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Study on the Influence of Geological Structure on Gas Occurrence and Gas Outburst

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ABSTRACT

Gas is a gaseous geological body and a product of geological genesis. The geological structure and the historical evolution of coal bearing strata control the generation conditions of coal-bed gas and the preservation conditions of coal-bed gas subjected to depression, uplift, compression and tension in previous tectonic movements. The geological conditions that control the occurrence of gas disasters determine the state of gas occurrence, gas content, gas pressure, gas emission and the risk of coal and gas outburst in coal seams. There are obvious characteristics of zoning and zoning. Gas occurrence and gas outburst are controlled by various geological factors, and geological structure plays a decisive role in coal and gas outburst. Studying the influence of geological structure on gas occurrence law and gas outburst and mastering gas geological law can achieve the purpose of gas prediction and gas control. This paper discusses the influence of fold, fault and sliding structure on gas occurrence, and discusses the influence of geological structure on gas outburst from three aspects of coal seam gas pressure, in-situ stress and coal body structure. It can provide a basis for the prediction of gas outburst and has important significance for the prevention and control of gas accidents in coal mines.

KEYWORDS

Geological structure; Gas occurrence; Gas outburst.

1. INTRODUCTION

Abnormal gas emission often occurs near the geological structure, resulting in gas overrun and even gas outburst accidents : on the one hand, the open geological structure is conducive to gas emission, and the closed geological structure is conducive to sealing gas. For example, the arc top part of the arc structure (such as the anticline axis) is often the stress concentration part, which is easy to drive the gas migration and the gas is relatively concentrated ; on the other hand, the coal seam near the geological structure is soft and broken, the tectonic coal pole is developed, the specific surface area is increased, the gas adsorption capacity is strong, and the diffusion speed is fast. It is of great significance to study the influence of geological structure on gas occurrence law for gas prevention and control in coal mining[1]. Gas outburst is a kind of dynamic phenomenon with sound and violent force effect, which is one of the most serious disasters in coal mine production. At present, most of the main coal mines in China are biogas mines, and the proportion of gas outburst mines is large. With the continuous extension of mines, the proportion of gas outburst mines is gradually increasing. The efficient and safe production of coal mines has been increasingly affected and restricted by coal and gas outburst. Therefore, it is very necessary and urgent to explore effective methods to eliminate and control coal and outstanding problems. The geological structure characteristics are the most important determinants of coalfield properties. By studying the influence of geological structure on gas outburst, the distribution law of coal and gas outburst can be accurately predicted, and various

means can be integrated to avoid coal and gas outburst or reduce the probability of outburst as much as possible, so as to improve the safety and efficiency of mine production.

2. EFFECT OF GEOLOGICAL STRUCTURE ON GAS OCCURRENCE LAW

2.1. The influence of fold structure on gas occurrence

The gas content in different fold parts has certain changes. In the syncline structure area, the top is compressively closed, and the lower tensile fractures are developed, which is conducive to gas storage and is the main gas storage structure. The second is the anticline wing. Because of the cracks in the axis, most of them are tensile open cracks. When the buried depth of the coal seam is small, it is beneficial to the emission of gas, and the axis of the anticline is not conducive to the accumulation of coal seam gas [2]. The tectonic coal at the fold is generally more developed, the specific surface area increases, and the gas adsorption capacity becomes stronger. On the other hand, in these structural development zones, the tectonic stress is relatively concentrated, so that the coal seam is in a strong extrusion state, which is conducive to the occurrence of high-pressure gas in the coal seam. At the tensile fracture, the gas storage capacity becomes weaker, and the gas content of the coal seam becomes smaller; in the deep buried part of the syncline, the formation damage is not serious, the gas preservation condition is good, and the gas content is high[3]. The gas control gas in the axis of the fold syncline is easy to enrich, and the gas content is generally higher than that of the two wings, while the gas control law of the anticline is opposite (the gas content in the axis of the anticline is generally lower than that of the two wings).

2.2. Effect of fault and fault structure on gas occurrence

Open faults are conducive to gas emission, while closed faults play a role in blocking gas emission. Therefore, the influence of open and closed faults on gas occurrence is also obvious [4]. The gas occurrence around the fault is complex. Due to the concentration of tectonic stress, the permeability of surrounding rock is not good, and the gas release capacity is reduced. The fracture zone caused by fault development and the gas accumulated in front form a closed barrier, which is conducive to gas storage. The soft coal around these faults is developed, and the tectonic stress is concentrated. Once the gas cannot be released in time, it has a certain risk of outburst. The influence of fracture structure on coal seam gas is mainly manifested in the following aspects: large drop, good gas dissipation conditions in the intersection zone, low gas content, and low risk of coal and gas outburst. Most of the structural planes of medium and small faults have compressive and torsional properties, and the fault plane is close. The coal seam is directly connected with the clastic rock with poor permeability, so that the fault constitutes the gas-blocking boundary of coal seam gas migration, which eventually causes the gas accumulation content near it to be high and the pressure is large, and the gas dynamic phenomenon in mining increases. Especially in the vicinity of small faults, the pinch-out end of large faults, the change of strata occurrence and other zones, the gas content of coal seam is high, and the risk of coal and gas outburst is large. The fault destroys the continuity of the coal seam, makes the fracture develop, and greatly helps the gas escape. In the fault interruption distance is mainly low gas occurrence (low gas content), indicating that the zone of gas closed preservation ability is poor ; the smaller fault distance is mainly high gas occurrence (high gas content), indicating that the sealing and preservation ability of gas is strong. Influenced by geological structure, whether it is normal fault or reverse fault, near the fault structure, it will cause the release of coal seam gas in different degrees, which makes the gas content near the fault zone smaller. However, within a certain distance on both sides of the fault zone, the gas content of coal seam is affected by stress concentration and other factors, and the gas content is larger. Then extending to both sides of the fault zone, the gas content gradually tends to the original gas content of coal seam[5].

2.3. The influence of sliding structure on gas occurrence

Under the action of sliding structure, the occurrence state of coal seam has changed dramatically, which is mainly manifested in the variation of coal seam thickness, which makes the thickness of coal seam thinner or thicker. The thin coal-free zone and the super-thick coal zone in the mine field are mostly related to the sliding structure. In addition, it also has a profound influence on coal quality and gas, coal seam roof and floor, etc., which can cause local gas accumulation, increase the degree of coal metamorphism, reduce the mechanical strength of coal seam roof and floor rock, and form structural roof, etc., which greatly changes the geological conditions of gas occurrence and dissipation. The sliding structure plays an important role in the occurrence of gas. The sliding structure expands the shear joints of the ore body, and the gas originally adsorbed in the coal seam is desorbed due to the expansion. In addition, the roof of coal seam damaged by gravity has good conditions for gas dissipation. The sliding structure may cause the coal seam to break, and a relatively closed space is formed under the fracture surface. In this closed space, the gas dissipation and seepage ability are greatly weakened, which plays a good role in the enrichment of gas[6].

3. EFFECT OF GEOLOGICAL STRUCTURE ON GAS OUTBURST

Gas outburst is a phenomenon that a large amount of coal, rock and gas are ejected from the coal body to the roadway or mining face in a very short period of time during the mining process of the mine. It is a violent energy release process of the gas-bearing coal and rock mass. It is an extremely complex dynamic phenomenon in coal mines [7]. Outburst requires not only good geological conditions for gas formation and preservation, but also geological conditions for gas outburst. The formation and preservation of gas laid the material basis for the occurrence of outburst, and the geological structure factor is the necessary condition for the occurrence of gas outburst. Geological structure affects gas outburst by controlling coal seam gas pressure, ground stress and media structure.

3.1. Influence of geological structure on coal seam gas pressure

The occurrence state of gas in coal is mainly free and adsorbed. The gas in coal is mainly adsorbed, supplemented by free state, and the two states of gas are in a dynamic equilibrium state. In coal, gas only shows pressure with free gas, which is the main power source of coal and gas outburst. The gas in the coal is in an equilibrium state under the interaction of outburst power and resistance. When the external pressure on the coal body suddenly decreases, the original free gas in the coal and the free gas converted from the adsorbed gas work together to produce high pressure. In addition, the outburst resistance decreases, and the outburst of coal and gas will break out. High pressure gas is a necessary condition for coal and gas outburst. The role of geological structure will affect the distribution and accumulation of gas in coal, control the high pressure of gas, and make the gas distribution uneven, affect the gas outburst. The uneven distribution of structure causes the uneven distribution of gas, and forms the conditions that are conducive to gas occurrence or gas emission. The complexity of the stress field and the geological tectonic stress makes the stress concentration in the same structural area appear in different blocks, resulting in a relatively low pressure and relatively high pressure area, so that the gas migrates with the change of pressure, resulting in the generation of local high pressure, so that the outburst is easy to occur. Usually, the pressure or pressure torsion fault is a closed structure, gas is easy to gather, gas content is high, gas pressure is large, coal and gas outburst risk is large ; the tensile fault is an open structure, gas is not easy to gather, outburst risk is small or even not prominent. In the fold structure, the two wings of the secondary fold in the compound fold are mainly torsional and compressive fractures, and the gas occurrence conditions are better. If the permeability of the surrounding rock is poor, the syncline and the secondary fold are prone to coal and gas outburst. The turning end of the partition fold is the strong part of the interlayer dislocation, the compressive stress is relatively concentrated, the gas is easy to occur in the coal seam, the gas content is high, the pressure is large, the outburst condition is good, and the outburst is also easy to occur. Moreover, under the

condition of little change in geological structure, the original gas pressure will generally increase linearly with the increase of depth, that is, the deeper the coal seam, the greater the gas pressure, the higher the risk of outburst.

The fault structure generally plays a sealing role in gas or becomes a channel for gas migration. The fault structure is conducive to the occurrence of coal and gas outburst. It is necessary to accurately control the location of the fault and determine its influence range. The closer to the fault, the greater the risk of outburst. In the depth of the mine, thousands of hidden faults cut the coal measures, and the faults do not expose the surface, linking the gas of each coal seam. Once the mining project exposes these faults, the gas will be poured out exponentially, which poses a serious threat to the safe production of the mine[8].

3.2. The control of geological structure on ground stress

In-situ stress is an important factor to control coal and gas outburst. The action of in-situ stress can make the media move and break suddenly, so as to cause coal and gas outburst. Crustal movement accumulates a large amount of tectonic stress in the rock, and tectonic stress is an important form of ground stress. The distribution range and deformation degree of geological structure determine the size and distribution of ground stress. Under normal circumstances, the distribution of tectonic stress is uneven, often accompanied by local stress concentration areas, which is conducive to improving the elasticity of coal. Coal and gas outbursts are prone to occur, and often the mining work enters the unbalanced stress distribution area. The original pressure balance is broken, and the outburst will occur. The geological structure area is often the area where the tectonic stress distribution is not balanced. According to the theoretical and actual production statistics, it can be said that most of the prominent concentrated areas are controlled by the geological structure. The folded and twisted parts of the fold structure, the two sides of the torsional fault, the fault intersection zone, the igneous rock intrusion zone, the convergent end of the rotating structure and the composite part of the structural system are all prominent dense high-incidence zones. In the production process of coal mines, we should pay attention to the analysis of the possibility of outburst in these areas, accurately predict and reduce the occurrence of safety accidents[9].

Under the action of tectonic stress, the stress concentration at the joints of the structure can accumulate large strain energy. In the process of coal mining, coal and gas outburst was induced.

3.3. The influence of geological structure on coal structure

In the mechanism of coal and gas outburst, the physical and mechanical properties of coal are mainly restricted by the mechanical strength of coal. The smaller the mechanical strength of coal, the smaller the outburst resistance, and the greater the possibility of outburst. The mechanical strength of coal is restricted by the structure of coal body. Therefore, the structure of coal body reflects the difficulty of gas outburst to a certain extent, and controls the occurrence of outburst. Coal structure refers to the structural structure of coal. In the geological sense, the coal structure is actually a structural feature, which reflects the strain history and strain characteristics of the coal seam. The coal structure of the original structure is stable, the bedding is good, and the coal strength is high ; after the primary structure is destroyed, the coal seam bedding is disordered, broken seriously, the coal quality is soft and broken, and the strength is low. The tectonic coal is the result of the serious damage of the dense structure of the coal seam. Its special structure becomes the gas concentration area and the stress weak plane area. The tectonic coal area is often the high incidence zone of coal and gas outburst. The effect of tectonic stress, on the one hand, causes the coal body to produce dense cracks, the coal body structure is destroyed, the mechanical strength of the coal body is reduced, the ability to resist external forces becomes smaller, and the outburst resistance and the energy required for outburst are reduced. On the other hand, the coal structure is destroyed, the pore spacing and inner surface area of the coal become larger, and the porosity of the coal layer is large, which can preserve more free gas, poor

permeability, and generally maintain high gas pressure, which creates dynamic conditions for outburst. At the same time, under the action of tectonic stress, the coal structure is destroyed, and then the fragments are squeezed, rubbed and rubbed with each other, and the coal fragments gradually become smaller. Even under other high-intensity forces, the media fragments will become powder, so that coal and gas outburst often occurs in the blocks of stratified development of tectonic coal. The development area of tectonic coal is a high incidence zone of gas outburst. It is of great practical significance to master and study the formation law and spatial distribution of ' tectonic coal ' for studying the occurrence conditions of coal and gas outburst and predicting the possibility and intensity of outburst. Therefore, in actual production, geological personnel should have sufficient professional sensitivity to tectonic coal. When encountering tectonic coal areas, special attention should be paid to the study of the geological structure of the area, so as to accurately judge the possibility of coal and gas outburst in the area and accurately predict the law of outburst. However, we cannot judge whether the outburst event will occur or predict the distribution law of coal and gas outburst only by tectonic coal, because coal and gas outburst is affected and controlled by various factors such as gas pressure, ground stress, coal body characteristics and surrounding rock conditions. In other words, the existence of a certain thickness of tectonic coal is the basis and necessary condition for the occurrence of coal and gas outburst, but it is not a sufficient condition for coal and gas outburst.

Fault structure can destroy the coal structure, resulting in uneven distribution of stress in coal. In addition, there are often a large number of tectonic coal near the fault, and a certain thickness of tectonic coal is a necessary condition for coal and gas outburst. These faults are more likely to induce outburst under high stress [10]. According to the previous statistical analysis of the outburst location, there is often a certain thickness of soft stratification near the outburst location, and the gas desorption index of drilling cuttings is obviously increased. Therefore, corresponding outburst prevention measures should be taken to enter the influence range of the fault. Gravity sliding structure will have an impact on the front and rear edges of the coal seam and the middle part. Similarly, the squeezing and rubbing effects of gravity sliding structures also have an important impact on the coal structure. Due to the influence of gravity sliding structure, the original morphological structure of coal will change greatly, and the structure of coal will present powder or fish scale. The firmness of coal has also been affected to varying degrees. In this case, the basic conditions of coal and gas outburst have been met.

4. CONCLUSION

(1) Geological structure has a great influence on gas occurrence. Different geological structures and different parts of geological structure have great differences in gas occurrence. Studying the influence of geological structure on gas occurrence law is helpful to prevent gas outburst.

(2) Geological structure affects gas outburst through three aspects of coal seam gas pressure, ground stress and coal body structure. Understanding the mode of action and influence range of geological structure on these three aspects can reduce gas outburst accidents.

(3) Gas occurrence and gas outburst are controlled by various geological factors, geological structure plays a decisive role in coal and gas outburst. Studying the influence of geological structure on gas occurrence law and gas outburst can achieve effective gas prediction and gas control.

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