3D Geological Modeling of DALU Mine Field based on 3DMine

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Abstract

In order to carry out coal mine design and mining safely and effectively, clarify the distribution range and distribution law of coal seam, and provide reliable geological guarantee for green mining of coal mine, Taking coal seam 11 in DALU mine field of Hegang City, Heilongjiang Province as the research object. This paper presents a 3D geological modeling method of coal mine based on 3DMine software, which is based on borehole data, triangle passing through wave point by surfaceoccurrence, analysis data and so on. Coal seams and faults are used to model respectively, and then combine the methods. This methods makes full use of the existing geological data, the surface model, structural model and coal seam model are established respectively, which are combined into mine geological models. The results show that 3DMine construction method takes into account the occurrence state of coal seam, the complexity of structure and the geological conditions of topography. It can carry out the geological modeling of mine field intuitively and realistically, thus providing geological reference for mine design and production deployment.

Keywords

DALU mine field; 3DMine; Structural model; Coal seam model; Mine geological model.

1. Introduction

Three-dimensional modeling is the process of displaying real or fictitious objects on the computer by means of point, line, surfaces and software to rendering on the basis of two-dimensional wireframe model through computer software[1]. In 1993, Simon W Houlding, Canada, first put forward the general wind of "3D geological modeling" [2], while French scholar Mallet published two articles on "discrete smooth interpolation" modeling method in 1989 and 1992, respectively. It indicates that the geological surface technology in 3D structural modeling technology has made substantial progress.

Domestic scholars have also made unremitting exploration on the theory and technology of three-dimensional geological modeling [3]. A large number of scholars have put forward many modeling methods according to the different research angles in their respective fields. For example, in the aspect of slope engineering, Zhang Ju-Ming and others developed a "three-dimensional visualization system of slope engineering geological information" [4], In the field of water conservavcy, Chai Hejun and others have developed a set of three-dimensional visualization system about rock mass structure [5]. In the aspect of urban construction, Zhu Hehua has developed a 3D geological body simulation and visualization operating system which can be applied to in urban underground space. Cao Daiyong and others have developed a slice synthesis method based on Open GL in engineering geology. A three-dimensional geological chess visualization analysis system suitable for coal field in developed [6]. In addition to the above fields, many domestic scholars have also carried out in-depth research and discussion in the fields of green mine exploitation, oil and gas exploitation and geological hazard prevention and control [7].

However, according to the existing drilling data, how to model the coal seams and faults are modeled separately, and then combined the into the geological model of the mine field, there are few research results at present. In this paper, 3DMine software is used to study coal seam 11 in DALU mine field of Heilongjiang Province, and how to carry out three-dimiensional geological modeling of coal seam and fault respectively is discussed. And how to combine the two models into a mine field geological model according to the measured data, so as to provide geological guarantee for mine safety mining.

2. Organization of the Text

2.1. Geology Survey of Mine Field

The object of this model is the DALU mile field of Hegang city, Heilongjiang Province. The geostructure of Hegang early Cretaceous coal-bearing basin is located in the secondary fault basin the in the Jihei-Black fold system, the Laoyeling uplift and the Qingheishan uplift belt[8]. The coal measure strata belong to the the lower Cretaceous Chengzihe formation (K1c), of the Mesozoic, and the lower part of the coal measures is mainly composed of sandstone, siltstone and mudstone, the thickness of the strata is 200m, and the coal bearing layers are 33, 35 coal seams, etc. Nonmining; The middle part of coal measures is the main coal-bearing section of Chengzihe formation. The strata in this section are characterized by fine lithology, large thickness and mostly coal seams. The thickness of which is 700m and contains 14 layers of coal. Among them, the recoverable coal seam are 11, 18-1,18-2,22 coal seams; the upper part of the coal measures is mainly composed of grayish white conglomerate, glutenite, medium-fine sandstone, black siltstone and gray matter siltstone, and the stratum in this section are characterized by coarse lithology and low coal content. The thickness of the formation is 100m, coal-containing layer 1, and locally recoverable.

The 11 coal seam in this area has the widest development range in the whole area, the structure of the coal seam is simple, the thickness varies greatly, the maximum is 20.95m, the minimum is 2.88m, the average thickness is 9.10m, and it is the thickest coal seam in the mine field, therefore, This modeling takes the 11 coal seam as an example, carries on the 3D geological modeling.

2.2. 3D Mine Geological Modeling of Mine Field

2.2.1. 3Dmine Software and Modeling Process

3DMine mining engineering software is a domestic mining software system developed by Beijing Sandiman Mining Software Technology Co., Ltd., which has independent intellectual property rights, adopts advanced three-dimensional introduction technology in the world and operates in all Chinese. The software includes six parts: drilling, surface, geological model, reserve calculation, open pit mining and underground mining design.

The geological modeling process of three-dimensional mine field is as follows:

(1)The rotation virtual core method is used to calculate the occurrence of faults, refining layers and oher layers in boreholes. The three-dimensional coordinates, azimuth and tilt angles of fault coal intersections.

(2)the occurrence of faults, coal seams and other geological strata in the borehole, the three-dimensional coordinates, azimuth and dip angle of fault coal intersections are taken as basic data, the startified numbering is carried out.

(3)The coal seam is divided into several fault blocks according to the fault seen in the borehole.

(4)In each fault block, the transition point of occurrence change in the triangle surface is solved according to the coordinates and occurrence of the same coal seam in every three adjacent boreholes in turn.

(5)To solve the coordinates and occurrence of the occurrence change transition of the same fault triangle surface delineated in three adjacent boreholes, and to solve the intersection point of this plate and another plate of broken coal, the coordinates, azimuth angle and dip angle of two adjacent fault coal intersections points are solved by solving the mark. azimuth angle of the transition point of discontinuous coal intersections line of two adjacent fault coal intersections.

(6)The surface, fault and coal seam are modeled and extracted respectively, and the contour lines are extracted according to the hole depth data, reasonable optimization is carried out, and finally the three-dimensional geological model of mine is synthesized.

2.2.2. Establishment of Ground Model

The surface model can clearly reflect the topgraphy and geomorphology of the mining area, and the spatial position relationship of the deposit and goaf [9]. The construction method of DTM mainly includes the following two types:

(1)DTM is generate from elevation point

Firstly, the elevation point file of mine is extracted, and the corresponding assignment processing is made. Then the terrain model is generated by the function of "generating DTM surface" of the software.

(2)Generate DTM from Open Lin

The terrain contour file in this area is vectorized and Z value is assigned, and then the digital terrain model is generated by using the "generate DTM surface" function of the software.

Because of the large workload and error of the above two methods in assigning the contour lines, this paper attempts to use the quick conversion function of 3Dmine software and Excel to paste the surface coordinates with elevation directly into the 3Dmine software to form scattered points. The ground model is generated through the "generate DTM surface" function of the software (figure 1). The isoline DTM under the surface function is used to generate the contour diagram, the step distance of 2m and the mark interval of 200m are selected respectively, and the smooth contour line of NURBS is used to generate the contour map of the ground (Fig. 2).

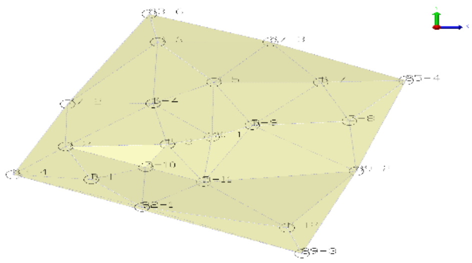

Fig 1. Ground Model based on irregular Triangulation Network

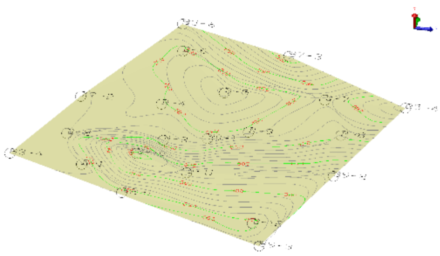

Fig 2. Ground model with isoline

In order to display the ground information more clearly, the terrain model is rendered by triangulation color (Fig. 3).

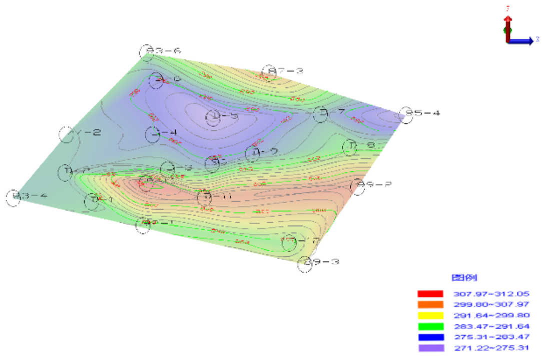

Fig 3. Rendered surface model

In the rendering process, the color interpolation field selects Z coordinates, the minimum value is 271.22m, the maximum value is 312.05m, and the Rainbow, shading scheme is chosen from minimum to maximum overshaded, and the rendering mode is smooth rendering. By inserting a legend to display the image, the terrain is displayed and presented in red, orange, yellow, green, blue, and purple from high to low. Different colors represent different elevations that overlap with the contour ground model in figure 2. More vividly reflects the ups and downs of the ground.

2.3. Structure Model

Because fault is the main tectonic type of this field, the structural model established in this paper is mainly based on fault information. The commonly used methods to establish 3D visualization model of geological structure include three-dimensional regular mesh method, TIN surface method, tetrahedral method and synthesis method.

The TIN surface method is used to deal with the faults in the 11 coal seam area. For the establishment of the fault model, two main problems are considered here: one is to make clear whether the fault modeling is single fault modeling or multiple fault modeling; The other is the cutting relationship between faults and faults.

According to the information of the outline and profile maps of the well structure, there are mainly six faults in this area, such as F6, F17, T9, T13, T14 and T35, which belong to several fault models, and there is a cutting relationship between the faults and the faults. That is, the order of existence time. Therefore, the cutting relationship between faults in modeling is mainly based on the structural outline diagram and the contour line of coal seam floor.

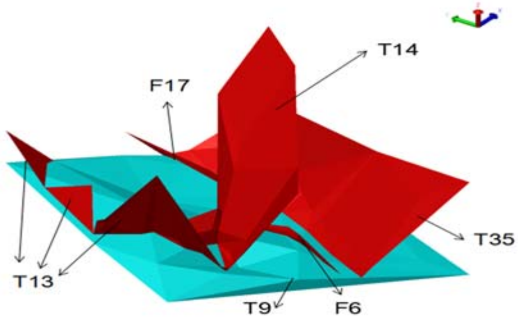

Fig 4. Fault model

As can be seen from the established fault model (figure 4), the light blue T9 fault at the bottom has a sharp depression in a small range, with a plane fault as a whole, while several other faults are almost perpendicular to the T9 fault. It is shown that there are many periods of strong tectonic activity in this area, which is basically consistent with the fault development described in the exploration report, and the accuracy of this fault modeling is demonstrated.

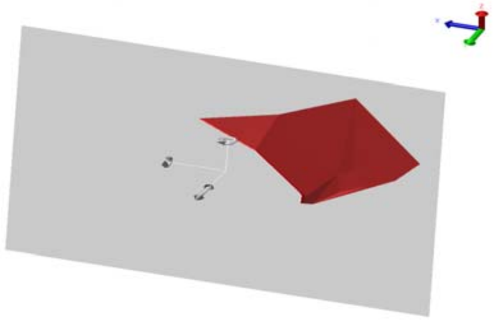

Fig 5. T_{14} fault profile

It can be seen from the section map of T14 fault (Fig. 5) that the break horizon is a curve, which is different from that of the traditional mineral exploration method, in which the fault line is drawn as a sloping line. This modeling method can effectively improve the fault capture rate. By mining the fault occurrence information, if three or more boreholes can see the same fault, the vector interpolation of the fault surface can be carried out, and a more accurate three-dimensional model can be established.

2.4. Coal Seam Model

Compared with metal orebody, the development of coal seam is relatively stable. However, coal seam modeling has always been a complex process. On the basis of absorbing previous research results [10], combining existing data and according to the contact relationship between fault and coal seam, 11 coal seam is divided into A, B, C, D, Six block segments, E and F, were modeled (Fig. 6). Compared with the fault model, the coal seam model is cut into six blocks, but each block has little change as a whole, and the shape of each block is mainly controlled by the fault.

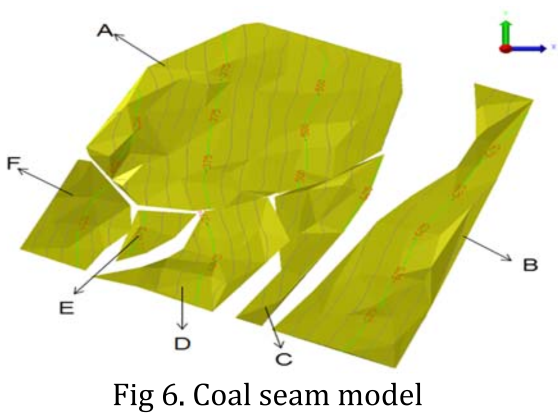

Fig 6. Coal seam model

2.5. Mine Geological Model

The establishment of the field model is based on the above-mentioned surface model, structural model and coal seam model, combined with the final hole depth data to form a three-dimensional model (Fig. 7). In the contact part of coal seam and fault, the fault and coal seam are given the same three-dimensional coordinate according to the coordinates of fault coal intersection line, combined with the measured data, reasonable extrapolation and model optimization are carried out.

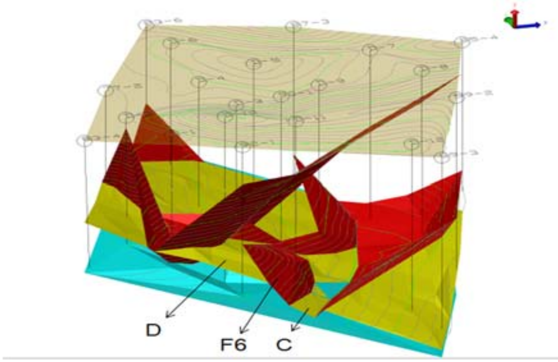

Fig 7. Mine geological model

It can be seen from the three-dimensional geological model (fig. 7) that the fault is steeper and steeper near the coal seam. F6 fault is the main fault, and the C and D segments of 11 coal seam are cut. The three-dimensional model can observe F6 as a normal fault, which is consistent with the measured data. The reliability of the model is verified. The model can directly show the influence of faults on coal, which has certain guiding significance for the later calculation of reserves. Therefore, the 3D geological model established by this method can intuitively see the real situation of adjacent faults and faults, and the spatial relationship between faults and coal seams, which is very difficult to see in the 3D geological model of 2D profile map and whole coal seam modeling. To [11].

3. Conclusion

(1) The three-dimensional geological model based on borehole data, triangle surface transition point, analysis data and so on, which is based on coal seam and fault modeling method, can better show the adjacent fault cutting in three-dimensional space in the depth of exploration. The whole view of the intersection is more reasonable than the whole coal seam modeling, which can only show faults within the depth of coal seam.

(2) The model can avoid the difficulty of modeling reverse faults, reverse folds and other special cases, which is beneficial to the analysis of spatial relations at fault junctions, and to the comparison and analysis of geological structures and coal seam occurrence from many aspects and dimensions. Avoiding single interpretation and error can effectively improve the accuracy of 3D modeling and make the coal seam and fault shape in the two-dimensional section map cut on this 3D model more in line with the actual situation

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