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Discussion on Environmental Geological Hazard Chain and Its Environmental Effects in Coal Mining Areas

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Abstract

Geological disasters are one of the main sources of pollution to the environment in coal mining areas. This paper mainly summarizes the harm caused by various geological disasters to coal mining areas, analyzes the relationship between primary disasters and secondary disasters and the environmental effects of coal mining areas, and briefly describes the types and compositions of geological disasters in coal mining areas and the causes of geological disaster chains. The main characteristics of a series of environmental effects, and at the same time, give effective preventive measures to prevent the occurrence of geological disasters in coal areas, so as to promote the long-term and healthy development of my country's coal industry.

Keywords

Coal mining area; geological disaster chain; environmental effect

Coal mining areas are of paramount importance in China's environmental governance, and their protection is crucial. Geological disasters, as one of the main sources of environmental pollution in coal mining areas, have a significant impact on environmental effects due to their disaster chains. The main reasons for this are unscientific coal mining processes and the influence of human activities, leading to frequent geological disasters in coal mining areas, which seriously affect the safety of people's lives and property and the socio-economic development. In-depth analysis of the classification, levels, and environmental impacts of geological disasters in coal mining areas is beneficial for addressing environmental problems and reducing adverse environmental impacts.

The clustering and derivative nature of geological disasters in coal mining areas are significant factors contributing to such chains. Coal mining damages the surrounding geological environment, leading to frequent geological disasters. These disasters do not occur in isolation but rather form a chain within the same coal mining area at the same time, causing immense environmental and economic devastation. Coal mining environmental geological disasters are characterized by their high destructiveness, diverse types, and significant casualties. Furthermore, these disasters trigger a series of chain reactions in the geological environment, adversely impacting the water, atmosphere, soil, and ecosystems of the coal mining area. Moreover, these primary geological disasters can trigger secondary disasters, further escalating the existing hazard (Guo, 2019).

Guided by geology and environmental science, this study explores the causes of environmental geological disasters in coal mining areas and aims to reduce their frequency to protect the natural environment and promote the healthy and sustainable development of coal mining areas. Furthermore, by conducting a detailed discussion of the causes, classifications, levels, mechanisms, and environmental damage caused by environmental geological disasters in coal mining areas, and proposing scientific and reasonable prevention and control strategies, the study can effectively maximize the economic, social, and environmental benefits of coal mining areas, ensuring their safe and stable development in China. According to incomplete statistics, environmental geological disasters in coal mining areas cause

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economic losses amounting to tens of billions of yuan annually in China, while also seriously threatening the lives and property of people living around these areas. This is especially true for small and medium-sized coal mines, where weak mining technology, harsh working environments, relatively backward management, and a lack of environmental awareness mean that the environmental and economic losses from geological disasters are incalculable. Therefore, during coal mining, it is crucial to improve disaster prevention measures, strive to protect the natural environment of coal mining areas, and ensure the harmonious and healthy development of the economy, society, and environment in these areas (Ren, 2022).

1. Composition and Types of Environmental Geological Hazard Chains in Coal Mining Areas

1.1 Composition of Environmental Geological Hazard Chain in Coal Mining Areas

Coal, as a non-renewable resource, is one of the essential energy sources for human production and life. However, in coal mining, humans sometimes focus solely on increasing output, neglecting the safety of mining and the enormous environmental pollution caused by geological disasters. Since the last century, the Chinese government has recognized the severity of geological disasters in coal mining areas and has taken numerous measures for prevention and control, achieving good results. However, human mining activities have, to some extent, damaged geological structures, leading to conflicts between geological disasters in coal mining areas and environmental protection and economic development. Therefore, understanding the composition and types of geological disaster chains in coal mining areas is crucial for identifying the main factors causing geological disasters and taking effective measures to prevent their occurrence. For coal mining areas, the main cause of geological disaster chains is the chain of disasters generated by coal mining activities, consisting of primary geological disasters and derived secondary geological disasters. These two types of geological disasters have a certain causal relationship, and primary and secondary geological disasters constitute a complex geological disaster chain. Currently, the main environmental geological disaster chains in my country's coal mining areas include mine gas, high temperature, mine water inrush, and goaf disaster chains. The mining process in underground coal mines may produce toxic and harmful gases known as methane. Directly releasing methane into the atmosphere causes direct pollution, but if it is not removed in time and reaches its explosive limit underground, it can lead to a methane explosion with serious consequences. Furthermore, underground temperatures rise with increasing mine depth, and variations in mine structure also contribute to this temperature increase. High temperatures pose significant safety hazards to underground workers. In addition to these two disaster chains, coal mining disrupts the stability of the groundwater circulation system, polluting the groundwater environment and triggering ground subsidence, thus causing geological disasters. A sudden drop in groundwater content in a coal mining area can cause surface deformation, leading to increased precipitation seeping underground, while surface water content gradually decreases, causing abnormal changes in the hydrogeology of the coal mining area and significantly impacting the growing environment for crops. Furthermore, with the continuous increase in mining depth and time, some underground goaf areas will inevitably form, leading to changes in underground rock stress. The stress field must re-establish equilibrium to adapt to the new geological environment. As the pressure inside the goaf gradually disappears, the potential energy accumulated in the rock mass is released due to the lack of pressure, causing movement and deformation of the rock mass near the goaf. If no measures are taken, the continuously acting elastic potential energy will trigger ground subsidence and cracks, and in severe cases, even earthquakes. In addition, geological hazards in coal mining areas have adverse effects on surrounding surface buildings, society, environment, and surface water. (See Figure 1.)

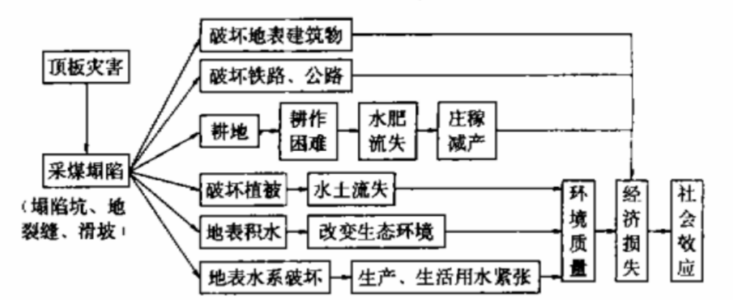

Figure 1. Impact of geological hazards in coal mining areas.

1.2 Main Types of Environmental Geological Hazards in Coal Mining Areas

Classifying the main types of environmental geological hazards in coal mining areas can help better study and prevent their occurrence. These hazards can be categorized as follows: First, based on duration, they can be divided into sudden and gradual types. Sudden environmental geological hazards are the most destructive because, although their duration is short, they accumulate significant energy, causing massive casualties and severely damaging the underground and surface ecological environment of the coal mine. Gradual environmental geological hazards, while occurring more gradually, have a longer duration and cause serious harm to the atmosphere, water, soil, and natural environment of the coal mining area. Second, they can be classified according to their dynamic action. Research shows that the environmental geological environment of coal mining areas is influenced by coal mine productivity and production technology, leading to an increasing frequency of geological hazards. Based on different dynamic action methods, geological hazards can be divided into two main categories: natural dynamic hazards and anthropogenic external dynamic hazards combined with natural dynamic hazards. Furthermore, due to the numerous geological tectonic movements that have occurred in my country, the geological environment of most coal mining areas is extremely complex. Therefore, coal mining may trigger a series of geological disasters, such as landslides, ground subsidence, fissures, settlement, and debris flows, as shown in Figure 2 (Shi, 2015).

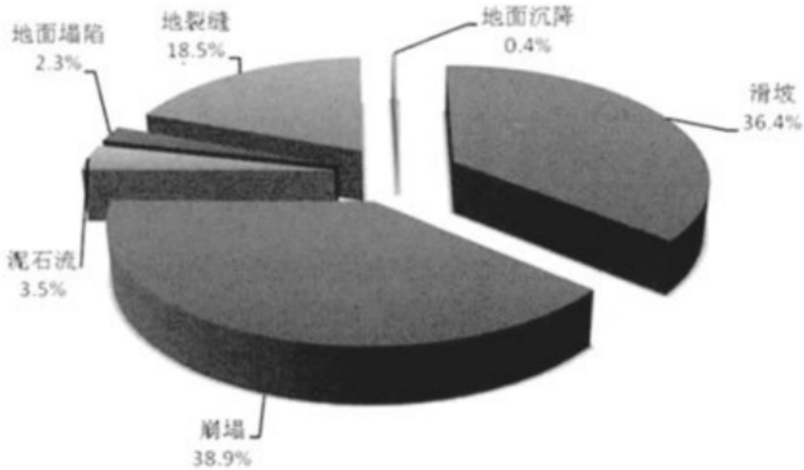

Figure 2. Geological disasters caused during coal mining and their proportion.

2. Main characteristics and triggering factors of environmental geological hazard chains in coal mining areas

2.1 Main characteristics of environmental geological hazards in coal mining areas

The main characteristics of environmental geological disasters in coal mining areas are as follows: First, they exhibit a consistent environmental impact at the end point. The ultimate effects of these disasters are enormous economic losses and severe social consequences. They significantly impact the natural environment, including the atmosphere, water, and soil, as well as the surrounding society and economy, leading to substantial economic losses and severely affecting the economic development of the surrounding areas. They also have a serious impact on the lives and mental well-being of the local population. Second, the main cause of the disaster chain is human engineering activities. Environmental geological disasters in coal mining areas are caused by both natural factors, such as underground magma activity and changes in geological structure, and human factors, such as excessive and unscientific mining activities. Furthermore, natural factors and human forces can also work together to cause environmental geological disasters in coal mining areas. Currently, the main causes of environmental geological disasters in my country's coal mining areas are excessive mining and irregular and unscientific mining activities. Extensive data shows that, based on the development of coal mining technology, the proportion of geological disasters caused by human factors has increased significantly, with an incidence rate exceeding 50%. Thirdly, the environmental effects of the disaster chain in coal mining areas are extremely widespread. The diverse types, high incidence, and destructive power of environmental geological disasters in coal mining areas make environmental problems particularly prominent among various industries. In particular, environmental geological disasters in coal mining areas can cause other secondary disasters, and the pollution of water, air, and soil can seriously affect the production and lives of people around coal mining areas. Therefore, their environmental effects are extremely widespread (Sui, 2021).

2.2 Inducing factors of geological disasters in coal mining areas

The occurrence of environmental geological disasters in coal mining areas is mainly induced by the following factors: First, mining personnel fail to strictly follow relevant operating procedures during coal mining, or fail to adequately anticipate the possibility of disasters. For example, as the depth of the mine increases during mining, the geostress around the mine also increases. If mining technicians fail to anticipate this in time, it may lead to large-scale roof collapses, and in severe cases, it may trigger serious geological disasters such as magma explosions. Second, some coal mines, driven by the pursuit of immediate economic benefits, neglect mining standards and regulations, and even prioritize mining rich coal mines while abandoning the mining of poor coal mines, thus hindering the development of the industry. The subsequent coal mining work was carried out; thirdly, due to the inconsistency of mining standards in coal mines across the country, some miners had poor safety awareness and low mining skills, and even seriously damaged the environment and resources in pursuit of one-sided economic benefits, posing huge safety hazards; fourthly, inadequate management and non-standard mining practices by some coal mine managers and technicians during the mining process ultimately led to environmental geological disasters in coal mining areas. For example, failure to backfill coal mine goaf in a timely manner, illegal command by managers or technicians, illegal operation by miners, arbitrary discharge of waste generated during production, insufficient understanding of groundwater and geographical conditions by geological technicians, and insufficient awareness of safety precautions by safety officers can all trigger geological disasters (Wang & Yuan, 2022).

3. Effective measures to prevent environmental geological disasters in coal mining areas

In order to ensure the healthy and sustainable development of my country's coal industry and protect the natural environment and the lives and property of people around coal-producing areas, the government and coal enterprises must increase their attention to the prevention of environmental geological disasters in coal mining areas and formulate effective prevention measures based on the actual conditions of coal mines in various regions.

3.1 Improve the management skills of coal industry managers

With the continuous rise in the incidence of environmental geological disasters in my country's coal mining areas, the government and the coal industry have attached great importance to the prevention of such disasters. They have actively organized training courses for coal industry managers, technicians, and safety personnel to improve their management skills. This has enabled managers to gradually recognize the significant impact of environmental geological disasters on the economy and environment of coal mining areas, understand the importance of scientific management, and establish a safety-first, people-oriented sense of responsibility. They have also recognized that while natural factors contribute to the occurrence of environmental geological disasters in coal mining areas, scientific and rigorous management, and strict adherence to mining regulations can significantly reduce the incidence of disasters. Furthermore, through scientific and rational planning of coal mining areas, it is strictly prohibited for unauthorized mining teams to engage in indiscriminate mining (Wang, 2011).

3.2 Understand the geological structure of the mining area and resolutely prevent blind mining.

A significant portion of geological hazards in coal mining areas are caused by geological tectonic movements, such as alterations to geological faults and magma activity. Therefore, understanding the geological structure of the mining area is crucial for ensuring safe coal mining. Geological technicians should first explore the geological environment of the coal mining area, including plate tectonics and groundwater conditions, to ascertain the characteristics of the geological environment. Blind mining must be resolutely prevented, and effective preventative measures should be taken based on the actual geological conditions during coal mining to reduce the frequency of geological hazards.

3.3 Optimize underground mining conditions to ensure the safety of mining personnel.

Optimizing underground mining conditions can effectively prevent geological disasters. For example, during coal mining, all coal mines should strictly follow relevant national laws, regulations, and industry standards, equipping mining areas with sufficient and effective ventilation systems to ensure normal airflow. Since some geological disasters are caused by excessive methane concentrations, a strict methane content inspection system should be established. Mining should not be carried out blindly if the methane content exceeds the standard. At the same time, safety education should be provided to mining personnel, prohibiting them from using open flames underground, and resolutely avoiding unsafe conditions for people and materials to ensure safe and stable coal mining production.

3.4 Implement comprehensive prevention and control measures based on the actual conditions of coal mining in different regions.

Different regions have different geological structures, local policies and regulations, mining conditions, and geological hazard risk points. Therefore, in the actual process of coal mining, comprehensive prevention and control should be carried out in combination with the actual situation of coal mining in each region. Reasonable preventive measures should be formulated according to the specific media structure and natural environment characteristics of the region, and a complete accident plan should be formed so that coal mining personnel can master it and escape in strict accordance with the accident plan in the event of a disaster, so as to maximize personal safety and safe production of coal mines (Yang, 2018).

4. Conclusion

As one of the most important energy sources for social and economic development, coal has seen rapid growth alongside my country's national economy. However, this rapid development has also exposed a series of problems, particularly the impact of geological disasters in coal mining areas on the natural and economic environments. These disasters not only severely impact the lives and livelihoods of surrounding residents but also seriously hinder local economic development. The causes of geological disasters in coal mining areas are diverse, including geological, anthropogenic, and environmental factors. Therefore, a thorough understanding of the types and causes of geological disasters in coal mining areas, along with the implementation of scientific preventative measures, is crucial for ensuring the healthy and sustainable development of the coal industry.

References

Guo, L. (2019). Research on the characteristics and prevention and control measures of geological disasters in coal mines. *Inner Mongolia Petroleum and Chemical Industry*, *45*(07), 28-29.

Ren, P. (2022). The impact of hydrogeological factors on geological disasters in coal mines and countermeasures. *Energy and Conservation*, (03), 218-219. https://doi.org/10.16643/j.cnki.14-1360/td.2022.03.049

Shi, J. (2015). Changing the geological environment of mines to accelerate the governance of geological disasters in coal mines—A brief discussion on the methods and measures for the governance of geological disasters in Pinggou Coal Mine. *Inner Mongolia Coal Economy*, (08), 23-24. https://doi.org/10.13487/j.cnki.imce.006922

Sui, C. (2021). Analysis of the characteristics and prevention of geological disasters in coal mines in China. *Journal of Harbin Vocational and Technical College*, (04), 76-78. https://doi.org/10.16145/j.cnki.cn23-1531/z.2021.04.024

Wang, S., & Yuan, P. (2022). Characteristics and prevention strategies of geological disasters in coal mines. *China Petroleum and Chemical Standards and Quality*, *42*(03), 147-148.

Wang, W. (2011). Research on Safety Evaluation and Loss Prediction of Geological Disasters in Coal Mines (Master's thesis). Shandong University of Science and Technology.

Yang, Y. (2018). Analysis of the characteristics of geological disasters in coal mines and thoughts on prevention and control strategies. *Farmers' Consultant*, (13), 205.