

Quantitative Study for Classification of Geological Condition of Coal in Indonesian National Standard - Guidelines for Reporting Resources and Reserves of Coal (Sni) No. 5015 / 2011

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Abstract

The classification of resources and reserves of coal in Indonesia is based on the Indonesian National Standard (SNI), which is published by the Agency National Standardization. SNI is an entitled Guideline for reporting resources and reserves coal (SNI 5015 2011 years). The current classification of the geological conditions in the SNI 5015 in 2011 is still a qualitative description, but in the future, the study of geological conditions of coal classification should already be using a combination of quantitative and qualitative methods. Therefore, the determination of the input parameters of sedimentation, tectonics and coal quality should be planned for as many as possible to get quantitative data rather than qualitative descriptions. The process of classifying geological conditions will be largely determined by geological knowledge and methods of quantifying the spatial relationship used in geostatistical approach. Merging the two of the above will provide a more acceptable in terms of geological knowledge and in terms of geostatistical approach.

Keywords: geological conditions, coal, geostatistics, SNI 5015/2011, quantitative and qualitative

Introduction

SNI 5015 in 2011 are guidelines for the reporting of exploration results and estimates (criteria for classification and qualification) of coal resources and reserves. The terms and definitions given in this standard are commonly used in the reporting of resources and reserves of coal. This reporting is adopted from The Australian Guidelines for Estimating and reporting of inventory coal, coal resources, and coal reserves, 2003 Edition. SNI 5015 in the year 2011 discussed on the type of coal deposits and geological conditions qualitatively, but not yet detailed. Geological conditions are very dependent on the level of complexity of the geology. Geological complexity is based on the process of sedimentation and tectonic influence. The geological characteristics can be grouped into three major groups: the simple geology, geology moderate group, and a group of complex geology. The third level of complexity of the geology can occur in certain areas. A description of the general limits for each of these groups as well as the type locality is as follows. (Source: SNI 5015/2011)

a. Simple geologic condition

Coal deposits in this group are generally not significantly affected by folds, faults and intrusions. The coal seams are generally gentle, continuous laterally until thousand meters, and have almost no splitting. The thickness of the coal seams in the lateral and the quality do not show significant variations.

b. Moderate geologic condition

Coal in this group is deposited in a sedimentation conditions that are more varied and to a certain extent has been the influence of tectonic and post-deposition process, characterized by the multiplicity and cesarean delivery. This group is also characterized by the moderate lateral variations of dip and thickness and splitting being in the coal seam, but its spread can still be followed up to hundreds of meters. The coal quality is directly related to the level of changes that occur both during and after the sedimentation process. In some places igneous intrusions affects the layer structure and quality of coal.

c. Complex geologic condition

Coal in this group is generally deposited in a sedimentation conditions that are complex or have undergone extensive tectonic deformation resulting in the coal seam thickness varied. The quality of coal is much influenced by the changes that occur during the process of sedimentation or at the post-deposition such as division or damage to the coating (washout). Folding, inversion (overturned) and the shift caused by tectonic activity and its common making it difficult for coal seam reconstruction and correlated. Strong folding shape also resulted in steep layer. Laterally, the spread of a layer of coal is limited and can only be followed up to tens of meters.

Summary of geologic complexity can be noted in the table below:

Table 1. Indonesian Geologic Assurance on Coal Resources Classification. It depends on sedimentary, tectonic and quality parameters, which lead to classification of Geologic Conditions into simple, moderate and complexes. (SNI 5015 in 2011)

Parameters	Geologic Conditions		
	Simple	Moderate	Complexes
I. Sedimentary Aspect			
Coal Thickness	Little variation	Some variation	Large variation
Coal Continuity	Thousands of meter	Hundreds of meter	Tens of meter
Coal Splitting	Almost none	Some	Many
II. Tectonic Aspect			
Faulted	Almost none	Moderate	Highly
Folded	Almost none	Moderate	Highly
Intrusion (igneous)	No influence	Moderate influence	High influence
Dip	Gently	Moderate	Steeply
III. Coal Quality Aspect			
varying quality	Little variation	Some variation	Large variation

In this study the authors will try to describe in more detail the aspects of a parameter geological complexity with qualitative and quantitative analysis. Research methods that will be used are the method of statistical analysis and geostatistics. In geostatistical analysis, variogram and kriging will be used.

Results and Discussion

Modifications SNI 5015 in 2011 with a quantitative analysis

Details of the quantitative analysis of SNI 5015 in 2011 also include aspects of sedimentation, tectonics and coal quality.

Sedimentation aspects

Aspects of sedimentation include variations of coal thickness, continuity, splitting, regularity, and form a layer of coal. Here are the details will be discussed one by one below:

a. Thickness variations

Variations of coal thickness for simple, moderate and complex geological conditions distinguished from the results of descriptive statistical analysis, and analysis of the variogram models include:

- Population type of data, whether the data is normal or abnormal, unimodal or bimodal. For simple geological conditions: normal population - unimodal, for moderate geological conditions: normal - unimodal -bimodal population data and for complex conditions: normal –bimodal population data.

- The coefficient of variation (CoV). For simple geological conditions coefficient of variation <0.2 , the moderate geological conditions, coefficient of variation $0.2-0.5$ and for the complex geological condition, the coefficient of variation > 0.5 .
- Skewness. For simple geological conditions approximately symmetric (skewness between $-\frac{1}{2}$ and $+\frac{1}{2}$); moderate geological conditions is moderately skewed (skewness between -1 and $-\frac{1}{2}$ or between $+\frac{1}{2}$ and $+1$); and for complex conditions is highly skewed (skewness of less than 1 or more than $+1$).
- Kurtosis. For simple geological conditions is mesokurtic; the moderate geological conditions is platykurtic - leptokurtic kurtosis; and the complex conditions is platykurtic -leptokurtic kurtosis
- Variogram model. For simple geological conditions : isotropy, unimodal populations data, nugget effect is close to zero; moderate geological conditions are bimodal population data, nugget effect > 0 and nested structure, and for complex geological conditions area bimodal populations data, nested structure and nugget effect > 0 .

b. Continuity

Aspects of coal seam continuity to the simple, moderate and complex geological conditions distinguished from the analysis of the range of the variogram. For simple geological conditions, range up to 1000 meters; moderate geological conditions, range up to 500 meters; and complex geological conditions range up ≤ 50 meter.

c. Splitting

Splitting Aspects of coal seam coal can be identified by the pattern of distribution of the data of the statistical analysis and variogram model. For simple geological conditions: isotropy, unimodal populations data, nugget effect is close to zero; moderate geological conditions are bimodal population data, nugget effect > 0 ; and nested structure, and complex geological conditions area bimodal populations data, nested structure, and nugget effect > 0 .

Aspects of Tectonics

For tectonics aspects consist of faults, folds, intrusion and dip of coal seam can be identified by the pattern of distribution of the data of the statistical analysis and the variogram model. For simple geological conditions: unimodal population data and normal distribution (symmetry); the moderate and complex geological conditions: bimodal population with data distribution is not normal (asymmetry positive or negative).

Especially for intrusion aspect, according to the authors would be more appropriate if it is put into the quality aspect, because the aspect of intrusion is very influential in the coal rank grouping.

Quality aspect

Aspects of coal quality will be known from the analysis of the range of the variogram. In this study only discusses three types of quality coal that is the ash content, sulfur content and calorific value. Resulting from the three different ranges. As a reference in the classification, the author uses the minimum distance among the three, intended to obtain better results. For simple geological conditions, moderate and complex quantitatively distinguished from the analysis of the range of the variogram. For simple geological conditions range up to 1000 meters; to the geological conditions of moderate range up to 500 meters; and for complex geological conditions Range up ≤ 50 meter. To further enhance the table Modified SNI 5015 in 2011, based on the results of assessment of statistical and geostatistical study, so in this study the authors try to create a table parameter aspects of the above by using the results of the methods of geostatistics, so the table parameter aspects more quantitative, as set out in the table below this:

Table 2. Classification geological conditions based on geostatistical analysis

Sedimentary Aspect	Geologic Conditions		
	Simple	Moderate	Complex
Sedimentary Aspect			
Coal Thickness	Coefficient Of Variation <0,5 ; Approximately symmetric (scenes is located between -1/2 and + 1/2); Mesokurtic kurtosis	Coefficient Of Variation <0,5 ; moderately skewed (skewness between -1 and -1/2 or between + 1/2 and +1); platikurtik - Leptokurtic kurtosis	Coefficient Of Variation >0,5 ; highly skewed (skewness is less than -1 or more than +1) ; platikurtik - Leptokurtic kurtosis
Coal Continuity	Range =550-1000 m Isotropy, nugget effect close to zero	Range =250-500 m ; nugget effect>0	Range =100-150 m Anisotropy, nested structure nugget effect>0
Coal Splitting	Normal distribution data (symmetry) , unimodal population data	distribution data is not normal (asymmetry positive or negative), bimodal population data	distribution data is not normal (asymmetry positive or negative), bimodal population data
Tectonic Aspect			
Faulted	Normal distribution data (symmetry) , unimodal population data	distribution data is not normal (asymmetry positive or negative), bimodal population data	distribution data is not normal (asymmetry positive or negative), bimodal population data
Folded	Normal distribution data (symmetry) , unimodal population data	distribution data is not normal (asymmetry positive or negative), bimodal population data	distribution data is not normal (asymmetry positive or negative), bimodal population data
Intrusion (igneous)	Normal distribution data (symmetry) , unimodal population data	distribution data is not normal (asymmetry positive or negative), bimodal population data	distribution data is not normal (asymmetry positive or negative), bimodal population data
Dip	Normal distribution data (symmetry) , unimodal population data	distribution data is not normal (asymmetry positive or negative), bimodal population data	distribution data is not normal (asymmetry positive or negative), bimodal population data
Coal Quality Aspect (Ash, Sulphur and Calorific Value)			
varying coal quality	Range =550-1000 m	Range =250-500	Range =100-150

Conclusion

Guidelines for the classification of geological conditions contained in SNI 5015/2011 are qualitative and not measurable. Using geostatistical approach, the results obtained are quantifiable and measurable. With geostatistical approach, geometry parameters and quality of coal can be considered simultaneously to determine the classification of the geological conditions of coal. And if this is done then any coal basin with particular geological setting is likely to assist in the exploration and classification of coal resources.

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