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Mining in Shekhawati Region: A Threat to Environment

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ABSTRACT

Shekhawati is a semi-arid historical region located in the northeast part of Rajasthan, India. The region was ruled by Shekhawat Rajputs. Shekhawati region comprises the districts of Jhunjhunu, parts of Sikar that lies to the west of the Aravalis and Churu. It is bounded on the northwest by the Jangladesh region, on the northeast by Haryana, on the east by Mewat, on the southeast by Dhundhar, on the south by Ajmer, and on the southwest by the Marwar region.

Environmental effects of mining can occur at local, regional, and global scales through direct and indirect mining practices. Mining can cause in erosion, sinkholes, loss of biodiversity, or the contamination of soil, groundwater, and surface water by chemicals emitted from mining processes. These processes also affect the atmosphere through carbon emissions which contributes to climate change. Some mining methods (lithium mining, phosphate mining, coal mining, mountaintop removal mining, and sand mining) may have such significant environmental and public health effects that mining companies in some countries are required to follow strict environmental and rehabilitation codes to ensure that the mined area returns to its original state.

Key words: shekhawati, mining, climate change, groundwater, implosives

INTRODUCTION

Mining is surface examination of a mineralised area normally gives an idea of the mineralisation. The old working gives considerable significances of the primary minerals worked out and the nature, size, shape and disposition of ores. It also gives an idea of cut-off grade of the ancient miners and also the mining conditions which may be expected to be encountered in exploratory mining. The study enunciates the position of ancient mining and metal-processing activities in the Shekhawati region. It brings forth the structure-inference concerning location, function, distribution and trend at regional scale with a view to understand ecological adaptation and cultural changes through time. The ancient mining and metal-processing activities were carried out to probe its relation with the archaeological sites. The study has revealed 19 ancient mining-areas and 14 metal-processing activity areas. Hence, this region gives ample of evidence of exploitation of metals by the inhabitants in different periods.

Metal mining is practiced in India since time immemorial. The mining for gold, silver, copper, lead zinc, iron metals and alloys are mentioned in ancient religious literatures. In Rajasthan metal mining is being conducted since ancient past, the testimony of which are numerous mine sites, mine waste dumps, slag heaps and remains of furnaces or retorts. Colonel James Todd (1894) indicated the importance of mining in Rajasthan. He mentioned working mines of silver-tin in Zawar, copper in Dariba and lead near Gwalior. Study of the old metal mines, which are popularly known as old workings, started in Rajasthan by Geological Survey of India during British period. The research area is confined between the parts of Sikar and Jhunjhunun districts and also known as Shekhawati region of Rajasthan. Shekhawati is a semi-arid region located in the northeastern part of Rajasthan. It encompasses the administrative districts of Sikar and Jhunjhunun. From the administrative and geographical point of view Shekhawati is limited to Sikar and Jhunjhunun districts only. The study area, Sikar and Jhunjhunu District display mosaic of land features, which forms five distinct units: rocky highlands, pediment zone, rocky peneplains, alluvial plains, and aeolian plains. It also exhibits vast accumulation of quaternary sediments of fluvial and aeolian origin. Rocky Highlands represent discontinuous hills and ridges belonging to the Aravalli hill range. These hills are Raghunathgarh hill, Danta Ramgarh, Ganwari hill, Dokan hill, Khetri hill, Kakariya hill etc. The rocky highland area is characterized by narrow to wide V-shaped valleys, numerous small streams, and rivulets. Rocky Highlands represent discontinuous hills and ridges belonging to the Aravalli hill range. These hills are Raghunathgarh hill, Danta Ramgarh, Ganwari hill, Dokan hill, Khetri hill, Kakariya hill etc. The rocky highland area is characterized by narrow to wide V-shaped valleys, numerous small streams, and rivulets.

Effects of Mining:

*Soil erosion is mainly caused by excessive rainfall, lack of soil management and chemical exposure from mining. In wilderness areas, mining may cause destruction of ecosystems and habitats, and in areas of farming, it may disturb or destroy productive grazing and croplands. Soil erosion can decrease the water availability for plant growth, resulting in a population decline in the plant ecosystem[2].

*A sinkhole at or near a mine site is typically caused from the failure of a mine roof from the extraction of resources, weak overburden or geological discontinuities1 (Singh, Kalendra B. 1997). The overburden at the mine site can develop cavities in the subsoil or rock, which can infill with sand and soil from the overlying strata. These cavities in the overburden have the potential to eventually cave in, forming a sinkhole at the surface. The sudden failure of earth creates a large depression at the surface without warning , this can be seriously hazardous to life and property. Sinkholes at a mine site can be mitigated with the proper design of infrastructure such as mining supports and better construction of walls to create a barrier around an area prone to sinkholes. Back-filling and grouting can be done to stabilize abandoned underground workings.

Copper is one of the very essential minerals and considerable alloy of copper is used such as bronze and brass. The bronzes are copper-tin-zinc (88 % Cu, 10 % Sn, 2% Zn) and the brasses are copper-zinc alloys (55 to 99% Cu). The chief gangue minerals of copper ores are rock matrix, quartz, calcite, dolomite, siderite, rhodochrosite, barite and zeolite[4]

In 1881, V Ball in Economic Geology of India has mention that copper ore mining in Khetri and other districts of Rajasthan especially in Dariba and Singhana had been carried out in large scale till the end of 19th century. Lynn Willies, 1992 carried out preliminary investigation at Khetri copper belt in Rajasthan. He came with result that most of existing copper mines sustain the ample of evidence of old workings, which are calibrate C 14 dates around 14th – 19th century and he came out with the observation that the ancient mines can be dated further.

Mining can have harmful effects on surrounding surface and groundwater. If proper precautions are not taken, unnaturally high concentrations of chemicals, such as arsenic, sulphuric acid, and mercury can spread over a significant area of surface or subsurface water. Large amounts of water used for mine drainage, mine cooling, aqueous extraction and other mining processes increases the potential for these chemicals to contaminate ground and surface water. As mining produces copious amounts of waste water, disposal methods are limited due to contaminates within the waste water. Runoff containing these chemicals can lead to the devastation of the surrounding vegetation. The dumping of the runoff in surface waters or in a lot of forests is the worst option9. Therefore, submarine tailings disposal are regarded as a better option (if the waste is pumped to great depth). Land storage and refilling of the mine after it has been depleted is even better, if no forests need to be cleared for the storage of debris. The contamination of watersheds resulting from the leakage of chemicals also has an effect on the health of the local population.

In well-regulated mines, hydrologists and geologists take careful measurements of water to take precaution to exclude any type of water contamination that could be caused by the mine's operations. The minimization of environmental degradation is enforced in mining practices by federal and state law, by restricting operators to meet standards for the protection of surface and groundwater from contamination. This is best done through the use of non-toxic extraction processes as bioleaching.

RESULTS

Mining is surface examination of a mineralised area normally gives an idea of the mineralisation. The old working gives considerable significances of the primary minerals worked out and the nature, size, shape and disposition of ores. It also gives an idea of cut-off grade of the ancient miners and also the mining conditions which may be expected to be encountered in exploratory mining. There are numerous old working areas spread over the entire terrain from Khetri in the north to Zawar in the south and Shakkargarh in the east to Basantgarh in the west. The earliest evidence of old working (C-14 dates of wooden ladder) found at Rajpura Dariba mines. There are no written records available about ancient mining activity, but there are profuse surface indications in the form of mine dumps, slag heaps, retorts, blow pipes, tuyeres, crucibles etc., which attest to the mining and metallurgical knowledge of the ancient miners . The six centers of copper ore deposits in India are: Aravalli region in Rajasthan and north Gujarat, Chhota Nagpur in Bihar, Garhwal and Almora in Uttaranchal, Jabalpur in Madhya Pradesh, Kurnool and Agnigundala in Andhra Pradesh and Chitaldurga in Mysore. There are around 165 copper minerals, out of which only seven are known from India . Among the seven, Chalcopyrite is commonly observed copper mineral. A pure chalcopyrite contains 30.5% Copper, 30.6% Iron, and 39% Sulphur. In the Aravalli's, chalcopyrite ore deposit are observed near Khetri, Babai, Singhana, Akawali, Dariba, Dev Bari, Delwara, Kotri, etc. In Aravalli region at Khetri, Babai, Dariba, and Singhana, chalcopyrite belt are continuous for about 25 km. All these copper ore deposits are delineated with ancient mining. All these copper ore deposits are delineated with ancient mining. Based on physical characters and use, the ancient metal mines are classified into three main categories:

1. Open Mines are open in nature and occur as irregular pits to trenches, and show shallow to moderate depth. Some of these might be trial pits. Generally these are filled-up by rubble, soil or vegetal material.
2. Shallow Mines occurs as vertical shafts with circular openings, narrow in diameter but deep. These are mostly situated close to the mine debris and seen in cluster of more than one. These are sub-classified as lined with stone mortar and lime, or un-lined. The lined shafts were used for haulage of ore or dewatering the mine when working below the water table. The un-lined shafts were meant for mine ventilation.
3. Deep Mines are inclines or tunnel-like openings meant for entering into underground mine.

The ancient metal mines can be classified based on the metal excavated: Copper mines, Multi-Metal mines (lead–zinc–copper), Iron mines, Gold mines and Silver mines. Ancient mining and metallurgical research was carried out to probe its relation with the archaeological sites. In the present study 19 ancient mining-areas and 14 metal- processing activity areas have been identified. Hence, this region gives the evidence of exploitation of metals by the inhabitants in different periods. Ancient Mines like Akawali Area located in "Akawali Pahar" in Babai village, Nim ka Thana (Khetri Maudh) in Khetri taluka of Jhunjhunun district. The exploration revealed ancient mining areas comprises pit mines only. In these clusters, one cluster comprises 5 mines while the second cluster comprises 4 mines. The area drained by ephemeral streams and the landform shows agricultural land on the northern side of the site. The site has revealed ancient mine area comprises open pit mine along with the drainage channels, which was used to extract water from the pits and narrow shafts lead into big stopes.

The landform shows number of sand dunes around the sites. A multi-cultural site revealed Mesolithic and Chalcolithic materials. Along with this cultural material, the site has shown open mine, which indicate mining area used by the ancient miners. The Khetri mine areas are the part of Khetri copper complex , the surface manifestations of the sulphides mineralization in this area are quite prominent and present in the form of gossans, old workings and huge heaps of metal slags.Ephemeral streams running across the village drain the site, which shows hills and open scrub area. The area also gives the evidence for soap stone mine within the vicinity of Kolihan Mine, Nim ka Thana (Khetri Maudh).

At present Hindustan Copper Limited is drilling out the deep mine having the depth around 434 feet. At the footsteps of the open mine, there are opening for old working on its wall, which shows heaps of mine spoil, gossan bands and malachite staining . The mining industry contributes between 4 and 7% of global greenhouse gas emissions.

Air pollutants have a negative impact on plant growth, primarily through interfering with resource accumulation. Once leaves are in close contact with the atmosphere, many air pollutants, such as O_3 and NOx, affect the metabolic function of the leaves and interfere with net carbon fixation by the plant canopy. Air pollutants that are first deposited on the soil, such as heavy metals, first affect the functioning of roots and interfere with soil resource capture by the plant. These reductions in resource capture (production of carbohydrate through photosynthesis, mineral nutrient uptake and water uptake from the soil) will affect plant growth through changes in resource allocation to the various plant structures[20]. When air pollution stress co-occurs with other stresses, e.g. water stress, the outcome on growth will depend on a complex interaction of processes within the plant. At the ecosystem level, air pollution can shift the competitive balance among the species present and may lead to changes in the composition of the plant community. In agro ecosystems these changes may be manifest in reduced economic yield.

Sub-surface mining often progresses below the water table, so water must be constantly pumped out of the mine in order to prevent flooding. When a mine is abandoned, the pumping ceases, and water floods the mine. This introduction of water is the initial step in most acid rock drainage situations.

Acid rock drainage occurs naturally within some environments as part of the weathering process but is exacerbated by large-scale earth disturbances characteristic of mining and other large construction activities, usually within rocks containing an abundance of sulfide minerals. Areas where the earth has been disturbed (e.g. construction sites, subdivisions, and transportation corridors) may create acid rock drainage. In many localities, the liquid that drains from coal stocks, coal handling facilities, coal washeries, and coal waste tips can be highly acidic, and in such cases it is treated as acid mine drainage (AMD). The same type of chemical reactions and processes may occur through the disturbance of acid sulfate soils formed under coastal or estuarine conditions after the last major sea level rise, and constitutes a similar environmental hazard.

The five principal technologies used to monitor and control water flow at mine sites are diversion systems, containment ponds, ground water pumping systems, subsurface drainage systems, and subsurface barriers. In the case of AMD, contaminated water is generally pumped to a treatment facility that neutralizes the contaminants[21]. A 2006 review of environmental impact statements found that "water quality predictions made after considering the effects of mitigation largely underestimated actual impacts to groundwater, seeps, and surface water".

Heavy metals are naturally occurring elements that have a high atomic weight and a density at least 5 times greater than that of water. Their multiple industrial, domestic, agricultural, medical and technological applications have led to their wide distribution in the environment; raising concerns over their potential effects on human health and the environment.

Naturally occurring heavy metals are displayed in shapes that are not promptly accessible for uptake by plants. They are ordinarily displayed in insoluble shapes, like in mineral structures, or in precipitated or complex shapes that are not promptly accessible for plant take-up. Normally happening heavy metals have an awesome adsorption capacity in soil and are hence not promptly accessible for living organisms. The holding vitality between normally happening heavy metals and soil is exceptionally high compared to that with anthropogenic sources.

Dissolution and transport of metals and heavy metals by run-off and ground water is another example of environmental problems with mining, a former copper mine that is now

With open cast mining the overburden, which may be covered in forest, must be removed before the mining can commence. Although the deforestation due to mining may be small compared to the total amount it may lead to species extinction if there is a high level of local endemism. The lifecycle of mining coal is one of the filthiest cycles that causes deforestation due to the amount of toxins, and heavy metals that are released soil and water environment. Although the effects of coal mining take a long time to impact the environment the burning of coals and fires which can burn up to decades can release flying ash and increase the greenhouse gasses.

Specifically strip mining that can destroy landscapes, forests, and wildlife habitats that are near the sites. Trees, plants and topsoil are cleared from the mining area and this can lead to destruction of agricultural land. Furthermore, when rainfall occurs the ashes and other materials are washed into streams that can hurt fish. These impacts can still occur after the mining site is completed which disturbs the presences of the land and restoration of the deforestation takes longer than usual because the quality of the land is degraded.

The environmental factors of the coal industry are not only impacting air pollution, water management and land use but also is causing severe health effects by the burning of the coal. Air pollution is increasing in numbers of toxins such as mercury, lead, sulfur dioxide, nitrogen oxides and other heavy metals[17]. This is causing health issues involving breathing difficulties and is impacting the wildlife around the surrounding areas that needs clean air to survive. The future of air pollution remains unclear as the Environmental Protection Agency have tried to prevent some emissions but don't have control measures in place for all plants producing mining of coal.

Water pollution is another factor that is being damaged throughout this process of mining coals, the ashes from coal is usually carried away in rainwater which streams into larger water sites. It can take up to 10 years to clean water sites that have coal waste and the potential of damaging clean water can only make the filtration much more difficult[9].

Soil texture and water content can be greatly modified in disturbed sites, leading to plants community changes in the area. Most of the plants have a low concentration tolerance for metals in the soil, but sensitivity differs among species. Grass diversity and total coverage is less affected by high contaminant concentration than forbs and shrubs. Mine waste-materials rejects or traces due to mining activity can be found in the vicinity of the mine, sometimes far away from the source. Established plants cannot move away from perturbations, and will eventually die if their habitat is contaminated by heavy metals or metalloids at a concentration that is too elevated for their physiology. Some species are more resistant and will survive these levels, and some non-native species that can tolerate these concentrations in the soil, will migrate in the surrounding lands of the mine to occupy the ecological niche. This can also leave the soil vulnerable to potential soil erosion, which would make it inhabitable for plants.

Plants can be affected through direct poisoning, for example arsenic soil content reduces bryophyte diversity. Vegetation can also be contaminated from other metals as well such as nickel and copper. Soil acidification through pH diminution by chemical contamination can also lead to a diminished species number. Contaminants can modify or disturb microorganisms, thus modifying nutrient availability, causing a loss of vegetation in the area. Some tree roots divert away from deeper soil layers in order to avoid the contaminated zone, therefore lacking anchorage within the deep soil layers, resulting in the potential uprooting by the wind when their height and shoot weight increase. In general, root exploration is reduced in contaminated areas compared to non-polluted ones. Plant species diversity will remain lower in reclaimed habitats than in undisturbed areas. Depending on what specific type of mining is done, all vegetation can be initially removed from the area before the actual mining is started.

Cultivated crops might be a problem near mines. Most crops can grow on weakly contaminated sites, but yield is generally lower than it would have been in regular growing conditions. Plants also tend to accumulate heavy metals in their aerial organs, possibly leading to human intake through fruits and vegetables[7]. Regular consumption of contaminated crops might lead to health problems caused by long-term metal exposure. Cigarettes made from tobacco growing on contaminated sites might also possibly have adverse effects on human population, as tobacco tends to accumulate cadmium and zinc in its leaves[16].

Habitat destruction is one of the main issues of mining activity. Huge areas of natural habitat are destroyed during mine construction and exploitation, forcing animals to leave the site.

Animals can be poisoned directly by mine products and residuals[10]. Bioaccumulation in the plants or the smaller organisms they eat can also lead to poisoning: horses, goats and sheep are exposed in certain areas to potentially toxic concentration of copper and lead in grass. There are fewer ant species in soil containing high copper levels, in the vicinity of a copper mine. If fewer ants are found, chances are higher that other organisms living in the surrounding landscape are strongly affected by the high copper levels as well. Ants have good judgement whether an area is habitual as they live directly in the soil and are thus sensitive to environmental disruptions[23].

Humans are also affected by mining. There are many diseases that can come from the pollutants that are released into the air and water during the mining process. For example, during smelting operations large quantities of air pollutants, such as the suspended particulate matter, SO_x, arsenic particles and cadmium, are emitted. Metals are usualldonoy emitted into the air as particulates as well. There are also many occupational health hazards that miners face. Most of miners suffer from various respiratory and skin diseases such as asbestosis, silicosis, or black lung disease.

Furthermore, one of the biggest subset of mining that impacts humans is the pollutants that end up in the water[(2)] which results in poor water quality. About 30% of the world has access to renewable freshwater which is used by industries that generate large amounts of waste containing chemicals in various concentrations that are deposited into the freshwater. The concern of active chemicals in the water can pose a great risk to human health as it can accumulate within the water and fishes. There was a study done on an abandon mine and this mine was not active to many years yet the impact of how metals can accumulate in water and soil was a major concern for neighboring villages. Due to the lack of proper care of waste materials 56% of mortality rate is estimated within the regions around this mining sites, and many have been diagnosed with esophageal cancer and liver cancer. It resulted that this mine till this day still has negative impacts on human health through crops and it is evident that there needs to be more cleaning up measures around surrounding areas[17].

The long-term effects associated with air pollution are plenty including chronic asthma, pulmonary insufficiency, and cardiovascular mortality.

DISCUSSION

The implantation of a mine is a major habitat modification, and smaller perturbations occur on a larger scale than exploitation site, mine-waste residuals contamination of the environment for example. Adverse effects can be observed long after the end of the mine activity. Destruction or drastic modification of the original site and anthropogenic substances release can have major impact on biodiversity in the area. Destruction of the habitat is the main component of biodiversity losses, but direct poisoning caused by mine-extracted material, and indirect poisoning through food and water, can also affect animals, vegetation and microorganisms. Habitat modification such as pH and temperature modification disturb communities in the surrounding area. Endemic species are especially sensitive, since they require very specific environmental conditions[10]. Destruction or slight modification of their habitat put them at the risk of extinction. Habitats can be damaged when there is not enough terrestrial product as well as by non-chemical products, such as large rocks from the mines that are discarded in the surrounding landscape with no concern for impacts on natural habitat.

Concentrations of heavy metals are known to decrease with distance from the mine,[7] and effects on biodiversity tend to follow the same pattern. Impacts can vary greatly depending on mobility and bioavailability of the contaminant: less-mobile molecules will stay inert in the environment while highly mobile molecules will easily move into another compartment or be taken up by organisms. For example, speciation of metals in sediments could modify their bioavailability, and thus their toxicity for aquatic organisms.

Biomagnification plays an important role in polluted habitats[4]: mining impacts on biodiversity, assuming that concentration levels are not high enough to directly kill exposed organisms, should be greater to the species on top of the food chain because of this phenomenon.

Adverse mining effects on biodiversity depend a great extent on the nature of the contaminant, the level of concentration at which it can be found in the environment, and the nature of the ecosystem itself[20]. Some species are quite resistant to anthropogenic disturbances, while some others will completely disappear from the contaminated zone. Time alone does not seem to allow the habitat to recover completely from the contamination. Remediation practices take time, and in most cases will not enable the recovery of the original diversity present before the mining activity took place.

The mining industry can impact aquatic biodiversity through different ways[24]. One way can be direct poisoning; a higher risk for this occurs when contaminants are mobile in the sediment or bioavailable in the water. Mine drainage can modify water pH, making it hard to differentiate direct impact on organisms from impacts caused by pH changes. Effects can nonetheless be observed and proven to be caused by pH modifications. Contaminants can also affect aquatic organisms through physical effects: streams with high concentrations of suspended sediment limit light, thus diminishing algae biomass. Metal oxide deposition can limit biomass by coating algae or their substrate, thereby preventing colonization.

Factors that impact communities in acid mine drainage sites vary temporarily and seasonally: temperature, rainfall, pH, salinisation and metal quantity all display variations on the long term, and can heavily affect communities. Changes in pH or temperature can affect metal solubility, and thereby the bioavailable quantity that directly impact organisms. Moreover, contamination persists over time: ninety years after a pyrite mine closure, water pH was still very low and microorganisms populations consisted mainly of acidophil bacteria[19].

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