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Overview Methods Calculation Resource and Reserve Estimation

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Abstract
The calculation of resources and reserves is carried out base on several factors, namely: Sediment Geology, Exploration Method, Type of data owned, purpose of calculation, and desired level of confidence. There are several methods for calculating resources and reserves, including: Area of Influence, Cross Section, Polygon, Triangulation, Isoline, as well as several Interpolation Methods such as; Ordinary Kriging (OK), Neighborhood Nearest Point (NNP) and Inverse Distance Weighting (IDW). Therefore, it is necessary to carry out an analysis related to the method of calculating the right resources and reserves in order to produce more accurate estimates of resources and reserves. The author analyses by making comparisons between several previous studies by looking at the advantages and disadvantages of these methods based on existing literature studies.

1. Introduction

Several methods for calculating resources and reserves have been developed in software, some of which are Ordinary Kriging (OK), Nearest Neighbor Point (NNP), and Inverse Distance Weighting (IDW). In exploration data processing, these methods are used to estimate the content of valuable minerals or other elements at locations that have not been sampled or do not have data.

The Ordinary Kriging (OK) method is a geostatistical method used to predict data at a certain location. This method is an interpolation of a variable value at a certain point by observing similar data at other locations [18]. Meanwhile, the Nearest Neighbor Point (NNP) method is a calculation method that is carried out by calculating the value in a block based on the value of the point closest to the block [11]. And the Inverse Distance Weighting (IDW) method is an estimation method that takes into account the relationship between spatial location (distance), which is a linear combination or weighted average price of the surrounding data points [15]. This research will compare these three methods based on previous research to find the best resource calculation method. According to the third edition of the SME Mining Engineering Handbook, there is a basis for selecting an estimation method based on deposit geometry and the coefficient of variance value [6].

Mineral resources and reserves are classified based on 2 criteria, namely the level of geological confidence and mineability assessment. The level of geological confidence is determined by 4 stages of exploration, namely: review survey, prospecting, general exploration and detailed exploration. This sequence of activities shows that the investigation is becoming more detailed, so that the level of geological confidence is higher and the error rate is lower.

Meanwhile, the mining feasibility assessment includes several factors, including economic, mining, marketing, environmental, social and legal. For ore mineral deposits, the metallurgical side is also a factor in assessing mineability. The mineability assessment will determine whether mineral resources will increase to reserves or not. Based on this study, the portion of mineral resources that are mineable will change their status to reserves, while those that are not yet mineable will remain mineral resources [12]

2. Methodology

This research is based on literature studies in both national and international journals. This research is expected to be able to determine the appropriate method for analyzing resource calculation methods that are suitable for calculating resources in mineral mines.

2.1. Preparatory Stages

At this stage it is carried out by searching and then studying literature related resource and reserves estimation method, updated laws and regulations, data from previous research, sources from books, journals and company archives.

2.2. Stages of Data Collection

This stage is carried out by looking for supporting data. The data obtained are mostly obtained from any journals about resources and reserves estimation method from any mine comodities.

2.3. Stages of Final Report Preparation

This stage is carried out by making analysis between any methods of resources and reserves estimation based on deposit geometry and the coefficient of variance value.

3. Results and discussions

3.1. Research Conducted by Hendro Purnomo (2018)

The research carried out was entitled "Application of the Inverse Distance Weighting Interpolation Method in Resource Estimation". The aim of this research was to map the lateral distribution of limonite ore and estimate nickel resources using the IDW interpolation method to estimate Ni content and thickness of the mineralization zone. This research was conducted based on prospecting drilling data from 60 drill points. The power parameters used in the interpolation process are 1,2,3,4, and 5, while to select the best power value, the Root Mean Square Error (RMSE) parameter obtained from the cross validation procedure is used.[17]

The cross validation calculation process is carried out by taking one data sample from a data set alternately so that it is not included in the interpolation process. Next, the value of the sample that was moved is compared with the estimation results resulting from the interpolation process at that point using all the remaining data that was not taken. The difference between the sample data value taken and the assessment result value is the error value of the assessment at that location. To compare the estimation results of each power value used by the IDW method, an evaluation was carried out using the RMSE statistical parameter, the calculation of which is based on the error value at each sample point from a data set. [17]

3.2. Research Conducted by Saparnas Roni, et al (2020)

The research is entitled "Estimation of Al_2O_3 Content in Laterite Bauxite Deposits Using Ordinary Kriging (OK) and Inverse Distance Weighting (IDW) Methods for Estimating Bauxite Resources at PT Sandai Kemakmuran Utama, Ketapang Regency, West Kalimantan". This research was carried out using the two methods above which will later provide an RMSE (Root Mean Square Error) value from the cross validation results with the smallest RMSE value being chosen as the best method. The research was carried out based on data from 104 exploration pit test results. In the OK interpolation method, experimental variogram fitting is carried out using spherical, exponential and Gaussian models. Based on variogram studies, the smallest RMSE value for estimating overburden thickness obtained by the best variogram model is exponential, while for estimating ore thickness it is spherical, and for estimating Al_2O_3 content it is exponential. [20]

Meanwhile, the IDW method is carried out using power value parameters 1,2,3,4 and 5 (Yasrebi et al, 2019). From the results of the power parameter evaluation that has been carried out, the best power parameters are obtained for estimating OB thickness using IDW power 2, while for estimating ore thickness using IDW power 5, and for estimating Al_2O_3 content using IDW power 4. [20]

3.3. Research Conducted by Muhammad Irwan Zibuka, et al (2016)

The research is entitled "Estimation of Nickel Laterite Resources Using the Nearest Neighbor Point and Inverse Distance Weighting Method". This research aims to determine the total resources of laterite nickel deposits using the Nearest Neighbor Point (NNP) and Inverse Distance Weighting (IDW) methods and to determine the factors that influence differences in resource estimation results using these two methods. Based on these calculations, a percent difference of 5% is obtained. The cause of the difference in resource estimation results is the number of influential points in a block. Calculations using the IDW method are calculated based on the data points closest to the point being estimated, while calculations using the NNP method calculate the value in a block based on the value of the point closest to that block. [22]

3.4. Research Conducted by Muhammad Rizky (2022)

The research is entitled "Iron Ore Resource Estimation Using Inverse Distance Weighting and Ordinary Kriging Methods at PT KUATASSI, Solok Regency, West Sumatra". This research aims to model, analyze and validate estimation methods to determine iron ore resources at PT Karya Usaha Aneka Tambang Solok Selatan Indonesia. The estimation methods used are the Inverse Distance Weighting Method and Ordinary Kriging using Surpac software. The accuracy of the two methods above will be compared using downhole composite validation. Based on the validation results, it was found that the IDW method obtained results that were closer to the composite value and obtained a greater value than the OK method. This is because the OK method applies a grade equalization system where the results obtained are less varied than the IDW method. [19]

3.5. Research Conducted by Agustian Aspiannur (2019)

The research is entitled "Calculation of Limestone Resources Using the Nearest Neighbor Point and Inverse Distance Square Method at PT Pama Indo Mining". This research aims to estimate Limestone resources and their levels using these two methods. Based on the estimation results using the NNP method, it was found that high values of CaO levels were located in the north, south and east. The results of the estimation of MgO levels are relatively small in the north and east. Meanwhile, from the estimation results using the IDS method, high CaO levels are evenly distributed to the west, north and south of the mining block and relatively low CaO levels are found in almost all mining blocks. [2]

3.6. Research Conducted by Y.A. Yulanda, et al (2022)

The research is entitled, "Analysis of Variations in Resource Estimation Using the Inverse Distance Weighting and Ordinary Kriging Methods". This research aims to determine the variation in the values of the two methods in each block grid. The data that is the object of estimation is coal thickness. In this research, the two methods will compare the tonnage of coal resources to determine differences in resource calculation results. The research data consists of 60 exploration drill points which were processed using coal resource calculation software. The results of this research show that a comparison of the IDW and OK methods at locations where there are drill holes as interpolation tie points shows variations that are not very significant so that by comparing the variation values of the two methods the resource calculation becomes quite convincing. [21]

3.7. Research Conducted by Rizky Pratama Pakudewa, et al (2020)

The research is entitled "Comparison of the Nearest Neighbor Point (NNP) Method and the Inverse Distance Weighting (IDW) Method in Estimating Coal Thickness in Tanah Grogot District, Paser Regency, East Kalimantan". This research aims to model and analyze estimation methods to obtain an accurate method used to estimate the thickness of coal resources. The accuracy of all methods in estimating will be compared using graphics and cross validation which will produce Root Mean Square Error (RMSE) values and linear regression values for each method. In this research, the data used is initial exploration data from 13 drill points which produced 61 coal thickness data without composites which will be used to determine the thickness distribution. Based on this research, the results of linear regression and descriptive statistical results from each method show that the IDW method with power 4 is better than other methods used at the research location. The use of graphical analysis cannot yet be maximized. Because almost all points have the same color distribution as the exploration results. [16]

4. Conclusion

From the results of overview, is The three estimation methods, namely Ordinary Kriging (OK), Inverse Distance Weighting (IDW), and Nearest Neighbor Point (NNP), each of them can be used in resource estimation methods and all three have different characteristics and principles. This is because the geometric shape of the deposit and the large value of the coefficient of variance greatly influence whether or not the results of the estimation are better and also indicate which method is more appropriate to use in estimating resources.

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