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Full Length Research Paper

Examination of cutoff grade parameters in magnesite mineral deposit

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One important critical value in mineral deposits is cutoff grade. The cutoff grade is defined as the value which discriminates between ore and waste with a given mineral deposit. In this study, the cutoff grade parameters such as SiO_2 and CaO% are examined by statistical distribution model. This paper shows a procedure for using the bivariate lognormal statistical distribution model with two uncorrelated samples to describe the SiO_2 and CaO% of Beylikova magnesite mineral deposit in Eskisehir, Turkey. After, it was determined that there are mean of SiO_2 and mean of CaO% involves the cutoff SiO_2 and cutoff CaO%, respectively. Finally, the bivariate lognormal distribution model with two uncorrelated samples is help to analysis in the cutoff grade parameters of mineral deposits.

Key words: Cutoff grade parameters, statistical distribution, magnesite, Turkey.

INTRODUCTION

Cutoff grade is important factor in mining because of its influence on the overall economic grains of a mining operation. Choosing the best cutoff grades maximize the economic outcome has been a major topic of research since the 1960's and many researchers have made contributions in devising various methods and algorithms (Wang et al., 2008).

The cutoff grade is used to distinguish ore from waste materials. If the cutoff grade is too high, much of the mined material will go to the waste dump area. If the cutoff is too low, then the input capacity of the entire mining and mineral processing operations will be fully stretched, while revenues do not necessarily increase. The optimal strategy is one that strikes the correct balance between these two limits (Bascetin and Nieto, 2007).

In literature, many cutoff grade theories are developed to mineral deposits. Some studies conducted in mineral deposits are as follows: Yi and Sturgul (1999) developed mathematical models are built and a nonlinear algorithm is coded to determine solutions to cutoff grade. Ataei and Osanloo (2003) presented an optimum cutoff grade of multiple metal deposits by using the golden section search method. Osanloo and Ataei (2003) selected cutoff grades with the purpose of maximizing net presented value subject to the constraints of mining, concentrating and refining capacities of multiple metal deposits will be discussed. Asad (2005) presented the ease of operation for the second case which became a reason of choice for the development of the cutoff grade optimization algorithm with a stockpiling option for deposits of two economic mineral. Bascetin and Nieto (2007) determined optimal cutoff grade policy to optimize net presented value by using an optimization factor.

This study describes the use of bivariate lognormal distribution model with two uncorrelated samples to examine the cutoff grade parameters of Beylikova magnesite mineral deposit in Eskisehir, Turkey.

METHODOLOGY

Bivariate lognormal distribution model with two uncorrelated samples

A positive random variable x is said to be lognormally distributed with mean (μ) and standard deviation (σ) if $y = \log(x)$ is normally distributed with μ and σ. If two uncorrelated continuous random variables x_1 and x_2 are lognormally distributed with

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different mean and standard deviation, the joint distribution of these variables have represented by the bivariate lognormal distribution with two uncorrelated samples. The probability density function of the bivariate lognormal distribution is given by equation 1.

$$f(x_1,x_2)=\frac{1}{2.\pi.x_1.x_2.\sigma_{y_1}.\sigma_{y_2}}\left(\exp\left(-\frac{1}{2}.\left[\left(\frac{\log(x_1)-\mu_{y_1}}{\sigma_{y_1}}\right)^2+\left(\frac{\log(x_2)-\mu_{y_2}}{\sigma_{y_2}}\right)^2\right]\right)\right) \quad (1)$$

where μ_{y_i} and σ_{y_i} are mean and standard deviation of y_i $(i=1,2)$ and they can be derived using the following formulae,

$$\mu_{y_i}=\log\left(\mu_{x_i}\right)-\left(\frac{\sigma_{y_i}^2}{2}\right) \quad (2)$$

$$\sigma_{y_i}=\left[\log\left(1+\frac{\sigma_{x_i}^2}{\mu_{x_i}^2}\right)\right]^{\frac{1}{2}} \quad (3)$$

Here μ_{x_i} and σ_{x_i} are the mean and standard deviation of x_i .

For the standard values corresponding to cutoff y_1 and y_2 can be derived as equation 4 (Konuk and Yersel, 1998; Yerel, 2008).

$$z_i=\frac{\log(x_i)-\mu_{y_i}}{\sigma_{y_i}} \quad (4)$$

From the above equations corresponding of tonnage rate of x_i $\left(T_{x_i}\right)$ is given by cumulative normal probability table. Mean of x_i $\left(\overline{x_{c_i}}\right)$ of magnesite mineral deposit under cutoff grade parameters, can be calculated by the equation 5 (Clark, 2001).

$$\overline{x_{c_i}}=\frac{D_i}{T_{x_i}}.\overline{x_i} \quad (5)$$

The equations 5 corresponding of the parameters D_i is calculated by equation 6.

$$D_i=\Phi(z_i-\sigma_{y_i}) \quad (6)$$

Dataset

This study area is located in the Southeast part of Eskisehir city, Turkey. The geological units are not complex in the study area. Metamorphic, volcanic and sedimentary rocks from Triassic to Quaternary age are the main geological units in the area (Gozler et al., 1997). In Beylikova magnesite mineral deposit, SiO_2 and CaO% have more important parameters than the MgO% (Yerel, 2008). In this paper, SiO_2 and CaO% were obtained from 40 vertical drillholes. Descriptive statistics of the SiO_2 and CaO% were presented in Table 1.

Table 1. Descriptive statistics of the SiO_2 and CaO%.

Parameters	n	Min.	Max.	Mean	Variance
SiO_2 %	135	0.01	1.21	0.224	0.077
CaO%	135	0.02	4.57	0.547	0.430

RESULTS AND DISCUSSION

The examination of cutoff grade parameters for a magnesite mineral deposit is most significant. The one of the most important cutoff grade parameters of a magnesite mineral deposits are the SiO_2 and CaO% (Yerel and Konuk, 2010). The correlation coefficient between SiO_2 and CaO% were calculated by using the regression analysis. The analysis result presented that a correlation coefficient between SiO_2 and CaO% was close to zero. Thus, we assume that SiO_2 and CaO% are uncorrelated parameters.

This study shows that the bivariate lognormal distribution model with two uncorrelated samples can be modeled by using the cutoff grade parameters including SiO_2 and cutoff CaO%. In this paper, mean of SiO_2 and CaO% with the Beylikova magnesite mineral deposit in Turkey was calculated by using the bivariate lognormal distribution model with two uncorrelated samples.

Considering that cutoff SiO_2 and CaO% with the Beylikova magnesite mineral deposit was modeled by using the bivariate lognormal distribution model with two uncorrelated samples. The mean of SiO_2 and CaO% were calculated by using Equation 5. These calculations were graphed and presented in Figures 1 - 2. The figures show that the cutoff SiO_2 and CaO% increased, mean of SiO_2 and CaO% also increased. But with mean of SiO_2 and CaO% increased, the quality of magnesite is decreased.

Conclusions

The most important parameters of a magnesite mineral deposit are SiO_2 and CaO%. The identification of mean of SiO_2 and CaO% involves the determination of cutoff SiO_2 and CaO%. In the magnesite mineral deposit, the cutoff SiO_2 and CaO% increased, the mean of SiO_2 and CaO% of the deposit also increased. However, with the mean of SiO_2 and CaO% increased, the quality of the magnesite is decreased.

This paper shows that the bivariate lognormal distribution model with two uncorrelated samples provide useful information for the cutoff grade parameters in helping them plan their magnesite mineral deposits.

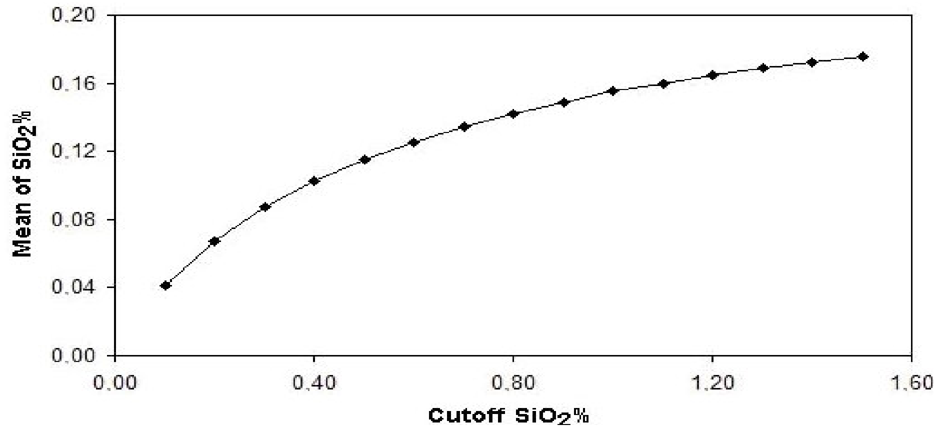

Figure 1. Cutoff SiO_2 versus mean of SiO_2%.

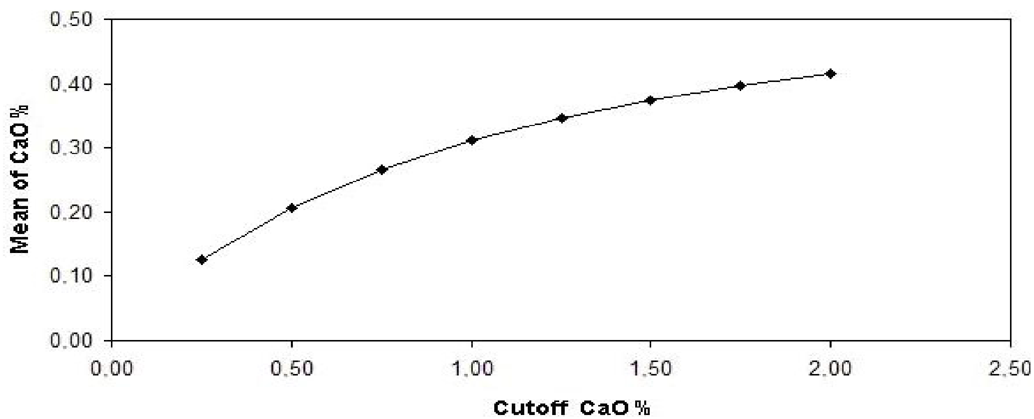

Figure 2. Cutoff CaO versus mean of CaO%.

These methods are believed to assist decision makers examining the cutoff grades parameters in order to improve the efficiently of mineral deposit planning.

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REFERENCES

Asad MWA (2005). Cutoff grade optimization algorithm with stockpiling option for open pit mining operations of two economic minerals, Int. J. Surface Min. Reclam. Environ. 19: 176-187.

Ataei M, Osanloo M (2003). Determination Of optimum Cutoff Grades Of Multiple Metal Deposits By Using The Golden Section Search Method. J. South Afr. Institute Min. Metallurgy 103: 493-499.

Bascetin A, Nieto A (2007). Determination of optimal cut-off grade policy to optimize NPV using a new approach with optimization factor, J. Southern Afr. Institute Min. Metallurgy 107: 87-94.

Clark I (2001). Practical geostatistics, Geostokos, Scotland pp. 50-119.

Gozler MZ, Cevher F, Kucukayman A, Asutay HJ (1997). Orta Sakarya ve Guneyinin Jeolojisi. MTA Report No. 9973, Ankara.

Konuk A, Yersel HG (1998). The risks of cutoff impurity decisions in magnesite open pit mining. 5th National Open Pit Mining Conference, Bugaria pp. 94-100.

Osanloo M, Ataei M (2003). Using equivalent grade factors to find the optimum cut-off grades of multiple metal deposits, Miner. Eng. 16: 771-776.

Wang Q, Gu X, Chu D (2008). A Dynamic optimization method for determining cutoff grades in underground mines. Gospodarka Surowcami Mineralnymi 24: 133-142.

Yerel S (2008). Determination of cutoff grade decision variables in multivariate ore deposits. Eskisehir: Eskisehir Osmangazi University (Ph. D. Thesis).

Yerel S, Konuk A (2010). Assessment of cutoff grade impurities: a case study of magnesite ore deposit, 100 years of mining research symposium: mine productivity, Arizona, USA pp. 93.

Yi R, Sturgul JR (1999). Economic significance of sub-cutoff grades in open pits operating with concentrator bottleneck. Miner. Resour. Eng. 8: 195-203.