Three-Dimensional Model of Cangshang Gold Mine Based on Surpac

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Abstract

The three-dimensional geological model of Cangshang Gold Mine, including the geological database, ore body model and block model, was established by mining software Surpac, which simplified the complicated hand-drawing and reserve calculation. The three-Dimensional development system visualization was also studied on the basis of conducting the vectorization of the whole development system design including excavation and construction project. The establishment of mine three-dimensional geological model simplified the complicated hand-drawing and reserve calculation. The calculation results are accurate, which can be used in the resource estimation, reserve calculation and mine design of the mine production stage.

Keywords: Geological Model, Surpac, Digital, Geological Statistics

1. Introduction

Mining has gradually developed toward digital and visualization today. The three-dimensional geological model is one of the key technologies of digital mine and has been one of the research directions in modern information technology field [1]. In this study, the Surpac software was used to build ore body solid model, grade block model and three-dimensional visualization development system. Through the three-dimensional model building, the ore body internal structure and external morphological spatial variation were vividly unfolded. Based on these, we can rational use of the resources and realize the dynamic management of mine in the future. The value of ore body reserve calculated and that of original geological report are in good agreement, and the error is small.

2. General geology of Cangshang Gold Mine

The Cangshang Gold Mine is located in the Guoxi town, Laizhou City, Shandong Province, which is subordinate to Shandong Gold Mining Co., Ltd. Sanshandao Gold Mine. The gold mine was built by Changchun Gold Design Institute in 1986, which was designed to exploit underground, and the production scale is 100t/d.

Because of the broken ore and complicated engineering geological conditions, the underground mining was too hard to continued, thus it transferred into open-pit. The production capacity has expanded to 1800t/d after repeated reconstructions and extensions. In June of two thousand six, the Cangshang Gold Mine was merged by Shandong Gold Mining Co., Ltd, and became a subsidiary of Shandong Gold Mining Co., Ltd. Sanshandao Gold Mine.

The mining area is located in the west of Jiaobei uplift of Jiaodong uplift area, Sanshandao ore-controlling fracture. The mining area stratum is simple, main is Quaternary and Jiaodong group; the Sanshandao - Cangshang fracture is the main structure, the large-scale alteration zone where the altered gold ore body occurrence in was formed along the ore-controlling fracture. The main magmatic rock of the mining area are granite and vein rock, the former contacts with the major fault of archaean Jiaodong group metamorphic rock, is a part of Linglong pluton; the latter is non-development, small scale and small amount.
3. Establishment of geological database

According to the format of Surpac software, the databases in 4 tables were tested, such as Collar, Survey, Geology, Sample. Then they were introduced into Surpac software to build geological database. Figure 1 shows the collar data table, which is one of the data tables.

The mining geological database is the foundation of deposit three-dimensional model, which the creation of deposit body model and grade body model, statistic analysis of collar data, grade model estimate and reserve calculation can’t lack. The building geological database has powerful post-processing function, when the geological database built [2, 3]. We can use the powerful image display system of Surpac software to display the geological database in three-dimensional, which include the trajectory of collar, grade value, lithology and code, layer’s strike [4].

In brief, almost all the geological information can be displayed by the methods of characters, diagrams, and graphics. We can also manipulate the editing, querying, refresh and statistical analysis of data as well as 3-D visualization display [5]. The 3-D view of collars can be seen in Figure 2.

![3-D view of collars](image)
4. Establishment of ore body model

Two methods always be used to build the ore body model:
(1) The geological collars were combined on the basis of geological database, according to the grade, rock properties etc. to refresh geologically explaining each ore body range of profile and each geological boundary [6].
(2) Based on the existing prospecting line transverse section drawings and the tagged ore body range by each geological boundary in plans, the body model was generated [7].

The two above methods were comprehensively used in this study. Firstly, give priority to the mid piece plan drawn on the basis of notch groove data, the subsidiary role is the prospecting line transverse section drawing based on collar data. We can establish the files of prospecting lines, boundary strings and fault strings. Then the ore body model was built based on the combination of collar test data and prospecting line [8].

4.1. Drawing string serial files

Cangshang Gold Mine already has a variety of blueprint, in order to sufficiently reflect the experience and knowledge of the engineering and technical personnel, especially the geology engineering staffs, meanwhile to satisfy the request of later market effect and grade dynamic controlling, and comprehensive consider the cause of deposit and effect of fault on mineralize [9].

The ore body delineation rule (boundary grade is $1.0 \times 10^{-6}$) were combined to delineated the mineralization area under the help of the technicists. The completed string file mainly include exploration string file, boundary string file, fault string file. The boundary string file can be seen in Figure 3.

![Figure 3. Boundary string file](image)

According to the above steps to deal with all maps of level and profile, a variety of methods of creating triangulation network were used to connect the same property and number string series in adjacent level. The three-dimensional model of boundary and fault is shown in Figure 4.
4.2. Ore body model based on Surpac

The ore body model was built on the basis of collar test data and exploration string. Main steps are as follows:

Gold grade and lithology were shown in different colors, collars were displayed in three-dimension;
Along the prospecting line direction profiles were made, which were respectively given geological explanation based on the body boundary of collar [10]. The ore body boundary was revised according to the exploration data, triangular network was connected was among the two sections or one section to generate the ore body model, which is shown in Figure 5.

4.3. Three-Dimensional development system visualization study

The vectorization of whole excavation engineering was conducted on the basis of development system design and constructed engineering. The middle tunnel section sizes and center lines were used to generate 3-D tunnel model [11]. The occurrence relationship between ore body and tunnel will be
visual displayed after the development system established. The 3-D composite model of boundary, ore body and development system can be seen in Figure 6.

![Figure 6. 3-D composite model of boundary, orebody and development system](image)

5. Establishment of block model

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Three-dimensional model of deposit can display the geometry space form, but difficult trace out the inner distribution of ore body, so we need to utilize the information of samples existed in the geological data base, adopt geological statistics method to value the grade, to establish the body model and to provide science evidence for optimization of dynamic grade [12].

The establishment of the ore body model is that dividing the ore body into patches one by one, then describing the patch respectively. We can describe the whole space range, check property of anyone piece and grade distribution [13]. When the grade model was established, we can express the distribution of metallic element by different color and pattern according to our need, and also can generate any directional grade distribution profile, revealing the inner grade distribution of ore body.

5.1. Selection of ore body size

The ranges of X, Y, Z are selected: \( X_{\text{min}} = 490650, \ X_{\text{max}} = 491952, \ Y_{\text{min}} = 4136300, \ Y_{\text{max}} = 4135700, \ Z_{\text{min}} = -350, \ Z_{\text{max}} = 10 \). The whole ore body was included, according to the form of ore body and engineering control net extent, the user block size was selected as: \( 6 \times 6 \times 4 \), the minimum size as: \( 3 \times 3 \times 2 \), then to establish the body model, which can be seen in Figure 7. Add constraint condition to limit the block model in the delineated body boundary, so as to estimate the body in the ore body range.
5.2. Body model valuation

The most common used method is the geological statistic method such as ordinary Kriging and the Distance Power Inverse Ratio Method. We can find that the gold grade of Cangshang Gold Mine can’t agree with the normal distribution when we make a based statistic of composite sample, so the distance power inverse ratio method was used to give the value of ore body model [14].

The distance power inverse ratio is one of the most common used spatial interpolation methods, it uses the distance power inverse ratio relationship of the known adjacent value to estimate the value of mesh point, the theory based on the contribution from the closest points around the not sampled point to the value of not sampled point is the largest, and the relationship between the contribution and distance is inverse [15]. It can be written as follow:

\[ Z = \frac{\sum_{i=1}^{n} \frac{1}{(D_i)^p} Z_i}{\sum_{i=1}^{n} \frac{1}{(D_i)^p}} \]  

Where \( Z \) is the estimated value; \( Z_i \) is the \( i \) (\( i=1,2,3,... \)) sample; \( D_i \) is the distance; \( p \) is the power of distance, which significantly affect the interpolation results, the selection criteria is the smallest average absolute error, The higher the power, the more smooth effect of the interpolation results. In order to facilitate the calculation, the 1, 2 or 3 are generally chose, the 2 is usually chose as the power.

We can value any ore body grade by determining the ellipsoid search parameters. Increasing the proportion of properties, assigning the value directly according to different grade range, you can add proportion of properties to the ore body, the color the ore according to properties, the grade distribution of ore body of this mine area will be clearly seen [16]. The spatial distribution of different gold boundary grade is shown in Figure 8.

Figure 7. Block Model
5.3. Calculation of ore grade model

The ore body volume and reserve of any ore area can be quickly calculated by the Surpac software according to the actual needs of mine when the ore grade model was established, and the report form of reserve can be submitted. The ore body reserve report of all ore body, including open pit and underground can be respectively gained by the automatic report, and the error is small when the calculation results was compared with the original geological report.

6. Conclusions

The ore body geological database of Cangshang Gold Mine was studied and established by the Surpac software from the view of mining information system engineering in this study. The geological database is the foundation of the “digital database”, and also one of its core contents. The establishment of geological database provided the basic data for the establishment of three-dimensional geological model.

The three-dimensional model of ore body was established by using of Surpac software, and the visualization of space form of ore body was displayed clearly. The ore body external character and space distribution regularity were reflected vividly, which help to realize the visualization analysis and evaluation of production information of mining enterprise. All of these provide a new platform for the research of each operation link of Cangshang Gold Mine such as engineering visualization design and production Planning Management.

While building the grade model, the grade information of each ore body inner point was reflected accurately, the function of automatically drawing the profile in any direction and calculating the reserves of any range quickly and accurately was realized, which enables the staff to grasp the distribution of ore body more clearly, meanwhile availed for estimation of mine resource, dynamic management of mine production, reserves statistic and analysis, optimization decision of production, ore body deep department prospecting, and enables the mine enterprise to make more efficient and rational utilization of mineral resources.

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8. References