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Eco-friendly mining in the Himalaya: a case study of Kharidhunga magnesite deposit, Nepal

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ABSTRACT

Mining is one of the core sector industries which plays a positive and significant role in the process of country's economic development causing some unavoidable environmental impacts. Environment has become a key issue and today have transgressed the national boundaries and have now become a part of the global concern. We need eco-friendly mining for sustained development and better quality of life with minimum negative impact on environment without any threat to the future generation. In short, a balance has to be struck between development, environment and mining. Nepal has very short history of commercial mining and existing mines are small in size, located in hilly terrain and are being mined by opencast method. The mining activities may cause serious environmental degradation if proper techniques, management policies and practices are not utilised in time. This paper presents the holistic environment promotional effects which have been introduced at Kharidhunga magnesite mine.

INTRODUCTION

Location

The Kharidhunga magnesite and talc mines are located in the district of Dolkha of Janakpur zone about 112 km in north-east of Kathmanu in route to Jiri (Fig. 1). Kharidhunga is situated at an elevation of 2700 m (amsl) at latitude 27 42' N and longitude 85 57' E. It is at the crest of a local watershed with water draining to the north and west to the Sunkoshi river and to the south towards the Tamakoshi River. It is bounded by steep mountain slopes and deeply incised streams. Slopes, particularly to the northwest of the magnesite, are developed by cultivated terrace thus, drainage and erosion controls are crucial to the maintenance of this very vulnerable agricultural land. Population pressure is heavy with isolated agrarian based villages being located sporadically throughout the area.

Climatic Condition

Local climatic conditions at Kharidhunga site are some what extreme due to high altitude 2700 m amsl. Summer temperatures may reach or exceed 28°C while winter temperatures average 5°C. The night temperatures may fall down to -5°C. The low temperatures have very adverse effect on the performance of mining equipment and living conditions of human beings. Precipitation occurs mainly during the rainy season between June and September, but snowfalls of over two feet occur sporadically during December and January month. Severe frost action occurs regularly during the winter period from December through March and the season is very windy. The most severe climatic occurrence from environmental degradation point of view at this site is rainy or monsoon period. During this season, June through September, 4000 mm of rain fall occurs. This is a particularly significant due to the nature of the industrial development at this stage.

Resources

Nepal is having large reserves of crystalline magnesite of all grades in the order of 300 million tonnes. The outcropping rocks in the vicinity of the deposits are metamorphosed and consist of augen gneiss, quartzite, phyllite and dolomite. The deposits have suffered from several step faulting, folding and joints. Faulting has divided the deposits into several blocks and it sometimes increases or decreases the

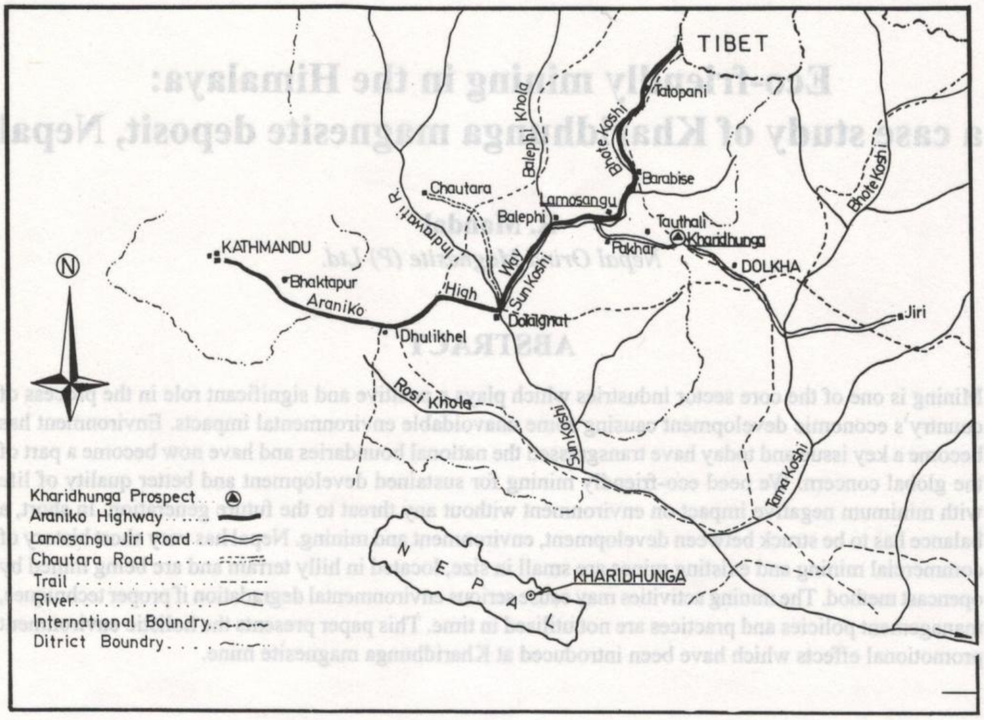

Fig. 1: Location map of Kharidhunga Magnesite deposit.

overburden and also creates problem in environment protection work. Faulting, folding and jointing have adverse effect on mining and grade of magnesite. The deposit is said to be syn-sedimentary in origin (ESSEN, 1973).

Mining Methodology

At Kharidhunga, mining is done by opencast benching method adopting Loader-Dumper combination in a systematic and scientific manner with a series of 5 m high benches. It is a semi-mechanized and labour intensive mine. Labourers are used for mining of talc and its chipping, sorting, grading and loading. In case of magnesite mining after primary or secondary blasting, labourers are used for secondary breaking, sorting, chipping, grading, stacking and loading. The blast holes of 100 mm diameter or 32 mm diameter are drilled and blasted using conventional explosives. The overburden is considerably high during the development phase of mining and it mainly consists of topsoil and talcose soil mixed with soft rock. The overburden is brought to a suitable dumping place while the low-grade magnesite is kept separately. Magnesite and talc are brought to Lamosangu about 35 km from the mine. Magnesite is being burnt in a shaft kiln to convert it into DBM. Talc is ground to 300 mesh in the Raymond mill and sold in to local market.

ENVIRONMENTAL ISSUES

Exploitation of the mineral resources is essential for improving the living standards of the growing population. From time immemorial, human beings are depending on minerals and forest for their survival. Even today, some of our tribes are solely depending on the forest for their livelihood. Today the tribes who have been living on "shifting cultivation" are demolishing the forests and causing heavy damage there of so, with the advent of civilisation the burden on forests has increased because of the population explosion and their increasing needs. With the advancement in technology we should be able to arrest the environmental degradation and find ways and means of improving the environment for the betterment of the society.

Unlike other industries, mining operation can be carried out in the areas where mineral/ore deposits are available; and we have no influence on the location of the mineral deposits. The most of mineral deposits occur mostly in forest area, thus mining operations are bound to degrade the forest and disturb the ecological balance. Therefore, it is necessary to minimise the damage and degradation, and even improve the environment with proper planning. Here, an effort has been made to identify the environmental impacts of the Kharikhunga Mine and safety measures to be taken for environment protection and future direction in a very high altitude and adverse climatic condition mining operation in the Lesser Himalaya. Air, water, sound pollution and ground vibrations have been found within the permissible limit, due to small size of excavation and blasts therefore, have not been discussed here.

Land Degradation

Land is the most vulnerable natural resources. It can be easily damaged but difficult to regenerate. Therefore mining activity should take proper care for protection of land. Kharidhunga mine has 2.56 km^2 lease area and about 60 % is mineralised zone and balance 40 % is non-mineralised zone. Presently the mining operation has disturbed about 100 hectares land directly both at mining and overburden disposal areas including infrastructure development. In order to minimise the disturbed land area at Khardhunga mines, mining operation has been concentrated in a very limited area. The area, which will not be used for mining within next twenty years, is proposed to be afforested. Land reclamation has been planned during mining/excavation itself by phasing out the areas so that the waste generated in future years can be dumped in the exhausted areas and there by reclaimed (Mandal, 1992). The present mining work is being done block wise to facilitate one block for mining and the exhausted block for reclamation of land. However, the Mine has not yet reached this stage. The slope of the exhausted mined benches and pits will dictate its uses for recreation, lake biomass plantation, agriculture or any other uses.

Erosion, Sedimentation and Landslide Control

Erosion is the process of detachment and transportation of soil materials by erosive agents such as wind, water and ice. Erosion and sedimentation are natural processes that are unusually gentle actions releasing controlled amount of silt from watersheds to receiving streams. Nepal is having variable topography, steep landform and violent rivers. It is estimated that Nepal is losing about 240 million m^3 of soil annually, which is equal to 1.63 mm of soil removed from surfaces of 147,181 km^2 of the country. If one excludes the snow and rock areas, where no significant erosion occurs and Terai, where no erosion occurs (rather, it is Sedimentation), the thickness loss works out to 2.38 mm. This enormous soil erosion in the watershed is the source of sediments to the rivers. This further causes rise of riverbeds, which in turn leads to frequent floods and river shifting. Landslide is the downward sliding or falling of the earth mass, rock or the mixture of the two under gravity and frequently occurs when the material is saturated with water.

In the Kharidhunga mine, the mining operation is likely to accelerate natural processes of erosion, sedimentation and landslide especially due to high altitude, steep topography, high rainfall weak rock formation and geological disturbances. In order to minimise the impacts due to erosion, sedimentation and landslide, bioengineering techniques have been adopted. Bioengineering refers to the utilisation of natural materials, such as grasses, shrubs and trees for the protection, restoration and improvement of the environment. The following protection works have been done in this context.

i) A series of check dams have been constructed in the streams originating from mining. These check dams are periodically cleaned and sediments are dumped at favourable place, levelled and stabilised.

ii) The streams having incompetent rock base and flowing along fault are filled with low grade magnesite boulders in order to prevent deepening of the stream beds. This has been found quite effective and cheaper solution to prevent river erosion.

iii) Mining benches are also the main source of soil erosion. The loose waste and overburden are being washed away by the rainwater during monsoon. This problem has been overcome by correcting bench slope. All the mining benches are cut and dressed to have gentle slope to prevent slope failure and soil erosion. All the loose, excavated soil is brought to a predetermined topographical favourable place (waste disposal area) before monsoon and compacted by Dozer.

iv) The drains are made in benches, quarry roads, and other places in order to avoid soil erosion. As far as possible, water is discharged over hard surface. Main mine road has been provided with leakproof drains. All the visible cracks and voids in the mining area have been sealed to avoid water penetration and landslide. Cross-drains or culverts have been provided in the main mine road. In case of slid portion, extra catch drains above the top of the cut face/slide of the road/ bench slope have been provided above the ground surface to control the excessive runoff.

v) Revegetation and afforestation have also been tried for prevention of soil erosion in certain areas. Due to high altitude and extreme cold weather, growth of plants have been found very slow. Pine, utis and populus have been planted in colony area and found quite effective. Turfings in conjunction with toe wall have been done at several critical points on sloping surfaces for soil erosion, slope stabilisation and landslide prevention. Gabion walls in conjunction with slope correction and turfing have been used to protect infrastructures.

Solid Waste Management

The present mine plan and mine development work have been done to exploit N-E and N-W zones of Kharidhunga Mines. The reserve of high-grade magnesite including both zones is about 15 million tonnes and the total waste and overburden is about 5 million cubic meters. To meet our present requirement of raw magnesite and talc, the total waste and overburden is about 100,000 m^3 per annum. This is a very small quantity compared to any large scale openpit mine of the world but its proper management is vital due to typical location of mine in a very difficult climatic conditions and mountainous topography. The overburden consists of different layers of topsoil, talc and low-grade magnesite mixed with talcose rock, including top phyllitic schist. The characteristic of the overburden is very typical in the sense that it consists of mostly soil mixed with talc, which decreases the internal angle of the friction and has very low angle of repose specially in wet condition. Talc acts as a lubricating media for landslide, mud flow and soil erosion on hill slopes. The talcose nature of soil overburden also minimises the retaining capacity of the structures due to very low angle of repose of the filled overburden.

In order to minimise the environmental impacts due to waste and overburden, the following work has been done at Kharidhunga Mine:

1) Waste and overburden area has been well chosen in the closed valleys, which are almost devoid of any vegetational growth, as a result of which the impact on existing flora in the area will be kept to the minimum level.

2) Retaining structures like gabion walls and sedimentation dam have been made in order to avoid slope failure, mud flow, erosion and to stabilise the new slopes suiting to site condition. This is of course first phase of application of bioengineering technology.

3) Prior to dumping of waste and overburden at dumpsite, the topsoil is removed by Dozer and kept separately. This operation facilitates the binding between the new soil and original ground surface, which is free from organic layers. Attempts are made to spread the topsoil on the newly filled surfaces. The compaction, levelling and terracing are done by Dozer.

4) Due attention is given to the topography of the dumping site and its present physical configuration and physical properties of waste and overburden to decide the filling area for that particular type of waste and overburden. Sometimes, blending of talcose soil has to be made with non-talcose soil for better stability and compaction. Advantage of low-grade magnesite boulders are taken for stabilising sloping of newly filled areas.

5) Drainage pattern is very important for this particular site. Proper drains are made manually during monsoon for safer discharge of water in streams. The terraces are made

with very gentle slope and water is allowed to flow via a sedimentation pond to main streams. Most of the solids are settled in the pond, where water gets stagnant and flows to main stream through a long hume pipe laid under the sedimentation dam.

6) The existing dump yard is proposed to be reclaimed after its filling to optimum capacity, slope correction, terrace formation, toe protection, revegetation, and afforestation.

Socio-Economic Impacts

Kharidhunga magnesite mines have so many positive impacts and some of which are listed below:

i) Development of a very remote place where agro-production is too little for survial for the local communities and they have to move place to place to meet their balance expenses of food if the mines are non-operational.

ii) The displaced persons were quite few who were rehabilitated outside the mining lease area, where the land cost was cheaper after payment of the attractive compensation.

iii) The mine is semi mechanised which labour-intensive and has created employment opportunities to local people.

iv) Drinking water and schooling facilities have been made available to the local communities.

v) Infrastructures like electricity and road facili slide. Employment opportunity in the mines is shifting on mining from low yield agriculture. Thus, Kharidhunga mines help in preventing vast deforestation, land degradation and erosion by providing employment to the local communities.

The only socio-economic negative impact is the population pressure at the site and resulting deforestation.

Future Directions

Mining and environment protection works have to be done side by side. The environment protection work will include:

i) Repair and maintenance of the existing tailings dam, check dams, main roads and drains.

ii) Planting of mineralised areas not to be mined in the next 20 years plus non-mineralised areas within the mining lease which had been previously cleared for agriculture.

iii) Spreading of topsoil on reclaimed areas and the planting of appropriate species.

iv) Construction of new check dams for landslide prevention work and dust management.

v) Cleaning of the tailings dams so as to accommodate more reject fine solids and to facilitate the management of tailings.

vi) Turfing at critical areas in the leasehold.

vii) Drains shall be made for prevention of landslide and erosion control.

viii) For erosion control purposes and as far as practical, no heaps of loose soil and waste shall be left on the benches during the rainy season.

ix) Bench slope and overall pit slope shall be maintained within safety limits in order to control slope failure.

x) Safety devices like helmet, hand gloves, safety boots etc. shall be used for workers' safety.

xi) Water shall be sprayed at quarry roads and waste disposal points for dust prevention.

xii) Any other environmental problems arising from the mining operation shall be taken care of.

CONCLUSIONS

Nepal has to exploit its mineral resources to develop its infrastructure and to create employment opportunities in remote places like Kharidhunga, to minimise the trade deficit and also to maximise its national income. Mining industries are resource based and environmentally fragile; therefore, eco-friendly mining is the only solution to overcome the situation. Community consultation and project awareness campaigns are important for getting public support and successful operation of the mining industry specially located in a very remote place like Kharidhunga. Kharidhunga magnesite and talc mines have now become the basic needs for the local community where agriculture yield is very less and population pressure is high and the people have to demolish large forest area for their livelihood. Air, water and sound pollutions and ground vibration in Kharidhunga mines are at low level due to small size of excavation and blasts. Environmental protection work has to be done side by side along with mining of talc and magnesite. Unplanned mining practices done in the past have resulted in environmental degradation all over the world and we have to learn lessons from those mining operations and implement the cleaner technology.

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REFERENCES

ESSEN, 1973, Investigation of the Kharidhunga Magnesite deposit, v. I.

Mandal R., 1992, Kharidhunga Magnesite Mine Plan Phase II