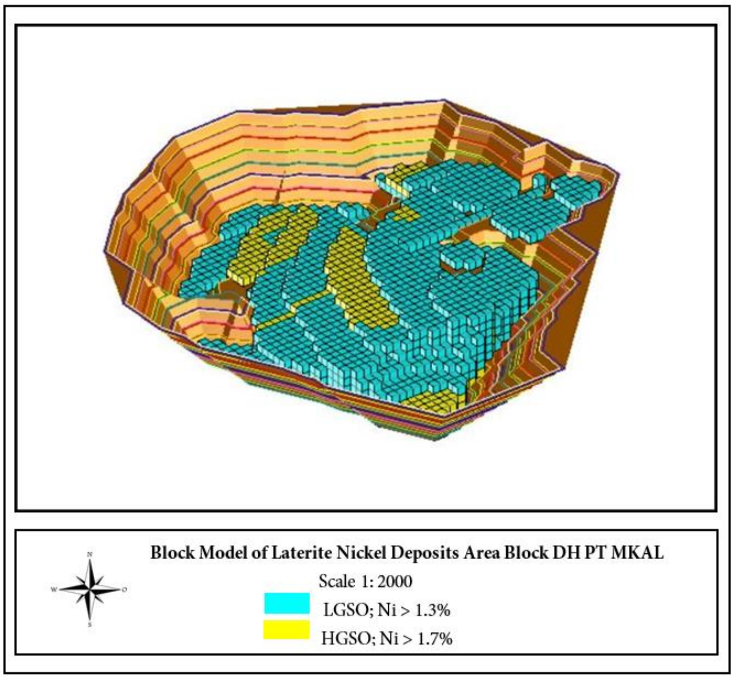


**Figure 2.** Block Model of Lateritic Nickel Deposits.

### *4.3. Low Grade Saprolite Ore (LGSO)*

Based on the results of data processing based on Ni content > 1.3 (LGSO) in the Surpac 6.3.2 program, an overview of the block model is obtained (**Figure 3**), and the estimated value of reserves is based on these grade values.

The low-grade model block is the type of ore often used in the ore blending process (lower-grade mixing) to obtain grade grades according to market demand.

### *4.4. High-Grade Saprolite Ore (HGSO)*

Based on the results of data processing based on Ni content > 1.7 (HGSO) in the Surpac 6.3.2 program, an overview of the block model is obtained (**Figure 4**), and the estimated value of reserves based on these grade values. The high-grade model block is an ore with an average grade value of 1.86%. This type is generally sold directly to the market for export and import.

### *4.5. Reserve Estimation*

Estimating resources or reserves is carried out to determine the quantity of the presence that can approximate the amount of existing resources or reserves. Provisions for determining the ore grade are based on a predetermined COG value. The COG value of a deposit that is considered economical to mine, so that at the stage of estimation of resources or reserves, a method is needed that determined by the company where the research was conducted was > 1.3%. Several classifications were also carried out, including:

1. Ni content <1.3 is classified as waste or is called topsoil.
2. Ni levels > 1.3 are classified as low-grade saprolite ore (LGSO).
3. Ni levels > 1.7 are classified as high-grade saprolite ore (HGSO).

At the study site, it was known that the distribution pattern and thickness of nickel laterite deposits varied. However, discontinuities were found at several drill points, so it would be better if the drilling data were more detailed, with a 25 x 25 meters drilling distance. This data can be used as supporting data in a more valid resource calculation.

Based on the research result, in general, provides information about the geological conditions of the study area. The data processed and analyzed using certain methods and applications provide information about the distribution of laterite nickel deposits and the estimation of PT MKAL's laterite nickel resources.

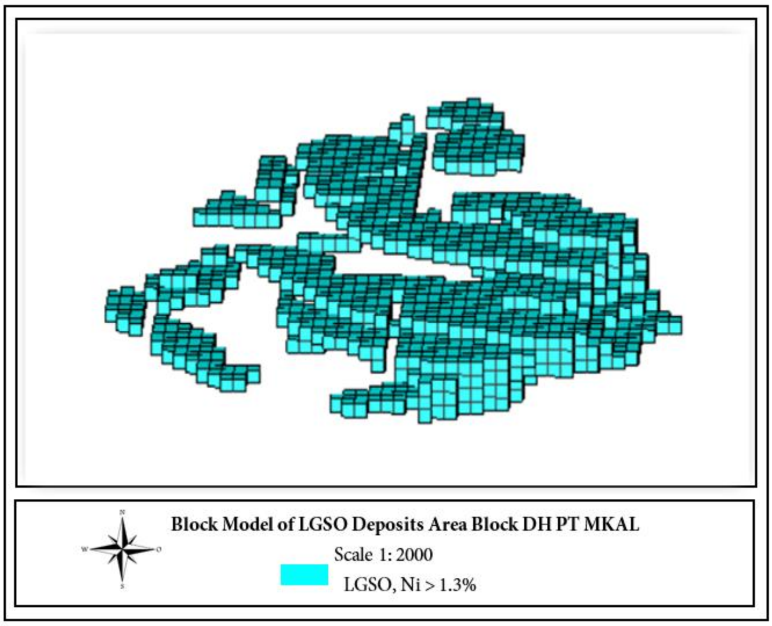


**Figure 3.** Block Model of LGSO Deposits.

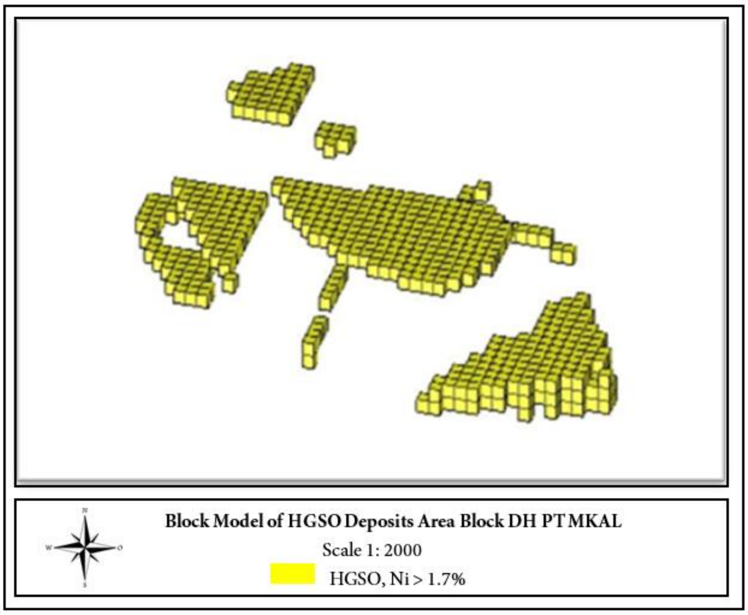


**Figure 4.** Block Model of HGSO Deposits.

## 5. CONCLUSION

Based on the study results, conclusions can be drawn, including the appearance of the model block distribution for nickel laterite LGSO, which is wider than HGSO. This is based on the fact that nickel laterite deposits dominate the study area with a Ni level value of > 1.3, and the estimation of nickel laterite reserves for LGSO is 483.038 tons and HGSO is 111.994 tons.

## ACKNOWLEDGMENT

The research team would like to thank LP2S UMI for supporting the implementation of this research in the form of providing research funds, PT Mitra Karya Agung Lestari for the opportunity to conduct research/data collection and support during the research process for two months in the mining area, and to the members of the research team (lecturers and students) who have worked hard in carrying out this research.

## REFERENCE

Anas, A. V., Amalia, R., Qaidahiyani, N. F., Djamaluddin, & Herin, S. R. D. (2020). Sensitivity Analysis of Net Present Value Due to Optimal Pit Limit in PT Ceria Nugraha Indotama, Kolaka Regency, Southeast Sulawesi Province. *IOP Conf. Ser.: Mater. Sci. Eng.* 875 012050

Akbari, A. D., Osanlou, M., & Shirazi, M. A. (2008). Determination of Ultimate Pit Limits in Open Mines Using a Real Option Approach. *International Journal of Engineering Science*. 19. 23-38.

Annels, A, E. (2012). *Mineral Deposit Evaluation: A Practical Approach.* Springer Science & Business Media.

Bargawa, W. S. (2018). *Perencanaan Tambang*. Yogyakarta: Kequ Book.

Butt, C. R. M., & Cluzel, D. (2013). Nickel Laterite Ore Deposits: Weathered Serpentinites. *Elements,* 9(2), 123-128.

Cardu, M., Ciccu, R., Lovera, E., & Michelottl, E. (2006). Mine Planning and Equipment Selection. *The Fifth International Symposium on Mine Planning and Equipment Selection,* pp. 1234-1239, Torino.

Dalvi, A. D., Bacon, W. G. & Osborne, R. C. (2004). The Past and The Future of Nickel Laterites. *PDAC 200 International Convention, Trade Show & Investors Exchange* (pp. 1-27). The Prospectors and Developers Association of Canada Toronto.

Guntara, N., Hartono, H., & Helmi, H. (2021). Pemodelan Sebaran Endapan Nikel Laterit Pada Daerah X Kabupaten Morowali Utara Provinsi Sulawesi Tengah. *GEODA,* Vol. 02, No. 02, September 2021, pp. 73-86.

Rahmi, F. & Yulhendra, D. (2019). Optimalisasi *Pit Limit* Penambangan Mineral Nikel Laterit PT.

ANTAM Tbk. Unit Bisnis Penambangan Nikel Di Site Pomalaa Sulawesi Tenggara Di Front X. *Jurnal Bina Tambang,* Vol 4., No. 3

Ramadhan, M. S., Ilyas, A., Nur, I., & Widodo, S, (2022). Perbandingan Antara Metode Poligon, Inverse Distance Weighting, Dan Ordinary Kriging Pada Estimasi Sumberdaya Timah Aluvial, Dan Analisis Sebaran Endapannya. *Jurnal Geomine,* 9(3), 254-266.

Hardiyanto., Widodo, S., & Nurwaskito, A. (2015). Pemodelan Endapan Nikel Laterit Kabupaten Morowali, Provinsi Sulawesi Tengah. *Jurnal Geomine,* Vol 02, Agustus 2015.

Liu, D., Li, G., Hu, N., Xiu, G., & Ma, Z. (2019). Optimization of The Cut-Off Grade for Underground Polymetallic Mines. *Gospodarka Surowcami Mineralnymi, Mineral Resources Management* 35 (1): 25-42.

Marsh, E., Anderson, E., and Gray, F. (2010). Ni-Co Laterites – A deposit model. Chapter H of Mineral Deposit Models for Resource Assessment. *UGSG Investigations Report* 2010-5070-H.

Rifandy, A., & Sutan, S. (2007). Optimasi Pit Tambang Terbuka Batubara dengan Pendekatan Incremental Pit Expansion, BESR dan Profit margin. *JGP (Jurnal Geologi Pertambangan),* Vol. 2 No. 24.

Thamsi, A., Ainunnur, I., Anwar, H., Aswadi, M. (2023). Estimasi Sumberdaya Nikel Menggunakan Metode Inverse Distance Weigth PT Ang and Fang Brothers. *JGE (Jurnal Geofisika Eksplorasi),* 9(1), 5-17. doi: https://doi.org/10.23960/jge.v9i2.235.