Research on Computer Stochastic Simulation of Large Spacing Pillar-less Mining Ore Drawing

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Abstract. The new technology of large spacing Pillarless Mining has been widely used because of its advantages, such as timely increase of parameters, improvement of stope ground pressure, and suitable for mining of gently inclined orebody. It has brought good benefits and has high research value. Based on this, this paper first analyzes the mining theory of pillarless sublevel caving method, then studies the computer random simulation test of large spacing pillarless large parameter mining, and finally analyzes the results of the new technology of large spacing Pillarless Mining Based on computer random simulation.

Keywords: Large Spacing Pillar-less Mining, Ore Drawing, Computer Stochastic Simulation

1. Introduction
With the deepening of social production, the demand and consumption of mineral resources in the infrastructure industry related to construction and transportation are increasing, which puts forward higher requirements for the mining tech of the mine. The stope adopting the new tech of Pillarless Mining has several advantages as shown in Figure 1, so it can be popularized and applied rapidly.

Figure 1. The advantages of stope adopting pillarless mining

However, there are many shortcomings in the non-pillar mining tech, such as low recovery rate, dilution and large loss [1]. These problems seriously restrict the play of the advantages of non-pillar mining tech, so it is urgent to innovate the tech. Increasing and optimizing the stope structure can effectively improve the productivity of pillarless mines, and can realize the control of dilution and loss based on the shape of drawing body. Therefore, the study of large spacing Pillarless Mining Tech
Based on computer random simulation has important practical value for improving the large spacing non pillar drawing tech and mine production efficiency.

2. Mining Theory of Pillarless Sublevel Caving Method

2.1. The practical value of the theory of large spacing
With the rapid development of pillarless sublevel caving method, the theory of large spacing without sill pillar has become one of the main mining methods in the current mining field, and has been rapidly applied and developed in other related industries [3]. With the in-depth application of the theory, a series of problems and shortcomings in practice are gradually exposed, such as small structural parameters, a small amount of ore collapse and so on. Therefore, through the large-scale structural parameters to improve the mine production capacity, improve the mining intensity of the applied theory can be gradually developed.

In recent years, the increasing trend of structural parameters in pillarless sublevel caving method is more and more obvious, and it is also gradually popularized. It is urgent to guide the mining theory of pillarless sublevel caving method, so as to lay a theoretical foundation for the scientific and reasonable increase of structural parameters.

2.2. Derivation of DSGE model
The traditional ore drawing theory has a series of shortcomings, such as ignoring the mutual influence between drawing bodies, overlapping of drawing bodies, section height greater than drift distance, etc., and the principle of drawing body tangent is damaged [3]. The traditional structural parameter optimization of drawing theory is mainly realized by optimizing the spatial arrangement of drawing body to ensure the compactness of drawing body spatial arrangement.

Generally speaking, there are two ways to optimize the structural parameters of traditional ore drawing theory. In the optimization mode with large spacing structure, the distance between access roads is obviously larger than the section height, as shown in Figure 2 (a). The optimization form of high section structure is obtained by 90 degree rotation of the optimization mode of large space structure, as shown in Figure 2 (b). It can be seen from Figure 2 that the compactness of the space arrangement of the two kinds of structural optimization forms is basically the same, but there are some differences in the arrangement direction. However, the optimization of high section structure is more difficult than that of large space structure in practice.

In addition, in the aspect of the three-dimensional model of large space arrangement, although the thickness direction of the release body of the large space structure is small, and the consistency between the three-dimensional model and the plane model is high, but the space arrangement of the release body of the large space structure is three-dimensional, so it is necessary to study the three-dimensional model to ensure the consistency of the three-dimensional model and the plane model.

![Figure 2. Structural optimization of space arrangement of drawing body](image)

2.3. Key points of the theory of space arrangement of released volume
First of all, the ore drawing of sublevel caving method without sill pillar is carried out under complex rock. The higher the coincidence degree of blasting accumulation body shape and drawing body shape of caving ore is, the better the technical and economic indexes can be obtained. The shape of blasting accumulation body of caving ore depends on the mining structure parameters of pillarless sublevel caving method, i.e. sublevel height, drift distance and three-dimensional dimension of caving step distance \[4\]. The main differences between the space arrangement theory of drawing body and the traditional drawing theory are as follows. On the one hand, the optimization of mining structure parameters of pillarless sublevel caving method depends on the spatial arrangement of drawing bodies, the greater the arrangement density, the better; on the other hand, among the two optimal structures based on the spatial arrangement principle of drawing bodies, the large spacing structure is more operable than the high sublevel structure \([5]\).

In addition, in the sublevel caving method without sill pillar, increasing the distance between the roadways is not necessarily a large distance, and increasing the height of the sublevel is not necessarily a high section. The key is to see the spatial arrangement of the caving body. In the parameters of large spacing structure, the ratio of section height to route spacing is a variable.

3. **Computer Random Simulation Test of Large Parameter Mining Without Sill Pillar With Large Spacing**

3.1. **Computer based stochastic simulation model**

Based on the ideal dispersion movement model and the ideal dispersion movement probability density formula:

\[
f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad (x \in R)
\]

(1)

In which, \(\mu, \sigma > 0\) is constant, and based on the experimental results of physical simulation without boundary conditions, the spatial-temporal diffusion displacement variance form of bulk drawing is obtained, and the theoretical model of ore drawing random medium is constructed, and various drawing body shapes are given \([6]\). In addition, the improved random simulation model can not only simulate the relationship between the discharge amount and the height, but also accurately fit the determined experimental data, which makes the simulation hole yield and physical simulation corresponding height amount have high consistency.

For the mobile simulation model, the moving probability of any point in the simulation moving band is as follows:

\[
f(y) = \begin{cases} 
\frac{\Gamma\left(\frac{n_1 + n_2}{2}\right)}{\Gamma\left(\frac{n_1}{2}\right) \Gamma\left(\frac{n_2}{2}\right)} \left(\frac{n_1}{n_2}\right)^{\frac{n_1}{2}} y^{\frac{n_1}{2} - 1} \left(1 + \frac{n_1}{n_2} y\right)^{-\frac{n_1+n_2}{2}} & y \geq 0 \\
0 & y < 0 
\end{cases}
\]

(2)

In order to ensure the similarity between the computer simulation results and the experimental results, it is necessary to ensure the consistency of the relationship between the release amount and the release height, in addition to adjusting the incremental probability value between the modules. Generally speaking, the deviation of drawing amount is positively correlated with the drawing height, and the increase of drawing height will cause the distortion of the relationship between drawing amount and drawing height, and finally lead to the distortion of drawing simulation results based on computer simulation.

3.2. **Analysis of computer simulation test results of large spacing non pillar mining**
The computer simulation test results of large spacing Pillarless Mining are shown in Figure 3. It can be seen from Fig. 3 that under the condition of specific section height (generally no more than 16 m), when the drift spacing changes from 8 to 21 m, the test results obviously have the characteristics of good at both ends and poor in the middle. That is to say, when the distance between the roadways is 8m, the sublevel height is 16m, and when the sublevel height is 16m, the drift spacing is 21m, which proves the existence of large spacing structure and High Sublevel structure. It can be seen from the above results that when the sublevel height is within a certain range (generally no more than 30 meters), there are two optimal ore drawing structures in the large spacing sublevel caving mining method: High Sublevel and large spacing.

![Figure 3](image)

**Figure 3.** Computer simulation test results of large spacing non pillar mining

Under the condition of mining structure with large spacing and without bottom pillar, the mining structure with large spacing is adopted, when the section height remains unchanged, the distance between the roadways increases and the depth of the blast hole is drilled with equipment. The stope can also be used without changing the mining equipment, which can not only improve the ore recovery rate, improve the mining intensity, improve the mining efficiency, but also greatly reduce the amount of pre mining engineering and reduce the cost of ore mining. In addition, the selection of reasonable parameters is not the bigger the better, which needs to be determined scientifically according to the conditions of ore body and mine itself.

4. Conclusion

In summary, The new tech of large spacing Pillarless Mining is not only beneficial to the mine to increase the parameters in time and improve the ground pressure condition of the stope, but also suitable for the mining of gently inclined ore bodies. After increasing the spacing, the depth of blast hole increases slightly, and the existing rock drilling equipment is still applicable, so it can be widely popularized and applied. In this paper, based on the shortcomings of Pillarless Mining Tech, a computer-based stochastic simulation is carried out to optimize the stope structure and realize the control of dilution and loss based on the shape of drawing body. It is pointed out that when the sublevel height remains unchanged, the drift spacing of the stope increases and the depth of the blast hole is drilled by using equipment, which can not only improve the mining intensity but also improve the mining efficiency.

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