

Research on ecological restoration and management of abandoned rare earth mines

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Abstract

The rare earth resources in southern my country is of the ionic type, and the mining adopts the pond leaching process, which requires the removal of all vegetation on the surface of the mountain. This seriously damages the local vegetation system, destroys a large number of land resources, leads to the decline of soil fertility, induces geological disasters, and causes a large number of economic losses and sediment deposition in the river, affecting the safety of flood control. Taking the problem as the orientation, adhere to the comprehensive management of mountains, rivers, forests, fields, lakes, grass, and sand, and adhere to the principle of "according to local conditions, adapting trees to trees, grasses to grasses, and famines," to ensure that prominent ecological and environmental problems are effectively managed and the quality of the ecological environment is significantly improved. Ecosystem circulation capacity, ecological product production capacity, and ecosystem service supply capacity will be significantly enhanced, and ecosystem stability will be significantly enhanced to achieve sustainable utilization of water and soil resources and sustainable development of the ecological environment.

Keywords

Abandoned rare earth mine; ecological restoration; governance; methods.

1. Introduction

Disordered mining has left a large amount of mining waste rock and slag in the mining area, forming a large area of bare surface^[1], causing geological disasters and geological environment problems in the mining area to become more prominent^[2], which has posed a serious threat to the regional ecology^[3], geological environment, and the production and life safety of downstream villages^[4]. The geological environment and ecological environment of the mining area need to be comprehensively controlled^[5]. Promoting the construction of national spatial ecological restoration, the beautiful Chinese ecological civilization under the big background, repair plan properly^[6], flexible application of the technology to repair, adjust measures to local conditions to the joint application of phytoremediation^[7] and physical and chemical remediation technology^[8], out of an effective repair of rare earth mining area ecological environment governance^[9], is the guarantee disused mine environmental governance effect, It is an important way to promote the coordinated development of the exploitation and utilization of rare earth resources and the protection of the ecological environment in mines and contribute to the national ecological progress^[10, 11].

2. Overview of Abandoned Rare Earth Mine

Because rare earth mining employs the "pool leaching process" known as "moving mountains," that is, stripping all vegetation and soil on the mining area's surface to obtain rare earth ore, completely destroying the original soil layer, the form accepts natural erosion^[12, 13]; at the same

time, corrosive drugs such as oxalic acid and ammonium sulfate are used. Under the action of infiltration and leaching, the waste water pollutes the soil and water bodies, and the mechanization degree and resource utilization efficiency of the latter heap leaching process are improved. The leaching agent has also been improved, but it will still destroy a large amount of soil surface vegetation, produce a large amount of waste liquid, ore, tailings and tailings, cause serious soil erosion, heavy metal pollution, and eutrophication of water, and cause environmental damage to the mining area. huge destruction. Eventually, the mines are acidified, the soil is poor, and ammonia nitrogen is enriched, which aggravates the hazards of geological disasters such as landslides and debris flows. Due to the lack of timely greening and reclamation measures after the mining activities were stopped in the mining area and time has passed, the boundary between the existing tailings yard and the heap leaching yard is blurred, and the long-term discharge of tailings has formed a large area of tailings yard. Some are not standardized, sand retaining dams and interception and drainage facilities are imperfect, and surface erosion and gully erosion are serious. Due to water and soil erosion, a large number of tailings are discharged and deposited in the gullies, changing the original topography, occupying the land, destroying the surface vegetation, and forming a larger range of tailings accumulation areas, which has a great impact on the ecological environment and the production and lives of the surrounding villagers.

3. Governance ideas and principles

3.1. Governance ideas

Through the investigation of the current situation of the mine geological environment according to the "landscape, forest, farmland, lake, and grass" system management idea, the regional and differentiated comprehensive management of prominent geological environmental problems in different regions is carried out; combined with different regional environmental conditions and control objectives, the suitable mines in the region are selected. The technical method of treatment is feasible, economical, and effective, and the comprehensive treatment measures of "phytoremediation + engineering treatment" are adopted, and finally the water and soil pollution, water and soil loss, and geological disaster risks in the project area can be effectively controlled.

3.2. Governance principles

(1) The principle of "prevention first, combined with prevention and treatment" For the existing environmental problems of abandoned mines, measures such as covering soil and greening, engineering treatment, and other measures are adopted to restore or control them, so as to minimize the damage to the geological environment of abandoned mines.

(2) The principle of "seeking truth from facts and adjusting measures to local conditions". According to the geological environment problems such as mine geology, hydrological engineering geology, environmental geological conditions and mine geological disasters, we formulate scientific and reasonable measures for the prevention, restoration and treatment of the mine environment. Different restoration and control measures are taken for different areas and different geological environmental problems.

(3) According to the principle of "feasible technology and reasonable economy", ecological restoration and management of mines should be carried out in accordance with the technical specifications formulated by the state.

(4) The principle of "design first and then build". In the process of mine ecological restoration and management, adhere to the principle of design first and then construction; in the process of plan implementation, adhere to the principle of safety first to ensure the safety of construction personnel and mine production personnel.

4. Governance options

4.1. Governance principles

- (1) Comprehensive utilization the earth and stone excavated during the project's construction shall be transferred and utilized to the greatest extent possible in order to reduce the phenomenon of soil erosion caused by the land occupation of spoil and slag.
- (2) Adapt to local conditions. According to the specific conditions of the project area, rationally arrange engineering measures, select local plant varieties suitable for growth, and improve the suitability of the measures.
- (3) Avoid "secondary pollution". No new pollution or new environmental problems will be brought about during the construction of the remediation project;
- (4) To avoid environmental and personnel risks. Avoid casualties and major environmental pollution accidents caused by mountain collapses during construction;
- (5) It is inexpensive and simple to implement. According to the current situation of environmental destruction combined with the local reality, the designed scheme is economical, environmentally friendly, and sustainable, and it is easy to operate during the implementation process.

4.2. Governance options

According to the on-site investigation and the actual situation of each point, except for the natural recovery area of each mining area, the abandoned rare earth mining area to be renovated has the phenomenon of bare mountains. Excessive ammonia nitrogen waste will cause great harm to agriculture and forestry in the basin. Therefore, the ecological restoration and remediation of abandoned rare earth mines mainly focuses on two aspects: ecological slope protection and soil improvement. From the perspective of ecological restoration and remediation project construction, it integrates new materials and technologies into soil improvement, plant breeding, recovery of mining wounds, and slope stabilization.

4.2.1 Ecological slope protection

(1) Geonet Cushion Planting Grass Planting Slope Protection Technology

Geonet mat is a new type of civil engineering material, which belongs to the technical field of new materials in the national high-tech product catalogue. 90% of the space can be filled with soil, gravel, and fine stones, and plant roots can pass through it, and grow comfortably, neatly, and evenly. Plant roots can penetrate 30–40 cm below the surface, forming a solid green composite protective layer, which has higher impact resistance than general turf slope protection.

(2) Soil spraying

Soil spraying technology uses a special spraying machine to evenly spray mixed plant growth base materials—soil and organic substrates, binders, water retention agents, pH relievers, fertilizers, and an appropriate amount of mixed grass and shrub seeds onto the slope surface. The soil layer for plant growth is formed on the top. After the seeds germinate and grow into a flat, it can effectively protect the stability of the slope and achieve the purpose of quickly rebuilding the vegetation ecosystem and biological slope protection.

(3) Skeleton Vegetation Protection

In the case of meeting the slope protection function, the skeleton vegetation protection has the characteristics of saving materials, reducing the project cost, and reducing the load of the slope body for high slopes. The skeleton can be in various forms, such as arch, herringbone, diamond, rectangle, etc., but the form and scale of the skeleton should be considered from the aspects of aesthetics and local cultural background. When the skeleton is to be highlighted, the skeleton construction should be fine. The vegetation protection in the framework can be combined with

the rock and soil properties and slope rate of the slope, and various measures of vegetation protection can be adopted. In general, the vegetation protection of mortar rubble or concrete skeleton and the vegetation protection of polygonal concrete hollow blocks are suitable for soil and fully and strongly weathered rock slopes with a slope ratio of less than 1:0.75.

(4) Xin triangle slope protection technology

The Xin triangle slope protection system consists of three parts: ecological bags, connecting buckles, and vegetation. After the system is installed, the Xin triangle connecting buckles fix the upper and lower adjacent Xin triangle ecological bags into a triangular stabilizer to form the slope and retaining wall. The ecological bag has the properties of water permeability and soil preservation, which can effectively prevent water and soil loss caused by water erosion, rain splash erosion, etc. The ecological bag provides a suitable growth environment for vegetation, and the bag body has the effect of fixing soil and protecting roots for the vegetation. The soil insulation and moisturizing effect are conducive to the survival and growth of vegetation.

4.2.2 soil improvement

(1) Foreign soil improvement

Applicable objects: mainly for sites with poor site conditions, thin soil layers or no topsoil layer. Main technical measures: Purchase base soil from outside the site, transport it to the mining area, add inoculants evenly to the base soil, and cover the soil with 30-50cm in suitable areas; at the same time, make full use of the plant row space and plant nitrogen-fixing plants to improve the soil.

(2) Soil stabilization and improvement

The soil solidification stabilization method is to mix the contaminated soil with a solidifying agent in a certain proportion, and then mature to form a solid mixture with low permeability. At present, the commonly used curing agents are mainly silicate, blast furnace slag, lime, fly ash, etc. Advantages and disadvantages: The effect of pollution control is obvious, and there is no destructive technology. However, there are many influencing factors, including pollutants' chemical composition, quantity of pollutants, water content, ambient temperature, etc. These factors can affect the binding force between pollutants and the curing agent and affect the curing effect.

(3) Fertilizer Improvement

Specifically designed for wasteland with a thick soil layer but high or low soil pH and poor soil fertility. Organic fertilizer improvement is mainly aimed at soils with a small amount of soil pH adjustment but poor soil fertility. Generally, soil improvement matrix fertilizers formed by composting and composting the residues of dead branches and fallen leaves are used. principal technical measures For different soil conditions, choose different fertilizers and improvement methods. The fertilizer improvement technology can be used together with foreign soil improvement technology. Advantages and disadvantages: chemical fertilizer improvement can quickly improve the physical and chemical properties of the soil, but after the application of chemical fertilizers, it can cause groundwater pollution due to soil erosion or water infiltration and leaching. Organic matter improvement is a soil improvement method with minimal side effects, but the production time is long and the price is high, which increases the construction cost.

(4) Plant improvement

It is appropriate for complex and changing wastelands with poor soil quality. Plant-level planting and restoration are adopted according to different soil qualities, mainly including nitrogen fixation, sand fixation, water purification of soil erosion, and water fixation. Advantages and disadvantages: The damaged ecology can be restored in place, but the time period is relatively long.

4.3. Engineering measures

In line with the development principle of "respecting nature and utilizing nature", making full use of the existing site conditions and minimizing earthwork works while reducing project investment, it well reflects the design concept of "regreening + soil and water conservation", the main project design principle. The engineering projects with the functions of re-greening and soil and water conservation are the main components of the overall layout of the renovation project measures. The main engineering measures are natural restoration, soil reconstruction projects, vegetation reconstruction projects, monitoring and management, and protection.

4.3.1 Soil reconstruction project

The purpose of the soil reconstruction project is to lay the foundation for the later vegetation reconstruction and make the land usable. There are primarily cleaning, leveling, soil improvement, and pit works. Specific measures include site cleaning, site leveling, soil improvement, land ploughing, pit excavation, topsoil covering, and slope cutting.

(1) Site cleanup: mainly for demolishing the structures in various abandoned rare earth mining areas; cleaning up the remaining abandoned earthwork and mining pits; abandoned water pipes and plastic films; and bare ground in various mining areas; backfilling high-level pools; liquid collection pools; liquid injection holes, etc., is mainly cleaned by mechanical cleaning, supplemented by manual labor. According to the on-site investigation, there are still some abandoned brick-concrete structures with high-level liquid distribution pools, mother liquor pools, and other structures in the mining area that need to be demolished, and the remaining abandoned water pipes and plastic film waste earth-rock piles and exposed areas in the remaining sub-mining areas need to be cleaned up.

(2) Site leveling: Mainly fill in the liquid collecting pools, mining pits, and small gullies in each mining area, and give priority to the use of the site to clean up the residual waste earthwork and strip bare land.

(3) Soil improvement: improve the contaminated soil in the mining area. According to the actual pollution situation in the mining area, the comprehensive improvement method of "soil stabilization and stability + foreign soil" is adopted, and the soil conditioner with lime as the main raw material is used to neutralize the acidity of the soil in the rare earth mining area, increase the pH value, and add appropriate organic fertilizer and guest soil. The soil is covered with soil to provide conditions for plant growth. The topsoil stripped in the project area or the earthwork that has been cut and cleared is preferentially used for covering the soil, and the remaining soil is borrowed from the immediate vicinity of the project area or from the surrounding villages outside the project area. Regreening is carried out according to woodland standards.

(4) Land tillage: In order to fully combine the covered topsoil and soil conditioner with the original land, the area where soil improvement is implemented in the mining area is designed to be tilled.

(5) Pit excavation: After the site has been cleared, a pit will be excavated and planted with trees and shrubs.

(6) Slope stabilization: it is mainly to excavate the earth from top to bottom on the slope formed by mining rare earth ore in the mining area. Mechanical excavation is mainly used, and manual excavation is partially supplemented to eliminate the hidden danger of collapse and geological disasters on the slope. Make the slope reach a long-term relatively stable state.

4.3.2 Revegetation Project

The timely biological reclamation of the area to be greened and the rapid restoration of vegetation can effectively control soil erosion and improve the ecological environment in the area. It is a key link in realizing ecological management and restoration of mines. craft.

5. Monitoring measures

Through regular monitoring (testing), problems can be found in time, so that relevant departments can solve the problem as soon as possible, which is conducive to monitoring the implementation of various environmental protection measures and timely adjusting the environmental protection plan according to the monitoring (testing) results. The environmental monitoring (detection) of the mining site includes the monitoring (detection) of the effect of land resources, geological landforms, land reclamation, and plant greening. The supervision (inspection) work shall be organized and implemented by the competent department, and a full-time agency shall be established to strengthen the organizational management and administrative management of the implementation of this plan and accept the supervision and management of the local mineral resources management department.

6. Governance Benefit Evaluation and Analysis

6.1. Ecological Benefit Analysis

One is to reduce soil erosion and improve land quality. Through ecological restoration projects, improving regional soil quality and restoring vegetation by more than 80% can effectively reduce soil erosion in the region and reduce sediment deposition in small watershed channels, dams and surrounding rivers can prevent geological disasters and protect the personal and property of surrounding residents.

The second is to effectively manage the ecological environment. Through the improvement of the physical and chemical properties of the soil in the project implementation area, the functions of water conservation and soil conservation have been significantly improved; the impact of the contaminated soil on the surrounding water bodies has been effectively controlled; the interference of the mining area with the surrounding water source protection areas has been reduced; and the water resources security capacity has been improved; biological diversity has also been effectively protected; the regional ecological environment has been significantly improved; and the ecological barrier function has been stably exerted.

6.2. Economic Benefit Analysis

It can stimulate the employment of local farmers and increase the income of local residents. At the same time, with the continuous deepening of the restoration work and the continuous improvement of the water and soil environmental quality in the project implementation area, the land utilization rate, land output rate, and labor rate can be further improved; the adjustment and upgrading of the agricultural industrial structure and industrial chain can be promoted; and the rural economic development.

6.3. Social Benefit Analysis

Promote the improvement of the quality of the ecological environment around the mining area and bring a strong sense of achievement of a good ecological environment to the surrounding people. At the same time, during the implementation of the project, the government can continuously strengthen the public's awareness of the importance and value of ecological environmental protection through reporting and publicity, and gradually establish ecological value awareness, ecological responsibility and ecological ethics awareness, ecological knowledge learning and education awareness, and green consumption awareness, which promotes the realization of green production and lifestyle and lays an important mass foundation for the protection of lucid waters and lush mountains.

7. Summarize

The treatment of abandoned rare earth minerals is an important embodiment of the practice of the theory of "clear water and lush mountains are gold and silver mountains," which is conducive to improving the ecological quality of the project area and its surrounding areas, maintaining biodiversity and ecosystem stability^[14, 15], and is of great significance to ensuring the safety of water supply and building a solid ecological barrier. Therefore, it is very necessary to control the abandoned rare earth mines.

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