Environmental Problems and the Use of Vetiver Grass for Revegetation in Rare Earth Mine , South China

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Abstract : China now supplies about 95 percent of the world's consumption of "Rare Earth"(RE),It has bring great benefits and cause a series enviroment pollution as well. This paper gives a brief history of RE mine exploitation in South china.The impacts of RE mining on enviroment were investigated and the characteristics of its soil erosion were summarized.To control soil erosion in abandoned area of RE mine,local people are using several plants such as *Albizia corniculata* ,*Paspalum notatum*, *Pennisetum purpureum* , planting native species. However it was difficult to survive. A study was conducted using Vetiver grass technology at the Daping county, Guangdong Province.

Results showed that soil organic matter increased from 0.20% to 0.74%, hydrolysable N decreased from 320 mg/kg to 43 mg/kg, So_4^{2-} decreased from 13.1 mg/kg to 7.46 mg/kg,EC values decreased from 0.46 ms/cm to 0.062 ms/cm,No_3^- decreased from 203 mg/kg to 10.2 mg/kg,available K and total S varied slightly; pH values of water increased and NH_3-N, No_3-N ,So_4^{2-} of water decreased remarkably; Therefore,the Veiver grass technology is a effective way for soil erosion and water pollution control in RE mine of South china.

Key words : RE mine , revegetation , environment pollution ,soil erosion, native plants

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1 INTRODUCTION

China is the world's largest RE producer and consumer in the world, supplies about 95 percent of the world's consumption of "RE", China's rare-earth processing capacity expanded from 50,000 tons per year in 1995 to 200,000 tons per year in 2005. China also produced 65,000 tons of rare-earth products (46,700 exported), including 32,000 tons of high-purity individual rare-earth oxide. Guangdong and Jiangxi province, the RE is of the ionic absorption type which is absorbed on clay particles at ionic state only found in China.Due to its advantages in exploiting and components,an upsurge had been appeared from 1986 to 1999. It has bring great benefits and cause a series enviroment problems as well.The history of ion-absorbed RE exploiting has evolved through four phases in South China:

- Ion-absorbed RE ore was first found in Longnan area, Jiangxi Province,China in1968,and named after ion-absorbed RE in 1970;
- First generation "pond leaching" stage, leaching by Nacl, subside by oxalic acid in 1970-1984;
- Second generation,new process of producing RE, leaching by NH_4So_4, subside by NH_4Co_3 in 1975-1985;
- In-situ leaching stage in 1986-1995.

Vetiver Grass with its unique morphological, physiological,ecological characteristics and its tolerence to adverse conditions, has a key role in the area of soil erosion control and environmental protection. Experiment site for the present study was at Daping RE Mine. Main aim of this project was to use vetiver for revegetation and alleviate environmental pollution caused by exploiting RE mines in South China.

2 ENVIRONMENTAL PROBLEMS CAUSED BY RE

2.1 Large amount of vegetation destroied

Open ponds exploiting technic has been used in South China from the 1970s. First cut down trees and shrubs, removal surface soil. According to investigation RE exploiting depth often for 10-20m, even more deeply.To produce 1 ton rare-earth oxide,160-200m^2 vegetation has been destroyed, the eco-environment is continuously worsen.

2.2 Soil Erosion

Soil erosion is a another environment problem. The local people calls the RE exploiting for"move mountain sports". To produce 1 ton rare-earth oxide will bring 1600-3000 tons tailing sands. Heavy rainfall can exceed the infiltration capacity of a soil resulting in water flowing across the soil surface. Heavy rainfall on bare soil can cause the soil surface to seal which further reduces the soil's infiltration rate. Rainfall then results in surface water run off.Erosion will remove the soil first, few plants will grow in the soil again. Without soil and plants the land becomes desert-like and unable to support life.

- loss of nutrients required for plants to grow;
- loss of organic matter, which plays a vital role in sustaining the desirable physical and chemical characteristics of the soil;
- bringing subsoil problems, such as sodicity,
- reduce stream clarity;
- make water unsuitable for irrigation;
- require treatment of water for human use; and
- increase land flooding .

2.3 Water pollution

To produce 1 ton rare earth oxide,1000-1200 tons wastewater will discharg,Wastewater contains much NH_3-N,No_3-N,So_4^{2-} when applied to agricultural land in excess amount,threrby leading to pollution ground water by acid wastewater.Because of most mines have no wastewater processing facilities, most wastewater from RE mines has been discharged directly in natural water,causing worse situation for water pollution.

- poisonous ground water,drinking water
- poisionous food animals (due to these organisms having bioaccumulated toxins from the environment over their life spans)
- unbalanced river and lake ecosystems that can no longer support full biological diversity

2.4 Air Pollution

To get rare earth oxides ,sediment must be heating.Burning produce much sulphur dioxide, carbon dioxide and suspended particulate matter (SPM):

- Sulfur dioxide can lead to lung diseases.
- SPM cause lung damage and respiratory problems.

3 ENVIRONMENTAL APPLICATIONS OF VETIVER

Over the past two years a series of research projects conducted at Daping RE Mine,located at the northeast of Guangdong, about 400 km from Guangzhou,near Daping county,Xingning City. The highest annual rainfall is 1447.3-1602 mm, the mean annual temperature is 19.4-20.4_. There were 40 RE mines in Daping County, which account for 60% of the total mines in Xingning City. Soil erosion is very serious problem in these areas. The trial site, had a gradient of 30-50°.

4_MATERIALS AND METHODS

The engineering measurement was conducted first and then the biological method. The engineering measure was dig up a 100 cm wide channel on the top of slope to disperse upper runoff. The biological method was to plant vetiver along contour line in May,2005 and April ,2006. Contour platforms with a width of 30-40 cm,and planting ditches with of 15 cm were first built on a row spacing of 80 cm,and then vetiver was planted at 10-15 cm spacing,3-5 tillers for each slip. After planting water quality,soil chemical properties and the changes of vegetation community were investigated.

5 RESULTS AND DISCUSSION

5.1_Water Quality Improvement

Table 1 indicates that pH values of water increased from 3.12 to 4.82,NH_3-N decreased from 204.3(N mg/L) to 81.3(N mg/L), No_3-N decreased from 78.35(mg/L) to 53.6(mg/L) ,So_4^{2-} decreased from 497.5(mg/L) to 308.5(mg/L). The result shows that water quality have been improved after palnting Vetiver grass.

5.2 Soil Chemical Properties Changes

Table 2 shows that soil orgnic matter increased from 0.20% to 0.74%, hydrolysable N decreased from 320 mg/kg to 43 mg/kg, So_4^{2-} decreased from 13.1 mg/kg to 7.46 mg/kg,EC values decreased from 0.46 ms/cm to 0.062 ms/cm,No_3^- decreased from 203 mg/kg to 10.2 mg/kg,available K and total S varied slightly;

Table 1 Water quality improvement after planting vetiver

Time after planting (months)	pH	So_4^{2-} (mg/L)	NH_3-N(N mg/L)	No_3-N(mg/L)
0	3.12	497.5	204.3	78.35
6	3.99	432.0	119.2	65.96
12	4.82	308.5	81.3	53.60
_	6-9	250	2.0	10

_: China's standards for ground water quality (GB 3838-2002)

Table 2 Soil chemical properties changes after palnting vetiver

Parameter	Ph	orgnic matter %	hydrolysable N mg/kg	available P mg/kg	available K mg/kg	total S %	So_4^{2-} mg/kg	No_3^- mg/kg	EC ms/cm

S1	4.30	5.6	180	--	100	0.038	8.05	2.84	0.048
S2	4.31	0.2	320	--	36	0.017	13.1	203	0.46
S3	4.48	0.74	43	12	36	0.018	7.46	10.2	0.062

S1:Original soil S2:Mineral soil S3: Vetiver's rhizosphere soil (12months after planting)

5.3 Vegetation Diversity Varieties

Eco-environment has been improved after planting Vetiver grass and suitable growth condition for the nativer plants created. Eight native species, *Borreria latifolia, Gynura crepidioides,* Blechnum orientale, *Sphenomeris chusana, Paspalum conjugatum,Ageratum conyzoides, Miscanthus chinensis* and *Hypericum chinensis* were found in Vetiver hedge. The result of this experiment has shown that Vetiver grass acts as a pioneer plant growing and provides micro-climatic conditions where native species may become established.

Table 3 Vegetation diversity situation after planting vetiver

Species	Description	Original habitat
Borreria latifolia	perennial herb	upland crop fields, and waste land
Gynura crepidioides	annual herb	moist soil and waster land
Blechnum orientale	fern	under forest,shurbs
Sphenomeris chusana	fern	under forest,shurbs
Paspalum conjugatum	perennial herb	on acidic, low-nutrient soils.
Ageratum conyzoides	annual herbhighly	adaptable to different ecological conditions
Miscanthus chinensis	perennial herb	sun plant
Hypericum chinensis	annual herb	sun plant

6_SUMMARY

The result of this study had showed that the use of Vetiver Grass for revegetation in RE mine area was practical. Results showed that soil orgnic matter increased from 0.20% to 0.74%, hydrolysable N decreased from 320 mg/kg to 43 mg/kg, So_4^{2-} decreased from 13.1 mg/kg to 7.46 mg/kg,EC values decreased from 0.46 ms/cm to 0.062 ms/cm,No_3^- decreased from 203 mg/kg to 10.2 mg/kg,available K and total S varied slightly; pH values of water increased and NH_3-N, No_3-N ,So_4^{2-} of water decreased remarkably; The Veiver grass technology is a effective way for soil erosion and water pollution control in RE mine of South china.

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A Brief Introduction to the First Author

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