Research on Comprehensive Prevention and Control Technology of Overlying Goaf Water under Complex Conditions Based on Computer

Nianhua Qu¹*, Haitao Wang¹, Xin Song¹, Tong Cheng¹ and Yajun Wang¹
¹HeiLongJiang University of Technology, JiXi, HeiLongJiang, China, 158100

*Corresponding author e-mail: nianhua@jxdx.edu.net

Abstract. With the gradual depletion of the upper resources of some coal mines with a long mining life, the operations of these coal mines gradually want to transfer to the lower coal seam. However, the mining activities of the upper coal seam have produced a large number of goafs, and due to human and natural factors, there are serious water problems in the goaf, and there is a big security risk. Based on this, this paper first studies the computer-based coal mining and overlying goaf exploration technology, and then gives the comprehensive prevention and control strategy of overlying goaf water under complex conditions based on computer.

Keywords: Comprehensive Prevention and Control Technology, Overlying Goaf Water, Computer

1. Introduction

As one of the important types of coal mine safety production accidents, the goaf waterlogging accidents often occur in recent years, and bring more serious casualties and property losses, so it should pay enough attention and research. The water disaster accident in coal mine goaf has strong suddenness and destructiveness, so it could only take preventive measures in advance and formulate scientific and reasonable plan to ensure the safety of the whole mining operation process. With the gradual depletion of upper resources in some coal mines with a long mining life, the operations of these coal mines gradually want to transfer to the lower coal seams. However, the mining activities of the upper coal seams have produced a large number of goafs, and due to man-made and natural factors, there are serious water problems in the goafs, which seriously threaten the safety production of the lower coal seams, therefore, how to prevent and control the upper coal seam goaf water has gradually become an unavoidable topic in coal mine safety production.

With the deepening of coal mining, the geological conditions encountered are more and more complex, and there will be more serious water problems in the overlying goaf. If not paid enough attention, it may lead to the structural stability of the lower working face of the coal mine weakened and the probability of potential safety accidents in the process of coal excavation and mining will be greatly increased [1]. Therefore, in the process of mining operation under complex geological conditions, the geological conditions must be explored and explored first. The specific geological conditions, the actual problems and the crux of the overlying goaf ponding in the mining area are analyzed. Based on
the actual site conditions, an effective and targeted prevention plan for goaf ponding is formulated. Only based on the actual geographical location of the mine to avoid the adverse factors of goaf ponding can effectively ensure the stable and efficient operation of mining operation and the safety of relevant operators.

In addition, for the mine with small interval between the upper and lower coal seams, the mining of the overlying coal seam will inevitably affect the normal mining operation of the lower coal seam, and the water accumulation in the goaf formed after the mining of the overlying coal seam will have a serious threat to the mining activities of each lower layer, and become a more serious potential safety accident. It can be seen that, it is necessary to take some technical measures to prevent and control the damage caused by water accumulation in goaf. Therefore, it has important practical value to study the comprehensive prevention and control technology of overlying coal seam goaf water under complex conditions based on computer.

2. Coal mining and survey technology of overlying goaf

2.1. Classification of stainless steel tubes
The area or scope of surface deformation and destruction caused by the space and surrounding rock instability after coal mining until the surface deformation and damage caused by the overall subsidence and bending of overlying strata. All caving method is adopted to deal with goaf in longwall working face. Generally speaking, the surface movement basin morphology of goaf in horizontal coal seam is shown in Figure 1 below.

![Figure 1. Basin morphology of goaf in horizontal coal seam.](image)

2.2. Computer based survey technology of overlying goaf in coal mine
The survey of overlying goaf of coal mine needs to survey the site first, and complete the process of engineering geological survey and mapping, geophysical exploration, drilling exploration verification, physical and mechanical test of rock and soil mass, and surface movement and deformation monitoring. Secondly, based on computer technology, the 3D engineering geological model of goaf is established, and the instability and failure mode of goaf are analyzed. In addition, through the prediction of coal mine surface residual deformation, residual cavity estimation and stability evaluation, the hazard evaluation and prevention measures of overlying goaf are formulated.

2.3. Engineering geological survey and mapping of overlying goaf in coal mine
The engineering geological survey and mapping of the overlying goaf of coal mine includes the investigation of mining situation and surface deformation, so as to build a preliminary understanding of the overlying rock structure of the goaf, clarify the main engineering geological problems, and initially establish the engineering geological structure model of the goaf[5]. Secondly, geophysical exploration is carried out for the overlying goaf of coal mine, and due to the typical differences in several aspects as shown in Figure 2 below, it is not possible to build a detection mode based on the unified standard. Therefore, it is generally based on the three principles of large-scale and macro goaf boundary, providing practical basis for drilling layout and drilling results, and studying the influence of goaf on overlying strata from the physical property.
Formation lithology  Mining time  Collapse
Stratigraphic structure  Mining layers  Water filling property
Goaf scale  Buried depth

Figure 2. The typical differences of overlying goaf.

2.3.1. *Comprehensive analysis of geophysical prospecting results in overlying goaf of coal mine*

Based on computer technology, the comprehensive analysis of geophysical exploration results of overlying goaf in coal mine is mainly carried out from three dimensions: multi solution, comprehensive and geological leading. Among them, the multi-resolution dimension is mainly that the multi-resolution should be considered when interpreting the geophysical data of the overlying goaf of the coal mine, and only useful information should be retained and used. In the comprehensive dimension, comprehensive exploration is based on a variety of methods, and the detection results are verified by drilling. In the pilot dimension, the comprehensive analysis and judgment scheme is formulated based on the close cooperation with the work and researchers of geology, geotechnical engineering, geophysical exploration and other related professional fields.

2.4. *Stability evaluation and analysis of overlying goaf in coal mine*

The content of stability evaluation of coal mine overlying goaf mainly includes the stability of goaf itself and the stability of building foundation. The stability level of goaf itself mainly includes the stability under natural state and the stability after applying engineering load, while the stability level of foundation mainly covers goaf activation and so on. Secondly, the stability evaluation method of overlying goaf of coal mine mainly includes prediction, numerical calculation and structural mechanics, as shown in Table 1 below.

| Methods                  | Typical means            | Applicability                        |
|--------------------------|--------------------------|--------------------------------------|
| Forecast                 | Probability integral     | Long wall mining of old goaf          |
|                          | Typical curve            |                                      |
|                          | Section function         |                                      |
|                          | FEM                      |                                      |
| Numerical calculation    | DEM                      | Long wall mining of old goaf          |
|                          | BEM                      | Partial mining of old goaf           |
| Structural mechanics     | 2D beam column model     | Partial mining of old goaf           |
|                          | 3D key layer model       |                                      |

In addition, the stability analysis of overlying goaf in coal mine needs further zoning of goaf stability, which is mainly based on the stability of goaf itself, mining geological conditions, and requirements of special structures and calculation results of surface residual deformation of mining area. The surface movement and deformation observation of mining area is mainly based on the surface change characteristics, change law and development trend, and carry out regular monitoring, so as to lay the foundation for stability analysis.

3. *Computer based comprehensive prevention and control of overlying goaf ponding under complex conditions*
3.1. Current situation of prevention and control of overlying goaf ponding under complex conditions
As a considerable proportion of the current coal mine and other accidents and disasters, the frequency and impact of water accumulation in goaf must be paid enough attention to and studied. However, with the deepening of coal mining, the mining conditions are becoming more and more complex, which leads to the prevention and control status of water accumulation in goaf is not optimistic. At present, there are still many problems and deficiencies in the prevention and control of overlying goaf water under complex conditions\(^5\). The specific table is the lack of clear control on the spatial distribution of mining and water inundation of old coal mines, which leads to the insufficient waterproof rock pillars, which easily leads to the sudden exposure of water inrush disaster in the process of mining.

Secondly, the current use of advanced fine exploration and prediction technology and equipment cannot effectively dew out the geological characteristics of overlying goaf, including hidden faults. In addition, the current water inrush accidents of overlying goaf are mainly caused by inaccurate and incomplete detection, prediction and prevention of complex geological conditions. Furthermore, for the complex geological conditions, the water inrush accident caused by the fault fracture in the overlying goaf is absolutely dominant.

3.2. Necessity of prevention and control of water accumulation in overlying goaf under complex conditions
From the above analysis, it can be seen that there are still many problems and deficiencies in the prevention and control of water in the overlying goaf of coal mine under complex conditions, and there is an urgent need for reform. These problems and deficiencies are mainly manifested in the lack of professional and technical personnel for the prevention and control of overlying goaf water under complex conditions, the lack of relevant knowledge reserves, and the weak research foundation. In addition, at present, the exploration and drainage section for the prevention and control of overlying goaf water under complex conditions is relatively backward, and there is a lack of full understanding of the importance of the prevention and control of water in goaf. These outstanding problems make it very urgent to carry out the prevention and control of water in overlying goaf under complex conditions.

3.3. Characteristics of water accumulation in overlying goaf under complex conditions
Under complex conditions, the overlying goaf space is mostly distributed in the shallow coal seam buried part or the upper coal seam mining area, and its location is generally higher than the coal seam elevation of the current production area\(^6\). The overlying goaf space water is often distributed in the upper coal seam of the existing mineable area. At this time, the mining space water may have the nature of confined water. When the distance between the upper coal seam and the lower coal seam is small, it is necessary to explore and discharge the mining space water in the lower coal seam which is higher than the mining elevation of the upper coal seam, and the new water accumulation characteristics need to be focused on.

In addition, in terms of geological conditions, the water accumulated in the overlying goaf may gather in the area with low elevation, and when the occurrence of coal seam changes and before the actual underground driving and mining, the attitude change of upper coal seam should be analyzed. In the section where the occurrence of local coal seam changes, it is necessary to strengthen the water exploration and drainage work to prevent the upper water from collapsing into the working face after mining.

3.4. Prevention and control measures of overlying goaf ponding under complex conditions
First of all, it is necessary to strengthen the basic geological work of the mine, carry out geological logging and attitude measurement in time. When the distance between coal seams is small, boreholes should be drilled in the low-lying area of the upper coal seam to prevent water inrush after mining. Secondly, for the exploration and drainage of the fault structure, the drilling scheme should be
adjusted timely to thoroughly investigate the distribution of water in the fault goaf, and to explore the fault water conductivity and fault.

3.4.1. Water characteristics of overlying goaf under complex conditions

Under complex conditions, the overlying goaf water is generally in a state of long-term stagnation, therefore, the mineralization degree of overlying goaf space water is relatively large. However, due to the rapid renewal of water quality, the typical characteristics of ponding are not obvious. Therefore, in the development of overlying goaf water quality can not only rely on water quality characteristics as the basis of judgment, otherwise it is easy to misjudge. Secondly, in the water level, the static reserves are the main, and the water pressure is closely related to the spatial location of the ponding area.

3.4.2. Water detection and waterproof measures for overlying goaf under complex conditions

First of all, under complex conditions, the water exploration of overlying goaf water is generally carried out by the combination of drilling and geophysical exploration, and its principle is to ensure the reliability of geophysical prospecting conclusions. As usual, dense drilling layout is used for water exploration, but the efficiency of this water detection method is low, and high drilling density is required to ensure no thick line leakage detection. Therefore, it is generally combined with the delineation method to ensure the accurate detection of goaf ponding under complex conditions. Secondly, the secondary water exploration combined with long-term exploration and short-term exploration can be adopted to ensure the reliability of water exploration and drainage design scheme in goaf.

In addition, under complex conditions, the water drainage layer of overlying goaf is mainly based on the principles of isolation before exploration and drainage, pressure reduction before exploration and drainage, and plugging before exploration and drainage, so as to ensure the feasibility of the scheme. In order to ensure the safety of overlying goaf water drainage under complex conditions, it is necessary to dredge the borehole plug in advance, reasonably install the orifice pipe, and all departments cooperate to achieve effective drainage of overlying goaf water.

4. Conclusion

In summary, for the mine with small interval between the upper and lower coal seams, the mining of the overlying coal seam will inevitably affect the normal mining operation of the lower coal seam, and the water accumulation in the goaf formed after the mining of the overlying coal seam will have a serious threat to the mining activities of each layer in the lower part, and become a more serious hidden danger of safety accidents. Therefore, certain prevention and control technology must be taken. The technical measures and the prevention and control measures of goaf ponding can prevent the damage caused by goaf ponding. This paper points out the comprehensive analysis method of geophysical exploration results of overlying goaf through the study of coal mining and overlying goaf exploration technology. Through the comprehensive analysis of geophysical exploration results of overlying goaf, the typical characteristics of overlying goaf ponding under complex conditions and its detection and prevention measures are given.

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