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Retardation Characteristics of Metal Mine Paste Filling Materials Based on Blockchain Technology and Farmland Ecological Protection

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Abstract: In recent years, most of the quarry sites are located in the periphery of the city, and for the convenience of transportation, they are generally close to traffic arteries and residential areas. When encountering severe weather, disasters such as landslides, mudslides, dust and sand will occur. The life safety and health of residents have caused adverse effects. Therefore, the development of researches suitable for paste-filling mining of metal mines in stone ore traces has important guiding significance for the smooth implementation of ecological restoration of stone mines. This paper takes the discrete mine paste network model as the research object, and studies the mineral degradation and influencing factors in the central and northern grasslands, the loess plateau, the southwest mountain and hilly area, and the northwest arid area of the western metal mining area, and then mining through the metal mine paste filling numerical simulation analyzes the repair of geological damage caused by paste filling technology. The research results show that the extremely severely damaged area in open-pit mines accounts for an average of 56.44% of the area, which is much larger than 5.61% of the underground mines. The mineral damage caused by mountain paste filling mining can be repaired in time. The sudden increase in the damaged area usually reduces the non-damaged area and increases the extremely severely damaged area. However, during the research period, as coal mining expands outward, there is a phenomenon that the non-damaged area increases and the extremely severely damaged area decreases.

1. Introduction

Research on the prevention and control technology of metal mine paste is the main method to prevent pneumoconiosis in mines. It is also a powerful technical means to improve the level of occupational hazard protection technology and equipment in my country's metal mining industry, improve the working environment and the quality of the atmosphere surrounding the mining area, and ensure the occupational health of workers. During the "Thirteenth Five-Year Plan" period, significant progress has been made in the development of paste control technology in my country's metal mining industry, and many technological achievements have reached international advanced levels. However, metal mining is different from coal mines. It has the characteristics of simultaneous mining in multiple middle sections and multiple operating points, which can easily cause damage to the mining area.

Professor HUSS M analyzed the influencing factors and diffusion law of slurry diffusion in the process of grouting to prevent fire in the goaf through numerical simulation [1]. GUITTONNY LM optimizes the traditional grouting fire-fighting technology, and proposes the pre-buried high-position casing grouting technology in the goaf and the downhole high-low combined directional grouting technology, which makes up for the shortcomings of the traditional technology and obtains a better field application effect [2]. LI X B proposed the use of grouting and filling in the construction project of the photovoltaic demonstration base in the Datong coal mining subsidence area to control the goaf to ensure the safety of ground structures, and achieved good practical results [3]. HEL provides a new solid waste treatment method for Chinese mining enterprises, enriches the solid waste treatment technology system of my country's coal industry, and lays the foundation for the realization of the scientific mining concept of green mining, clean utilization and zero waste discharge of coal resources [4]. Professor ALAM M K conducted an in-depth study on the mechanism of separation of the overlying strata grouting of metal mines to slow down the surface settlement, and summarized the dynamic changes of the separation space, which provided a strong support for the control of the grouting effect [5]. YANG Y believes that scientific mining needs to maximize the utilization of resources and realize the waste-free emission of coal production and utilization. Starting from the nature of the relationship between man and nature, he explains that in the process of acquiring and using natural resources, being kind to the environment means being kind to human beings [6]. LAMB D built a gangue emission reduction technology system in the framework of green mining technology, and proposed the use of technical measures such as reducing gangue sources, encouraging underground treatment, and strengthening comprehensive utilization to reduce environmental pollution and realize the purpose of turning waste into treasure [7].

ERSKINE PD emphasizes the need to achieve near-zero emissions of pollutants in the development, utilization and transformation, promote coal from "black" to "green", and achieve maximum resource utilization of pollutants and associated resources [8]. WEYERA D V pointed out that the application of information technology, intelligent manufacturing technology and artificial intelligence technology to achieve safe, green and efficient mining and clean and efficient utilization of coal is the basic task and the only way for the construction of smart mines [9]. Aitzhan N Z clarified that the construction of green mines needs to achieve multiple zero discharge goals such as zero water discharge, zero gangue discharge, and zero pollution discharge in the whole life cycle of the mine [10]. In view of the large deformation characteristics of rock burst roadways, PAN Y has developed cross-resistance bolts, which can achieve cross-resistance yield under impact load. It is not only suitable for deep soft rock roadways, but also suitable for surrounding rock control of rock burst roadways [11]. POBEREZHNA A studied the static and dynamic mechanical properties of non-equal-strength rebar anchor rods and anti-impact energy-absorbing anchor cables, and revealed the mechanical response laws of the two materials

[12]. Bajwa IS has carried out a series of refined research on bolt support theory, bolt material optimization, supporting components, etc., developed a series of CRM500, CRM600 and CRM700 heat-treated bolts, and analyzed the static mechanical characteristics of different materials of bolts. Fracture morphology and metallographic structure have selected good bolts for rock burst roadway support [13].

In this paper, a numerical simulation study of metal mine paste filling mining based on blockchain technology under the background of agricultural environmental protection is carried out. Based on the definition of metal mine paste filling mining, its characteristics and influencing factors are analyzed, and theoretical analysis and numerical simulation are used. The criterion of full mining failure of overlying strata in high-strength mining is given, which can provide a theoretical basis for the on-site measurement of overlying strata failure in safe coal mining and water-preserving mining under water.

2. Internet of Things Technology and Artwork Display Model

2.1. Current Situation of Mine Environment Restoration under Blockchain Technology

The metal mine paste filling mining operation platform is part of the open-pit mine slope, but compared to the slope surface, its ecological restoration is easier to achieve. This is mainly because the operation platform is relatively flat, which is conducive to covering soil and planting or planting plants, and conducive to reducing the loss of water, soil and fertilizer [14]. In the research of paste filling mining in metal mines of operating platforms, it is currently used to build soil ridges or retaining walls at the outer edge of the platform, and plant woody or herbaceous plants after covering the inner side with soil to achieve ecological restoration of the slope platform [15]. After adopting the technical measures of piling stone ridges, the container seedlings were planted on the stope platform of Lespedeza chinensis, which played a very good role in water and soil conservation; the slope platform of a certain mine was covered with soil and planted with arborvitae for ecological restoration, and finally realized the re-greening of the mine [16]. By building a retaining wall on the east side platform of Yanshan Iron Mine and planting seedlings after covering the inside of the retaining wall, the ecological restoration of the high slope platform has been realized [17]. Although the ecological restoration of the working platform is easier than the slope surface, there are also problems of lack of soil and poor soil. After covering it, soil improvement and fertilization must be carried out. On this basis, the irrigation system should be designed to prevent drought. The seasons cause plants to suffer from drought, and technical measures to prevent soil erosion should be taken at the same time [18]. In terms of plant selection, native plants should be preferentially selected to enhance the stress resistance of plants [19]. Taking a variety of measures to repair the platform can effectively increase the final repair effect of the platform and ensure the long-term stable growth and development of the plant [20].

At present, the ecological restoration and reconstruction of mining areas mainly involve major areas such as coal mining subsidence areas, coal gangue hills, open pits, tailings ponds, dumps, and mining industrial squares [21]. Many scholars at home and abroad have carried out extensive and in-depth research in related fields. At present, most of the quarry is still filled with mountain paste, and the quarry traces formed after mining make the vegetation, animals and microorganisms in the mining area extremely high. It is scarce, the interaction between organisms is reduced, and after mining is completed, due to changes in soil, geological and hydrological conditions and other factors, it is difficult to form self-recovery capacity in the mining area, and the natural ecological succession speed is extremely slow. The local climate will also have a certain impact [22]. At the same time, the quality of its ecological restoration is related to the success or failure of the ecological restoration of the entire mine [23]. Switzerland, France, the United States, Japan, Australia and other countries have carried out research work on the ecological restoration of rock slopes relatively early, and have formed ecological restoration methods and concepts suitable for their own countries, and achieved good ecological restoration effects [24]. The above research can provide reference for the ecological restoration of the slope surface of the stone mining site after the pit is closed. The ecological environmental protection scientific research team of the mining area applied the planting bag method, the floating platform method, and the fujimoto slope protection technology to the ecological restoration project of a limestone mine rock slope in Tangshan Jidong, achieving the purpose of greening the slope and improving the landscape [25].

2.2. Paste Filling Mining Technology in Metal Mines

(1) Paste filling mining in pit bottom metal mine

The bottom of the pit is usually the lowest point of the mine elevation. After the mine is closed, groundwater and surface water are often collected at the bottom of the pit, which has an adverse effect on vegetation restoration, but it can provide irrigation water for the ecological restoration of the mine slope, or according to the mine site. The location of the mine can be developed as a place of leisure and entertainment, making it enjoyable and entertaining, so as to make full use of the topographical features of the mine, so that the closed mine still has a space for sustainable development. If the mining area is in an arid and semi-arid area, the bottom of the pit cannot form long-term accumulation of water, and the bottom of the pit can be developed into forest and grassland. Poa and Pennisetum were planted after covering the bottom of a stone mine in Tangshan to effectively improve the physical and chemical properties of the soil. From the perspective of paste filling mining in metal mines, the ecological restoration of the pit bottom involves relatively few and simple technologies, mainly because the topography of the pit bottom is relatively flat after the mine is closed. Although pit bottom ecological restoration is easy to achieve better results, its success or failure mainly depends on the stability of the slope, the effectiveness of the ecological restoration of the slope, and the soil erosion of the entire mining area, such as landslides or soil erosion caused by local landslides. The generated sediment will cause siltation and damage to the restored vegetation at the bottom of the pit.

(2) Paste filling mining in metal mines of dumps

Most dumping sites are ecological restoration on the basis of soil reconstruction, water storage and land preparation and optimization of vegetation allocation mode. During the mine dumping process, large pieces of waste rock can be placed at the bottom of the dumping site, and fine-grained soil can be covered on the slope and platform to provide basic conditions for plant growth. Soil texture, bulk density, pore state and infiltration, water retention and fertilizer retention will affect the growth of vegetation, which also affects the ultimate effect of ecological restoration. Surface soil reconstruction and vegetation restoration are key links in the ecological restoration of dumping sites. Soil is the basis for plant growth. On the other hand, it can increase vegetation coverage and improve the ecological environment of the mining area. The soil at the platform of the dump site is compacted, which increases its bulk density and reduces its porosity, which seriously affects the development of plant roots and reduces the vegetation biomass per unit area. The soil density on the slope is relatively low, which is easy to cause gully erosion, causing soil erosion. Therefore, the topsoil should be plowed at the platform to facilitate the development of plant roots, and technical measures of water storage and river closure and vegetation restoration should be adopted as soon as possible on the slope to reduce soil erosion. The vegetation configuration mode has an important impact on the overall stability of the entire mining area's ecosystem after restoration and the soil in the restoration area. At present, the platform usually adopts ecological protection technology that combines trees, shrubs, and grasses for restoration, and the slope surface usually adopts ecological protection technology that combines shrubs and grasses for restoration. Among them, trees usually choose acacia, elm, Chinese pine and other tree species, shrubs usually choose torch tree, amorpha, lespede, wattle, etc., and herbs usually choose barren-tolerant alfalfa, ryegrass, etc. Although the difficulty of ecological restoration of the dump is lower than that of the rocky slope, the soil-rock mixture is easy to cause uneven deformation of the dump during the consolidation process, resulting in stretched mine paste near the slope and the outer edge of the platform. It will because small-scale changes in soil structure, worsen soil moisture, and increase the possibility of geological disasters such as landslides and mudslides. It is extremely detrimental to plant growth, soil microbiological characteristics, plant communities and overall stability of dumping sites. Therefore, after the mine dump reaches the design height, the slope and platform should be covered with soil as soon as possible, and then mixed planting of alfalfa, ryegrass and other herbs to achieve rapid re-greening, reduce soil erosion and accelerate soil maturation. At the same time, the waterproof and drainage system should be constructed well. After the soil in the dump site is basically consolidated, plant or sow trees, shrubs and herbaceous plants on slopes and platforms. After vegetation restoration, real-time monitoring of the stability of the dump site, the development of ground and mine pastes, and the growth status of vegetation should be carried out. When abnormal conditions are found, corresponding engineering and technical measures must be taken to ensure the safety and stability of the dump site and its location. The ecosystem succeeds in the positive direction. Large-scale dumping yards are faced with the contradiction of lack of water in dry seasons and rainy seasons that easily cause soil erosion and slope instability. Safety and stability are the prerequisites for achieving ecological restoration of dumps. Before vegetation restoration, the slopes and steps of the dumps are usually cover soil on the upper surface to provide a growth substrate for later vegetation restoration. However, the slope cover is usually dumped from the top of the slope by a dump truck, and the soil slides from the top of the slope to the foot of the slope under the action of gravity, which results in a larger particle size. Stones or coarse-grained soil are concentrated in the middle and lower parts of the slope, and the particle size of the stones or soil is larger at the foot of the slope, while the particle size of the soil at the top of the slope is relatively small.

(3) Paste filling mining of road metal mines in mining area

In the planning and design of ecological restoration and reconstruction of the mining area, the road in the mining area is not only a transportation channel for ecological restoration of slopes, working platforms and pit bottoms, but also areas that require ecological restoration after the mine is closed. The road in the mining area is relatively flat, which creates favorable conditions for the smooth progress of its ecological restoration. The hidden dangers of landslides on roads in mining areas should be cleared in time, and drainage ditches should be installed on the inside of the roads. After deep flattening the highway, the ecological restoration is carried out by planting or planting trees and shrubs after covering with soil. In the ecological restoration treatment of the Beiwei Quarry in Zhangjiakou, Wang Yue used the method of planting trees after covering the soil to restore the road in the mining area; Wang Dong and others adopted the mixed mode of arbor and grass on the deep flat road in the mining area to effectively restore the surface vegetation. The above-mentioned paste-filling mining of metal mines is mainly for roads in mining areas that have not been hardened by concrete. For roads in mining areas that have been hardened by Guo concrete, if the above-mentioned repair technology continues to be used, the difficulty and cost will increase accordingly. This is because the removal of road concrete not only requires manpower and material resources, but also produces a large amount of non-degradable outbound garbage, which is likely to cause secondary pollution. Therefore, when designing the metal mine paste filling and mining plan for the roads in the hardened concrete mining area, while retaining the roads, it is possible to strengthen the maintenance of the greening and water-proof and drainage systems on both sides of the road to ensure the smooth flow of the road, which is the subsequent slope and pit. The maintenance of the bottom ecological restoration project provides roads. During the design of the ecological restoration plan for the road in the mining area, it should be coordinated with the ecological restoration plan of the entire mining area to integrate it into the entire ecosystem.

(4) Paste filling mining in the metal mine of the industrial square

Industrial plazas play an important role in the mine's entire life cycle and are an indispensable part of mine production and life. Regarding the ecological restoration and reconstruction of the Mine Industrial Plaza, some scholars have also carried out corresponding research work. When Zhibin planned the industrial plaza of a limestone mine in Yangqu County of Taiyuan as a shrubland after the mine was closed, mainly for planting seabuckthorn and alfalfa; Fang Nanping is predicting mineral damage based on the engineering geology, hydrogeology and environmental geology of the mining area on the basis of the assessment, a comprehensive planning and design of the ecological restoration project in the Gutian Dalongji mining area in Fujian was carried out. The metal mine paste filling mining in the industrial square of the mining area is simple and relatively mature. When designing the metal mine paste filling mining scheme, under the premise of ensuring the restoration effect, the restored landscape should be coordinated with the surrounding environment. At the same time, such as this area for point or surface pollution sources, the pollution sources need to be properly handled to prevent pollution to the air, soil or groundwater.

(5) Mining-affected areas around the mining boundary

During the mining process and after the pit is closed, it will have varying degrees of impact on plant growth, engineering geology, hydrogeological environment, etc. within a certain range around the mining boundary, mainly due to quarrying dust, groundwater drainage, and stope slopes. Caused by the paste of surrounding mines. At present, there are relatively few research results on the paste-filling mining of metal mines around the mining boundary, and this phenomenon will become more and more serious as the pit is closed. Therefore, it is necessary to carry out ecological restoration and reconstruction of the area around the final realm affected by mining, so that the entire mining area has a good ecological environment after the pit is closed, and reduces the impact of mining on the regional groundwater seepage field and slope stability. For areas where micro-mining pastes are relatively developed and soil nutrients are severely lost, on the basis of engineering measures to control the development of micro-cracks, legumes with developed root systems and low shrubs can be mixed. For areas that are not significantly affected by mining, such as the surface vegetation is basically not damaged, under the premise of appropriate supplementation of water and fertilizer, the way of closing hills and reforestation can be adopted for ecological restoration. If the surface vegetation is seriously damaged, a combination of trees, shrubs and grass can be used to carry out ecological restoration. In the future, when ecological restoration is carried out in the areas disturbed by mining around the mining boundary, divisions should be made according to the degree of mining disturbance, the change of groundwater seepage path, the degree of paste development in micro mines, the loss of soil nutrients, etc. Select targeted metal mine paste filling mining schemes for different environmental conditions in the region to achieve the best repair effect.

2.3. Discrete Mine Paste Network Model

In the discrete mine paste network model, the shape of the mine paste is a disc, and the size of the mine paste is characterized by the diameter of the mine paste. In nature, mine paste generally follows a power law distribution. The density of mine paste is defined as α, and the number of mine paste per unit volume is:

$$G = G_w + G_{nb} + G_t \tag{1}$$

$$G = \frac{\sum_{j=1}^{k}\sum_{h=1}^{k}\sum_{t=1}^{n_j}\sum_{r=1}^{n_h}\left|y_{ij} - y_{hr}\right|}{2n^2 u} \tag{2}$$

Where G is the number of mine pastes with a size of K per unit volume; the range of mine paste size K is defined between Min and Max, which is used to determine the proportional relationship between large-size mine paste and small-size mine paste:

$$u_h \le u_j \le \ldots \le u_k \tag{3}$$

$$Gjj = \frac{\frac{1}{2u_j}\sum_{i=1}^{n_j}\sum_{r=1}^{n_j}\left|y_{ji} - y_{jr}\right|}{n_j^2} \tag{4}$$

$$Gw = \sum_{j=1}^{k} G_{jj}\, p_j s_j \tag{5}$$

In the cube area with side length L, the quantity of mine paste size within the standard range can be expressed as:

$$G_{jh} = \frac{\sum_{Z=1}^{h_j}\sum_{r=1}^{n_h}\left|y_{ji} - y_{hr}\right|}{n_j n_h (u_j + u_h)} \tag{6}$$

$$G_{nb} = \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{jh}(p_j s_h + p_h s_j) D_{jh} \tag{7}$$

$$G_t = \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{jh}(p_j s_h + p_h s_j) D_{jh}(1 - D_{jh}) \tag{8}$$

The cumulative probability density can be expressed as:

$$D_{jh} = \frac{d_{jh} - P_{jh}}{d_{jh} + P_{jh}} \tag{9}$$

Therefore, the length of a single mine paste can be expressed as:

$$d_{jh} = \int_0^{\infty} dF_j(y) \int_0^{y} (y - x)\, dF_h(x) \tag{10}$$

$$d_{jh} = \int_0^{\infty} dF_h(y) \int_0^{y} (y - x)\, dF_j(y) \tag{11}$$

2.4. Numerical Simulation Method of Mine Paste Shape

The position of the mine paste is represented by the coordinates of the center point of the disc-shaped mine paste. The positions of the mine paste in the DFN model are independent of each other and obey a uniform distribution, which can be expressed as:

$$f(x)=\frac{1}{Nh}\sum_{i=1}^{N}k(\frac{X_i-x}{h}) \tag{12}$$

$$k(x)=\frac{1}{\sqrt{2\pi}}\exp(-\frac{x^2}{2}) \tag{13}$$

$$h_t=\tanh(w_c x_t+u_c(r_t\Theta h_{t-1})+b_c) \tag{14}$$

$$h_t=z_t\Theta h_{t-1}+(1-z_t)\Theta h_t \tag{15}$$

When generating mine paste, suppose the probability of generating mine paste at this location is:

$$\sigma t=\frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(FI_{it}-FI_{it})^2}}{FI_{it}} \tag{16}$$

$$u_{(j|i)}=w_{ij}A_i \tag{17}$$

$$s_j=\sum_i c_{ij}u_{(j|i)} \tag{18}$$

Assign a probability value P to this point, P is a random number between 0-1, P is compared with the generation probability Prob, there are:

$$\ln(\frac{FI_{it}}{FI_{it}-1})=\alpha+\beta\ln FI_{it}-1+v_i+\Im_t \tag{19}$$

$$c_{ij}=\frac{e^{b_{ij}}}{\sum_k e^{b_{ik}}} \tag{20}$$

β determines whether to generate mine paste at this location. If β=1, the mine paste will be generated. If β=0, the location will be abandoned. Repeat this process until the termination condition is reached:

$$r=\frac{\alpha}{1-\beta} \tag{21}$$

$$\theta=-\frac{1}{T}\ln(1+\beta) \tag{22}$$

$$\tau=\frac{\ln(2)}{\theta} \tag{23}$$

Occurrence of mine paste includes two variables: dip angle and inclination. The direction of mine paste distributed in nature often has a certain dominant value, and the direction of a single mine paste is randomly distributed around this dominant direction. The Fisher distribution not only reflects the dominant direction of mine paste occurrence, but also shows the randomness of single mine paste occurrence. When describing mine paste occurrence, the influence of mine paste on the movement and deformation of overburden rock in filling mining is often used. The Fisher probability function is expressed as:

$$\ln(\frac{FI_{it}}{FI_{it}-1}) = \alpha + \beta \ln FI_{it} - 1 + \varphi X_{it} - 1 + v_i + \tau_t \tag{24}$$

$$k_{t1}[i] = \sum_j \cos(w_i^1, w_j^2) \tag{25}$$

Among them, X represents the external influencing factor variable matrix as the corresponding coefficient matrix. If it is significantly less than 0, the numerical simulation of paste mining in metal mines tends to converge, that is, there is conditional convergence.

3. Numerical Simulation Study of Paste Filling Mining in Metal Mines

3.1. Elements of Metal Mine Paste

This paper further diagnoses the distribution of mineral degradation in the mining area from a dynamic perspective, identifies the effect of ecological restoration of the dump (gangue), which is of great significance to guide the ecological restoration of the mining area, and is a further deepening and improvement on the basis of its research. However, mineral degradation in metal mining areas is restricted by many factors, such as groundwater, slope, soil, water, and air pollution. In addition to the small research time span, the conclusions drawn may have certain limitations. Therefore, in the future, it is necessary to take into account the monitoring and diagnosis of mineral degradation in mining areas with multiple methods such as remote sensing technology and on-site sampling, all elements, and long time series to further improve the scientificity and credibility of the conclusions. Multi-temporal remote sensing images are used to comprehensively analyze the mineral degradation status and influencing factors of the central and northern grassland areas, the loess plateau area, the southwest mountain and hilly area, and the northwest arid area in the western metal mining area.

3.2. Content and Steps

Mineral damage refers to the combination of man-made and natural factors that negatively affect the quality of minerals, causing serious ecological and environmental problems. Based on the connotation of mineral damage, a total of 2 types of evaluation indicators have been selected: the mineral damage index that most intuitively represents the impact of the mining industry on mineral damage, and the type of mineral utilization that indirectly reflects the mineral damage, vegetation coverage, desertification/rocky desertification, soil erosion, etc. Indicators, the four indicators are the main manifestations of mineral damage, which can reflect the status of mineral damage from the side. According to the evaluation index's influence, it is re-assigned from large to small, and the degree of mineral damage is obtained. Use existing literature research ideas and methods for reference to construct a measurement model, Model I and Model II:

$$Y_{it} = \alpha_0 + \alpha_1 AF_{it} + \alpha_2 IFI_{it} + \alpha_3 IFI^2{}_{it} + \alpha_4 GOV_{it} + \alpha_5 PI_{it} + \alpha_6 RM_{it} + \alpha_7 AM_{it} + \alpha_8 FG_{it} + \alpha_9 FP_{it} + \alpha_{10} FR_{it} + \alpha_{11} FM_{it} + \varepsilon_{it} \quad (26)$$

$$Y_{it} = \beta_0 + \beta_1 NAF_{it} + \beta_2 TAF_{it} + \beta_3 (NDNAF)_{it} + \beta_4 (DTAF)_{it} + \beta_5 GOV_{it} + \beta_6 PI_{it} + \beta_7 RM_{it} + \beta_8 AM_{it} + \varepsilon_{it} \quad (27)$$

For quarry sites, rock slopes and dumps are still the key and difficult parts of the ecological restoration and reconstruction of the entire mine. This research focuses on the ecological restoration and reconstruction of slopes, dumps and the entire mining area. Discuss the future directions for in-depth study of the ecological environment protection of the quarry site. Many scholars at home and abroad have obtained a lot of research results and valuable experience in the research of paste filling mining in open-pit metal mines, which provide a useful reference for the ecological restoration of quarry sites.

4. Numerical Simulation Research and Analysis of Metal Mine Paste Filling Based on Blockchain Technology

4.1. Cost Analysis of Paste Filling and Repair

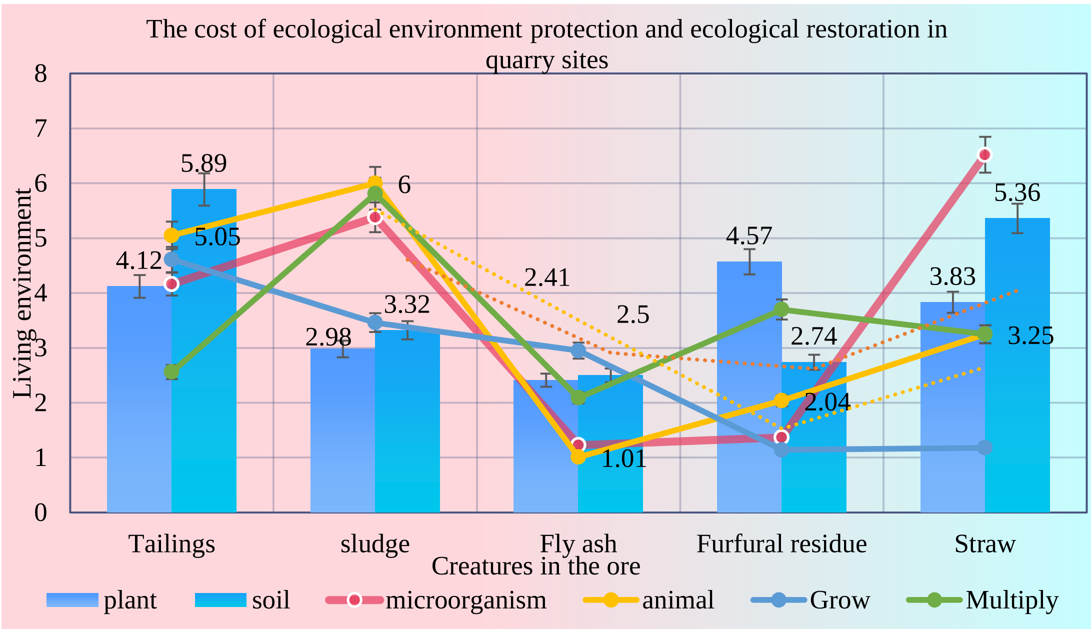

Figure 1. The cost of ecological environment protection and ecological restoration in quarry sites

As shown in Figure 1, in the ecological environment protection of the quarry site, the substrate is the basis for the growth and reproduction of plants, soil microorganisms and soil animals, and at the same time controls the cost of ecological restoration in the entire mining area. Its physical, chemical, mechanical properties and plants synergistic coupling control mechanism for growth suitability; reasonable ratio of low-cost plant base materials with solid waste (tailings, sludge, fly ash, furfural residue, straw, etc.) as the main raw materials; base materials are frozen, thawed, dried the durability, erosion resistance, internal microstructure changes and the migration and loss of water and nutrients under external conditions such as wet cycle, heavy rainfall and continuous rainfall, and key technologies such as substrate fertility and continuous fertilizer supply capacity need to be implemented In-depth and systematic research.

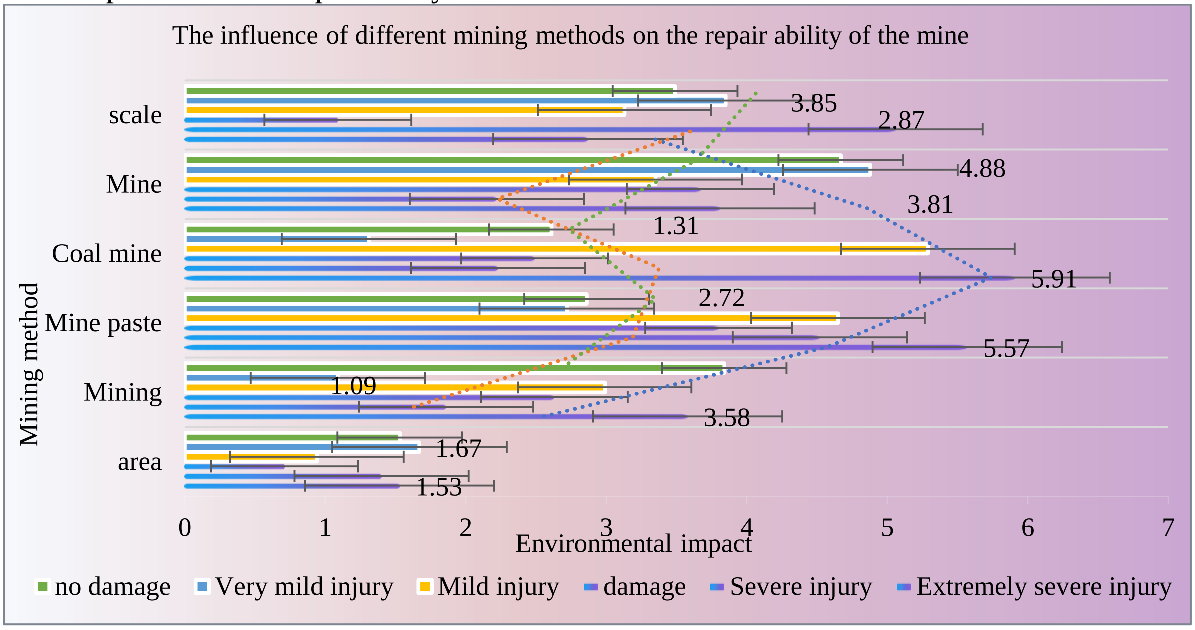

Figure 2. The influence of different mining methods on the repair ability of the mine

As shown in Figure 2, in terms of mineral damage, the extremely severely damaged area at the mine scale accounts for an average of 9.21% of the total area of the mine, and the extremely severely damaged area in the natural area excluding the mine accounts for an average of 2.98% of the area, indicating that coal mining is more vulnerable to damage surface. Open-pit mines account for 56.44% of the area with extremely severe damage on average, which is much larger than 5.61% of underground mines. The mineral damage caused by mountain paste filling mining can be repaired in time. The sudden increase in the damaged area usually reduces the non-damaged area and increases the extremely severely damaged area. However, during the research period, as coal mining expands outward, there is a phenomenon that the non-damaged area increases and the extremely severely damaged area decreases.

Table 1. Limestone resources of various grades are used for the production of one or two products

	plant	soil	microorganism	animal	Grow	Multiply
Tailings	4.12	5.89	4.16	5.05	4.61	2.56
sludge	2.98	3.32	5.38	6	3.46	5.81
Fly ash	2.41	2.5	1.23	1.01	2.95	2.09
Furfural	4.57	2.74	1.37	2.04	1.14	3.7
Straw	3.83	5.36	6.52	3.25	1.18	3.25

As shown in Table 1, the general products of enterprises are relatively single, and limestone resources of various grades are used for the production of one or two products, which will lead to a large number of high-quality limestone resources being used for production. The market demand is large, the technology and investment threshold are high. Low value-added products, especially in the construction sand and cement industries. Most of the construction sandstone pays attention to its mechanical properties and does not pay attention to its ore grade requirements, and due to its characteristics of small investment, large demand, and quick results, a large number of high-quality limestone can be made by simple processes such as simple crushing, shaping and screening. Sand and gravel aggregates are one of the most important ways to consume limestone resources.

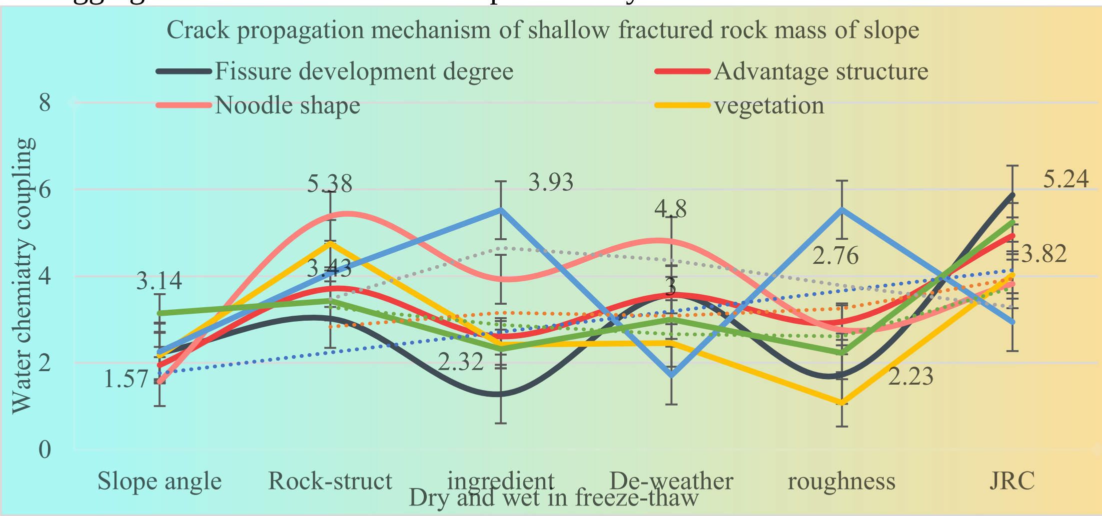

Figure 3. Crack propagation mechanism of shallow fractured rock mass of slope

As shown in Figure 3, under different conditions such as slope angle, rock structure and composition, weathering degree, interface roughness (JRC), crack development degree, dominant structural surface appearance, vegetation configuration mode, etc., analyze the shallow part of the slope. The crack propagation mechanism of the fractured rock mass under the coupling effect of freeze-thaw-dry-wetness and water chemistry, and the influence mechanism of plant root growth on the growth behavior of the rock mass fracture network and the reinforcement and anchoring effect of plant base material, explore the freeze-thaw-dry-wet and water under chemical coupling, the overall stable evolution law of the shallow fractured rock mass-root system-vegetative base material of the slope reveals the synergistic mechanism of the three. This part of the content is the difficulty in the study of ecological restoration of rock slopes in quarry sites.

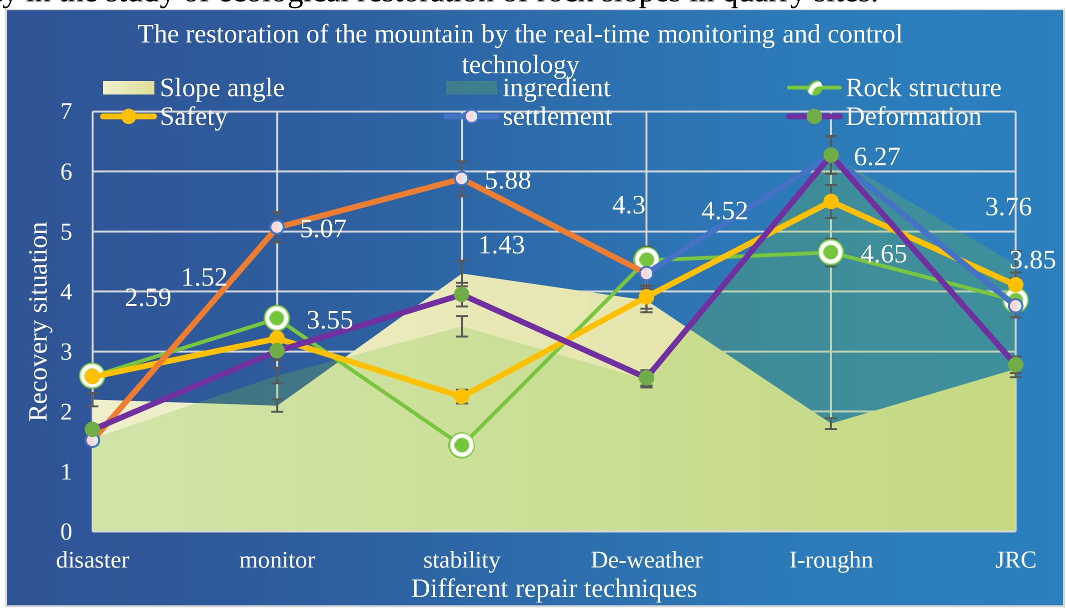

Figure 4. The restoration of the mountain by the real-time monitoring and control technology

As shown in Figure 4, safety and stability are the prerequisite for the successful ecological restoration of the dump site, and the development speed and trend of the mine paste is the key to the success of the ecological restoration. At present, the monitoring technology in the settlement, deformation, disaster monitoring, stability monitoring and other aspects of the dump site is relatively mature, while the real-time monitoring and control technology of the mine paste, the adverse effect of the extension of the mine paste on the vegetation restoration and the plant root suppression area. The research work on the expansion mechanism of mine paste and the vegetation configuration mode in the development process of mine paste needs to be strengthened.

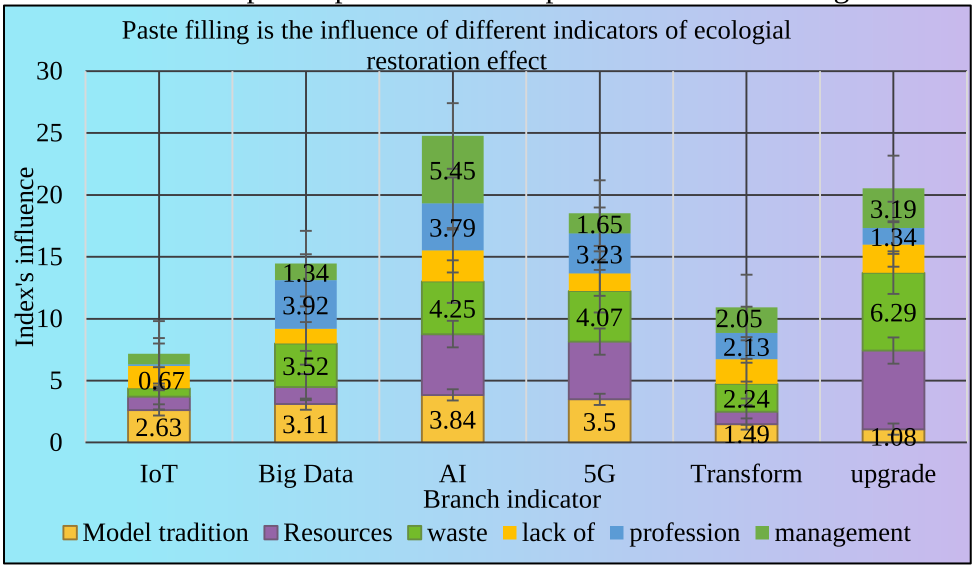

Figure 5. Paste filling is the influence of different indicators of ecological restoration effect

As shown in Figure 5, paste filling is a key means to maintain the effect of ecological restoration of stone mining sites (especially slope projects), and is an important indicator of the results of ecological restoration in mining areas. The current irrigation and maintenance technology still has problems such as traditional model, waste of resources and lack of professional management. 5G technologies strengthen and deeply integrate technologies such as the Internet of Things, big data, and artificial intelligence, which have strongly promoted the transformation, upgrading and intelligent development of various industries. According to intelligent real-time monitoring to obtain plant substrates, soil moisture content, air humidity and their dynamic changes in different areas of the mining area, combined with weather changes in the mining area, the integration of 5G technology and water-saving timely irrigation and maintenance technology in the mining area can effectively improve the ecological restoration project in the mining area. Quality and cost reduction is also one of the directions of future development.

As shown in Figure 6, ecological restoration in mining areas is a large-scale and long-term process. Monitoring and evaluation need to be carried out simultaneously during restoration. However, traditional monitoring technologies are difficult to achieve multi-channel and full-area coverage. Because they cannot track and evaluate the effect of ecological restoration in real time. As a result, part of the ecological restoration work cannot meet actual needs. The purpose of ecological restoration in mining areas is to build a relatively stable ecosystem. This requires the establishment of a sound restoration effect evaluation index system and the study of scientific and reasonable vegetation index evaluation methods.

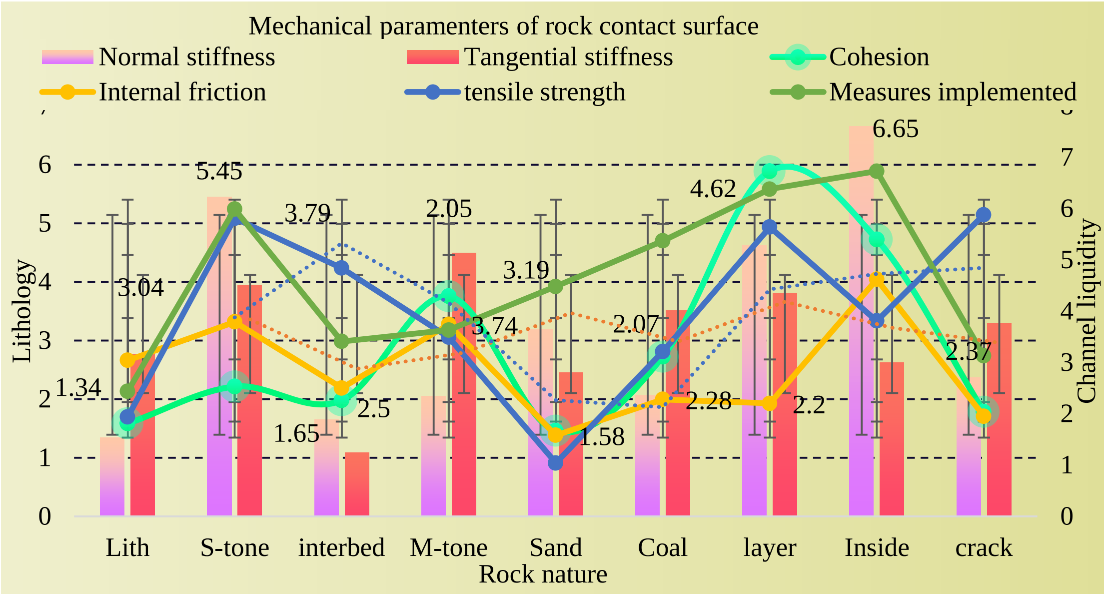

Figure 6. Mechanical parameters of rock contact surface

4.2. Damage Degree of the Mining Area and the Numerical Simulation Analysis under the Blockchain Technology

Table 2. Paste filling mining in metal mines in stone ore sites

Item	Normal stiffness	Tangential stiffness	Cohesion	Internal friction	tensile strength	Measures implemented
Lith	1.34	2.77	1.81	3.04	1.94	2.44
S-tone	5.45	3.95	2.53	3.79	5.81	5.99
interbed	1.65	1.09	2.26	2.5	4.84	3.41
M-tone	2.05	4.49	4.29	3.74	3.49	3.63
Sand	3.19	2.45	1.67	1.58	1.04	4.48
Coal	2.07	3.51	3.11	2.28	3.21	5.37
layer	4.62	3.81	6.73	2.2	5.64	6.38
Inside	6.65	2.62	5.4	4.62	3.81	6.73
crack	2.37	3.3	2.04	1.95	5.88	3.13

As shown in Table 2, in the face of the overall requirements of building "green water and green mountains are golden mountains and silver mountains", it is necessary to complete the whole process of site condition analysis, implementation of ecological restoration measures, dynamic changes of soil moisture, and monitoring and evaluation after restoration. Effectively integrate 5G technology, GIS, and RS, and with the support of artificial intelligence technology, obtain dynamic monitoring data of mining area destruction, ecological restoration and restoration effects, use digital models to simulate monitoring and evaluation of restoration effects, and integrate information technology and space technology into traditional mining areas. In the ecological restoration work, it will help promote the application of metal mine paste filling mining in quarry sites, and solve the problems of large area, large amount of data, and complex data.

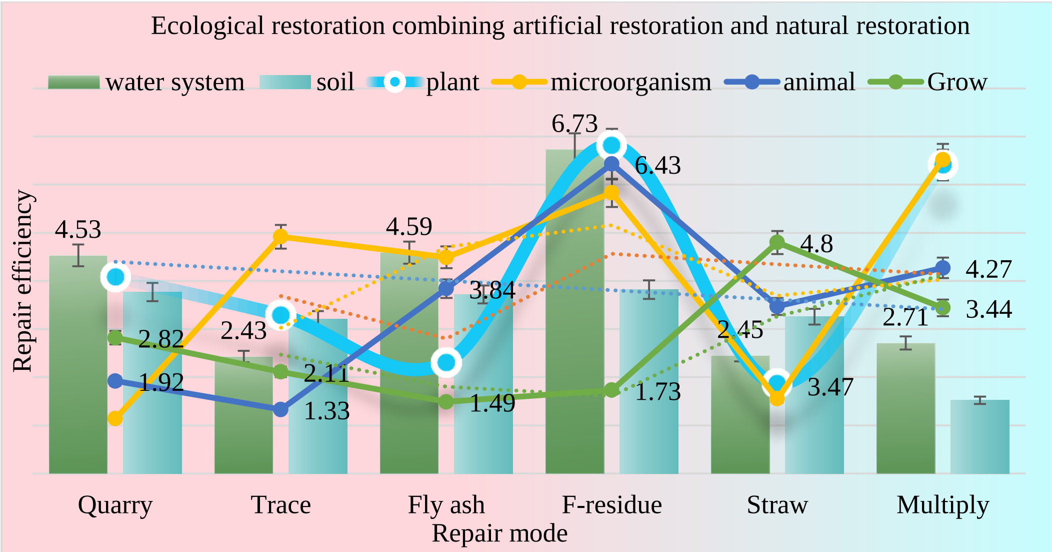

Figure 7. Ecological restoration combining artificial restoration and natural restoration

As shown in Figure 7, the key technologies of ecological restoration combining artificial restoration and natural restoration, the key technologies of microorganism, plant and engineering restoration, the mechanism of the impact of groundwater system changes on the ecological environment of the mining area, the key technologies of ecological restoration in different damaged areas, and the evaluation of ecological safety. And control modes are important research directions for ecological restoration and reconstruction of mining areas in the future.

Table 3. The principle of high-efficiency utilization of limestone resources

Item	water system	plant	soil	microorganism	animal	Grow
Quarry	4.53	4.08	3.77	1.14	1.92	2.82
Trace	2.43	3.29	3.21	4.92	1.33	2.11
Fly ash	4.59	2.31	3.72	4.49	3.84	1.49
F-residue	6.73	6.82	3.82	5.83	6.43	1.73
Straw	2.45	1.87	3.26	1.55	3.47	4.8
Multiply	2.71	6.41	1.52	6.52	4.27	3.44

As shown in Table 3, to establish and improve the principle of high-value efficient utilization of limestone resources, the core is to follow the existing national/industry standards and norms for the utilization of limestone resources on the basis of closely surrounding the national opinions on the conservation and efficient utilization of mineral resources. For the specific situation of industrial development, further establish and improve the standard and standard system for high-value and efficient utilization of limestone resources. For the mining and utilization of paste filling in metal mines, the existing standards mainly refer to the DZ/T0213-2002 issued by the Ministry of Land and Resources for the requirements of limestone for cement, ferrous metallurgical flux limestone, non-ferrous metallurgical solvent limestone and other industries, which can reach the ferrous metallurgical solvent.

As shown in Table 4, more than 80% of the cement industry is currently centrally owned/ state-owned enterprises and large private enterprises, which control more than 90% of the mining rights of limestone resources. This has led to more than 90% of limestone resources that may be used for low production of valuable cement. In view of the current status of paste filling mining and utilization in my country's metal mines, to achieve cascade high-value and efficient utilization of limestone resources, it is necessary to achieve mine integration and green mining, based on compliance with the existing national/industry standards and norms for the utilization of limestone resources Integrating the current industrial development and the specific conditions of product technology and technology, further establish and subdivide the upper limit of the limestone grade required for each product, and maximize the value of high-grade limestone resources.

Table 4. Cascade high-value efficient utilization of limestone resources

	Jungle	victory	Xiaolongtan	Zhundong	open air	thickness
2015	3.04	4.24	2.79	1.72	2.73	3.99
2016	1.4	4.9	1.63	3.12	1.59	2.64
2017	5.71	3.73	6.73	4.88	1.72	4.79
2018	2.95	5.23	1.49	3.19	6.78	2.33
2019	5.54	5.04	6.67	4	3.66	2.43
2020	4.79	3.81	4.19	3.34	1.45	6.94

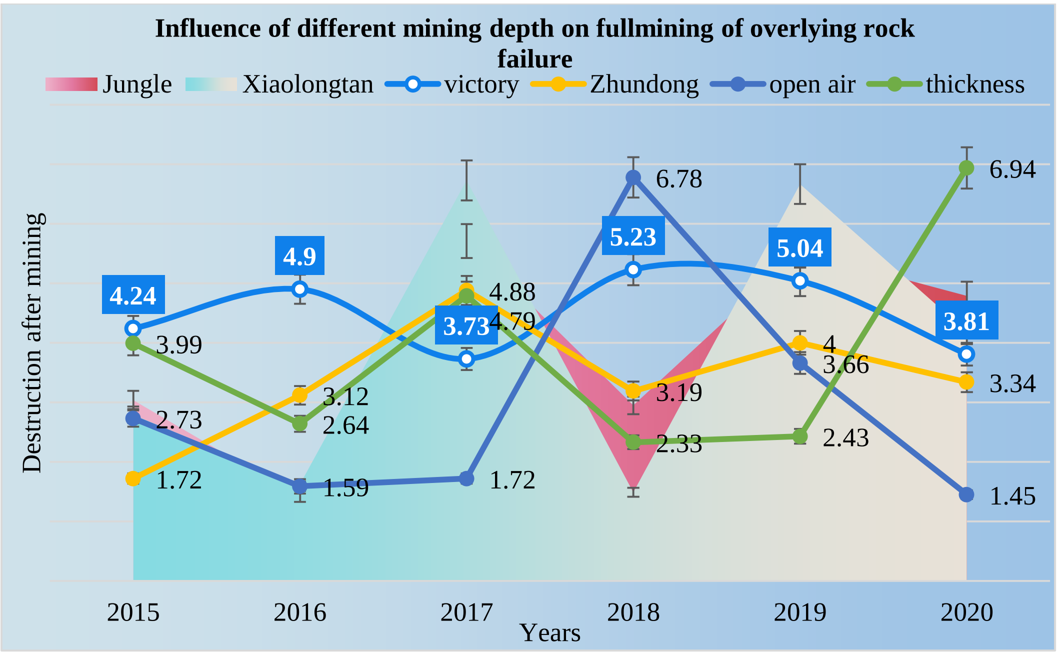

Figure 8. Influence of different mining depth on full mining of overlying rock failure

In recent years, the distribution of mineral degradation in the western metal mining areas is shown in Figure 8. In terms of the degradation distribution: the degradation areas are mainly distributed at the mine scale, especially concentrated in the Zhungeer Mine, Shengli Mine, Xiaolongtan Mine, and Zhungeer Mine, which are mining paste filling mining. The pit and dump (gangue) area of the East Mine have a particularly serious impact on the environment.

As shown in Table 5, the severely degraded area of open-pit mines accounts for 13.58% of the area, which is greater than 8.27% of jinggong mines; the slightly degraded area of jinggong mines accounts for 30.49% of the area, which is 15.41% higher than that of open-pit mines. The degraded area caused by well mining is large but the degree of degeneration is relatively light. The area of mountain paste filling and mining causes less degradation but the degree of degradation is more serious. The improvement in the mining area is in good condition, and the heavy improvement is relatively regular and widely distributed in open-pit mines. For example, the large area of heavy improvement in the dump (gangue) of Zhungeer shows that the ecological restoration of the dump (gangue) has a good effect.

Table 5. Well mining causes a wide range of degradation but the degree of degradation

Item	Vicious circle	Land degradation	General law	compatibility	Reveal mining	Relief landform
Coal mining	4.53	4.08	3.77	1.14	1.92	2.82
Disturb	2.43	3.29	3.21	4.92	1.33	2.11
Damage	4.59	2.31	3.72	4.49	3.84	1.49
Vege-damage	6.73	6.82	3.82	5.83	6.43	1.73
So-Erosion	2.45	1.87	3.26	1.55	3.47	4.8
Res-develop	2.71	6.41	1.52	6.52	4.27	3.44

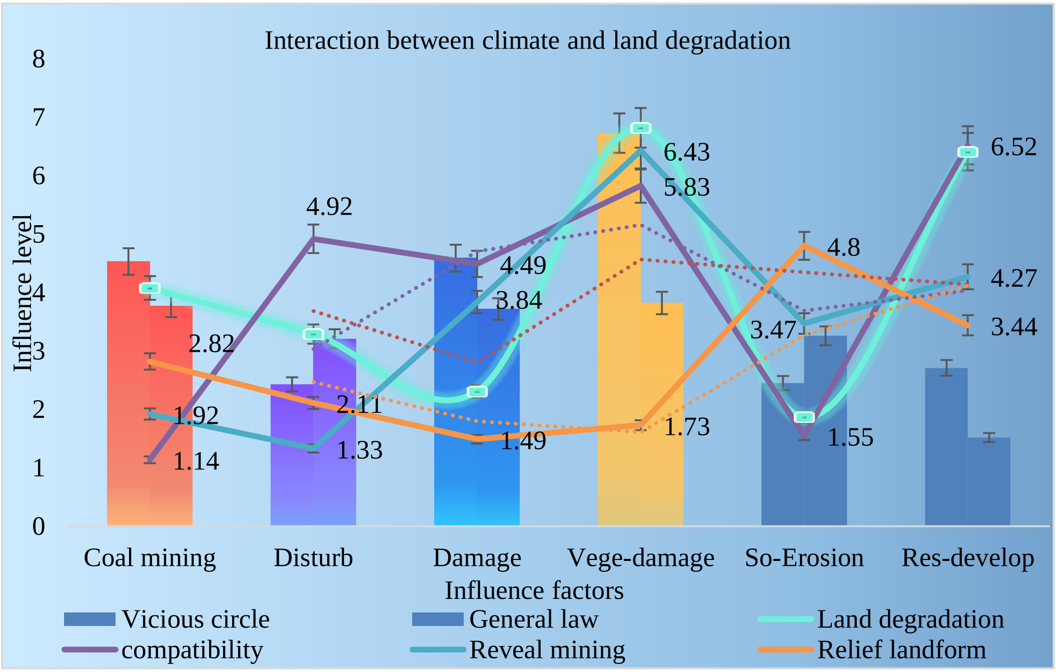

Figure 9. Interaction between climate and land degradation

As shown in Figure 9, the interaction of climate and mineral degradation affects water quality and quantity. Abundant rainfall will promote the growth of plants in and around the mining area, thereby changing the mineral degradation status; the alleviation of mineral degradation can also act on surface vegetation and enhance vegetation transpiration forms a virtuous circle and alleviates mineral degradation caused by coal mining. However, this is not applicable to all regions, such as the particularity of the karst landform in the mountainous and hilly areas of southwestern China. The abundant precipitation can easily lead to soil erosion and rocky desertification, which in turn aggravates mineral degradation.

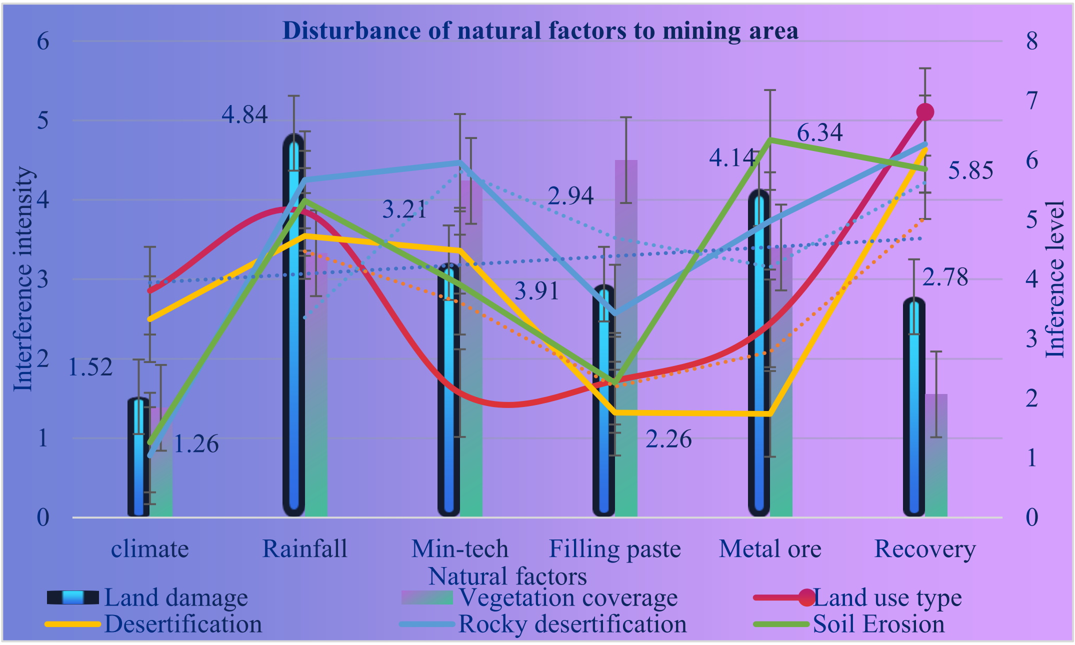

Figure 10. Disturbance of natural factors to mining area

As shown in Figure 10, coal mining has a strong disturbing effect on the ecological environment of the mining area, causing environmental problems such as mineral damage, vegetation damage and soil erosion, which degrade regional minerals, restrict resource development, and form a vicious circle between resources and the environment. However, because mineral degradation is affected by local climate and rainfall, the overall law between coal mining and mineral degradation is unclear, and the compatibility of its mineability with the environment is uncertain. It is difficult to reveal the mechanism of coal mining’s impact on mineral degradation.

5. Conclusion

Appropriate mineral reclamation methods should be selected according to different mining methods. Compared with mine mining, mountain paste filling mining has less impact on the ecological environment. Metal mine paste can use stripped soil and rock to fill the completed pit, cover the surface with fertile soil and plant vegetation, and re-deploy the topography of the dump. To this end, the ecological restoration of mining areas should be strengthened. While ensuring the development of the metal mining industry, the mining intensity and restoration methods of each region should be determined according to the ecological carrying capacity to alleviate the degree of mineral degradation. As the mechanism of coal mining's impact on the environment is not clear, some people suggests to systematically investigate soil, water and ecological characteristics, and proposes that water protection and utilization are the key to the restoration of the ecological environment in mining areas. The western metal mining area spans a large area, and the climate, soil, water resources and mining methods are different. When carrying out ecological restoration, measures should be taken according to local conditions, and targeted environmental treatment measures should be taken to the metal mining area to realize the sustainable development of the western coal industry.

This paper further diagnoses the distribution of mineral degradation in the mining area from a dynamic perspective, identifies the effect of ecological restoration of the dump (gangue), which is of great significance to guide the ecological restoration of the mining area, and is a further deepening and improvement on the basis of its research. However, mineral degradation in metal mining areas is restricted by many factors, such as groundwater, slope, soil, water, and air pollution. In addition to the small research time span, the conclusions drawn may have certain limitations. Therefore, in the future, it is necessary to take into account the monitoring and diagnosis of mineral degradation in mining areas with multiple methods such as remote sensing technology and on-site sampling, all elements, and long time series to further improve the scientificity and credibility of the conclusions. Multi-temporal remote sensing images are used to comprehensively analyze the mineral degradation status and influencing factors of the central and northern grassland areas, the loess plateau area, the southwest mountain and hilly area, and the northwest arid area in the western metal mining area.

In recent years, the phenomenon of mineral degradation in the northern grassland and southwest mountainous and hilly areas is slightly severe, but the improvement is good; the ecological environment of the Loess Plateau is relatively stable, and the ecological environment of the arid area in the northwest has improved, but its own vulnerability still cannot be ignored. The extremely severely damaged area of open-pit mines is 50.83% lower than that of underground mines, and mountain paste filling mining has less environmental disturbance; the severely degraded area of open-pit mines is 5.31% lower than that of underground mines, and the slightly degraded area of underground mines is lower than that of underground mines. Open-pit mines are 15.41% high. Open-pit mines have a relatively small area of mineral degradation, and mines have a wide range of mineral degradation. The degradation of minerals in metal mining areas is affected by both natural and human factors. The overall mineral degradation at the mining area scale is greatly affected by precipitation, and the mineral damage caused by coal mining is the main driving force for the mineral degradation at the mine scale. In summary, with the continuous deepening of the concept of ecological civilization development in the new era, the rational and legal application of paste filling mining in metal mines has become a focus of attention from all walks of life.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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