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"DISTURBANCE TO ECOLOGY AND EXCESSIVE MINING: A STUDY IN SPECIFIC REFERENCE TO LEGAL CONTROL MECHANISM"

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ABSTRACT

Mining continues to be a dangerous activity, whether large-scale industrial mining or small-scale artisanal mining. Not only are there accidents, but exposure to dust and toxins, along with stress from the working environment or managerial pressures, give rise to a range of diseases that affect miners. I look at mining and health from various personal perspectives: that of the ordinary man (much of life depends on mined elements in the house, car and phone; as a member of the Society for Environmental Geochemistry and Health environmental contamination and degradation leads to ill health in nearby communities); as a public health doctor mining health is affected by many factors, usually acting in a mix, ranging from individual inheritance—genetic makeup, sex, age; personal choices—diet, lifestyle; living conditions—employment, war; social support—family, local community; environmental conditions—education, work; to national and international constraints—trade, economy, natural world); as a volunteer (mining health costs are not restricted to miners or industry but borne by everyone who partakes of mining benefits—all of us.

INTRODUCTION

'Mining" probably conjures several images. One familiar scene is of the old West, where prospectors blast the sides of mountains, tunnel through the earth, or pan at a river's edge for gold. Another is of environmental impacts of acid mine drainage from older mines that did not benefit from modern technology and management practices. The common view of mining is of environmental degradation. Few individuals outside the industry are aware of modern mining practices and associated business, environmental, and public policy issues or of how mining companies are responding to today's environmental challenges.

The extraction of ore from underground or surface mines is but one stage in a complicated and time-consuming process of producing minerals. A mine is born through exploration and mine development. This is followed by mining and beneficiation, and ends with mine closure and rehabilitation. A mining company must undertake all mining activities to be viable and competitive. It must adhere to a comprehensive set of rules of regulations.[1]

GENERAL PRINCIPLES

Most states have comprehensive environmental regulations for the mining industry. Federal regulations aimed directly at the mining industry have not yet been put into a place, but broad-based statutes such as the Clean Water Act, Clean Air Act, National Environmental Policy Act, and numerous others apply to mining activities. Further, the federal government has been addressing the cleanup of historic mine wastes through its Comprehensive Environmental Response, Compensation,

and Liability Act (CERCLA, otherwise known as Superfund). More recently, the U.S. Environmental Protection Agency (EPA) has used CERCLA to address active mining operations. There is no evidence that this attention from the general public or the regulators will diminish, and mining companies in the United States can expect an ever-increasing level of scrutiny and control over their operations.

Proper concern and regard for the environment is one of the fundamental elements of any successful business strategy. Given the increasing level of attention to environmental issues in the mining business, it is even more critical today, as illustrated by the experience of Kennecott Corporation. Kennecott Corporation—a wholly owned subsidiary of RTZ, PLC, the largest mining company in the world—manages mining operations and exploration activities across North America, including several low-sulfur coal mines in the Powder River Basin, precious metals mines in the Southeastern and Western United States, and copper mines in Wisconsin and Utah. Kennecott is best known for its Bingham Canyon copper mine near Salt Lake City, which generates one-sixth of the total U.S. copper production. Kennecott's environmental strategy is based on

[1] Measham, T.G.; Haslam Mckenzie, F.; Moffat, K.; Franks, D.M. An expanded role for the mining sector in Australian society? Rural Soc. 2013, 22, 184–194

an environmental policy that builds from a foundation of compliance with the legal, regulatory, and consent requirements of the countries and localities in which it operates. The firm's environmental policy attempts to strike a balance between society's need for metals and an environmentally sound approach to operations.[2]

In general, the company's environmental policy dictates that its operations go beyond simply meeting current regulatory standards. The operations must exemplify best contemporary practice for the minimization and, where feasible, elimination of adverse environmental effects. The company does so by

- incorporating environmental matters as a basic part of short- and long-range planning for all projects and operations;
- complying with all applicable environmental laws, regulations, and prescribed standards and criteria, and ensuring that its contractors do likewise;
- participating in the development of environmental legislation;
- promoting and, where feasible, implementing new or more effective practices for environmental protection, compliance, and emergency response;
- taking reasonable measures to ensure that Kennecott operations are responsive to the environmental needs of the communities in which they operate; and
- regularly reporting Kennecott's performance on environmental matters through the Board of Directors to RTZ, PLC, Kennecott's parent corporation based in London.

POLICY IMPLEMENTATION

Kennecott's environmental policy is administered by the vice president of environmental affairs whose responsibilities, with the cooperation and support of the other departments within the company, are the following:

Review, approve, and monitor all environmental management and emergency response programs

Assess, coordinate, and monitor the environmental aspects of Kennecott's projects and operations for uniform and consistent compliance with current and anticipated laws, regulations, and standards

Direct environmental planning for and investigations of proposed projects and investments[3]

Direct or review and approve, as appropriate, the preparation of all environmental studies and documentation for all operations, permits, and licenses

Evaluate applicable developments in environmental technology and waste-management practices, and provide technical assistance and guidance for management of environmental programs at each operation

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[2] Oviir, M.; Utouh, L.S. Auditing Mining: Guidance for Supreme Audit Institutions; INTOSAI Working Group on Environmental Auditing (WGEA): Helsinki, Finland, 2010; pp. 1–59

[3] Boadi, S.; Nsor, C.A.; Antobre, O.O.; Acquah, E. An analysis of illegal mining on the Offin shelter belt forest reserve, Ghana: Implications on community livelihood. J. Sustain. Min. 2016, 15, 115–119.

Monitor and assess trends in environmental legislation and regulation and, where appropriate, actively represent Kennecott's interests

In conjunction with each operation or project, develop and implement community relations programs that provide open, timely, and responsive communication on environmental programs

Inform and advise Kennecott management on environmental compliance and performance and the technical and economic implications of environmental programs and developments

Develop and maintain a continuing education and training program in environmental matters for all staff

The managers of all operations, projects, or activities are responsible for carrying out this policy in accordance with the direction and guidance of the vice president of environmental affairs.

Impact and mechanism of mining to the environment

The impacts of mining on the environment could take place at region, district, and worldwide via indirect and direct mining operations. Environmental impacts of mining could occur on the account of mine damage mechanisms suchlike erosion of mine dumps, sinkholes, and the pollution of surface water, groundwater and soil through the chemicals released from mining processes and the extinction of species worldwide. In addition, these processes have negative effect on the atmosphere because of the release of carbon, which in turn influences biodiversity and the quality of human health .

Erosion of mine waste, particularly tailing and waste rock could greatly affect the quality of surface water. Considering that practices of mining and mineral processing usually generate extensive amounts of solid and liquid waste, mobilised metals could directly come from open mine tailings or mine dumps. Furthermore, non-vegetated surface-mined lands shelter substantial zones in different parts of the world. Therefore, it is evidently shown that substantial discharges could take place due to other external turbulences (such as transformation of in-channel topography or construction of roads and infrastructure) at mining sites[4]. The contamination of the environment through heavy metal from mining takes place through different distinguished passageways via operational timescales and associated effects on ecosystems. Sediment-bound metals are placed in topographic sinks situated in the mining regions or at lower-lying natural flood plains and wetlands during transportation. Remobilization can then take place through any kind of erosive processes. Furthermore, the extent of river loading by metals can be effected by in-channel storage and erosion, underlining the complication of the dispersion of noxious waste, storage and remobilization in mining regions.

[4] Bansah, K.J.; Dumakor-Dupey, N.K.; Kansake, B.A.; Assan, E.; Bekui, P. Socioeconomic and environmental assessment of informal artisanal and small-scale mining in Ghana. J. Clean. Prod. 2018, 202, 465–475.

Monitoring of life-cycle of the vadose and saturated zones contained in the dump area

Monitoring is a crucial factor of engineered barricade scheme design and operation. Monitoring systems at waste control locations could be intended for different kind of media like surface water, soil, air and groundwater. The monitoring of vadose zone lifecycle is responsible for early detection of risk; and afterward, embark on a remedial action prior to the degradation of recoverable water resources by the contaminants. The monitoring of up-gradient and down-gradient of the dump at saturated zone life-cycle is done for the determination of site impacts, validation of short and long period projection and the efficiency of prevention and remediation schemes in the dumping location.[5] The range of factors that should be integrated into the monitoring scheme are centred on: (1) the determination potential used for characterizing waste, utilized for the getting polluted water out of the generation and release of macro- and trace component from the discarded mine waste. (2) The constituents generation channels, interactivities and movement in the anthropogenic and natural vadose and saturated zones in the definite hydrogeological and hydrologic conditions.

Vadose zone is a geologic media that spans from the land surface to the groundwater table of the first unconfined aquifer. It comprises of several coupled physical, geochemical, and microbial procedures; the interaction of these procedures is very complex to comprehend, particularly from the perception of remediation. The characterization of vadose zone and monitoring approaches are normally utilized for the purpose of developing a comprehensive and precise assessment of the inventory, dispersal, and transportation of pollutants in the unsaturated zone; development of enhanced predictive methods for liquid flow and conveyance of pollutant. Furthermore, the characterization of vadose zone and monitoring approaches are employed for remediation systems design such as, barrier systems and stabilization of buried wastes in situ. Other approaches are to cover systems for waste isolation, in situ treatment barriers of dispersed contaminant plumes etc., chemical treatment technologies design for the destruction or immobilization of highly concentrated contaminant sources such as, metals, explosive residues, radionuclides, and solvents, which are accrued in the subsurface.[6] Arora et al. presented a summary of methodologies that can be used for monitoring and modeling of vadose zone dynamics occurrence amidst complex and heterogeneities features, together with the integration of transient conditions. In order to develop predictive models for the processes in the vadose zone, a conceptual framework is needed. Typically, conceptual models describe the key physical processes that occur in the vadose zone; conceptual models also describe the manner in which these processes work hand in hand or control the system. Generally, the conceptual physical framework comprises of different processes and characteristics suchlike a hydrologeologic setting which describes the hydro-stratigraphic and structural details; and relevant hydrological and biogeochemical processes. Modeling results could be utilized to offer early advice on the contamination of soil and groundwater prior to when problems arises.

[5] Jain, T.; Jamali, D. Looking inside the black box: The effect of corporate governance on corporate social responsibility. Corp. Gov. Int. Rev. 2016, 24, 253–273

[6] Hentschel, T.; Hruschka, F.; Priester, M. Global Report on Artisanal and Small-Scale Mining. Report Commissioned by the Mining, Minerals and Sustainable Development of the International Institute for Environment and Development. No 70. 2001

Furthermore, the model could offer scientific and regulatory standing to environmental management decision-making process in order to improve the protective measure taken for human health and the environment. Likewise, the recent advancements in numerical modeling of hydro-geochemical responses, transportation of contaminant in saturated-unsaturated media, and groundwater flow offer some advanced software packages that provide a prospect for a credible long-term prediction for the prevention and remediation schemes in the dumping site. The above listed practical principle is better than a prescriptive approach when it comes to dealing with the problem of mine dump.

Mine dump pollution monitoring/Mine dump design

Pollution monitoring is the making of several sporadic observations in order to quantify change with a particular type of pollution over time. Mine dump pollution monitoring is the series of discovery of the presence of mine dump and magnitude of pollution caused by mine dump. Several monitoring methods can be used depending on the type and environment of the pollution. Some monitoring methods involve visual observation and judgement, analysis of hydro-chemical composition of mine water and electronic detection. Some of these methods are manually operated, while others are automatic computer based methods. Site-specific toxicological test is also necessary in order to assist in pollution monitoring. This will target the types and level of elements in the mine dump for the purpose of demonstrating the efficiency of the remediation used in reducing contributions of AMD to the mine dump.[7]

Quite a number of researchers have used several monitoring methods to monitoring mine dump pollution. Pehoiu et al.examined the rate of the dose and the level of contamination of four mining tailing dumps. Samples were evaluated in situ for dose rate. The values of optimum concentrations in samples were sustained by the dose rate and pollution factor, which were computed as ratio between the content of metal in sample and the earth, crust metal. Further investigations were done by utilizing diverse physico-chemical approaches for additional complex data. The study confirmed the existence of chemical groups in soil composition together with the heavy and radioactive metals, which was expressed by pollution factor. The existence of the oxidation of metal sulphides in La Concordia mine was investigated and established by Nieva et al.. This mine produced a concentrated acidic solution that comprises of arsenic, dissolved metals and sulphate that drains into the creek and produces high concentrations of dissolved metals, upsurge salinity and lower pH values caused by the mine refuse. The discharge of arsenic in the course of sediment-water interaction was analyzed in 10 months. The data they obtained showed that primary arsenic-bearing minerals are arsenian pyrite and polymetallic sulfides. Nonetheless, the fast discharge of arsenic from suspensions of the investigated sediments in water, gave the impression of been connected to the dissolution of extremely soluble (hydrous) sulfates, since it was found in samples of the efflorescences that shield the whole site. Nieva et al. [90] further investigated and analyzed the magnitude of metal and acid discharged in tailing dumps of La Concordia Mine

[7] Dubi ´nski, J. Sustainable development of mining mineral resources. J. Sustain. Min. 2013, 12, 1–6

via surveys of field and laboratory experiments. Static tests were done for the purpose of predicting the capability of the sulphidic refuse to produce acid, while XRD, SEM/EDS analysis and sequential extraction methods were used to identify Cu-, Zn-, Fe- and Pb-bearing stages in the wastes. The metals analyzed were adsorbed onto Fe (hydr) oxides or form less soluble hydroxyl sulfates. Metals resulted from these phases were slowly discharged into water body, hence demonstrating a prospective long-lasting source of metal ions contamination. The application of monitoring methods is an optimistic discovery of the existence of mine dump and degree of pollution instigated by mine dump. The utilization of these monitoring methods will continue as long as there is proof of increasing number of published articles on the subject matter, indicating increasing research in this area.[8]

Mine dump management strategies for some selected countries

The management of dust coming from mine dump is very important both in developed and developing countries, for the purpose of avoiding environmental contaminant and the spread of disease. Principally, the open mine dump in an uncontrolled sites, open burning of mine dump fractions and the leachate formed from the final disposal site should be properly managed. Dust coming from mine dump get worsen in slum regions that have high density population, traffic, air and water contamination, if the dump is not properly managed. Emissions of dust and noise have the capacity to produce a substantial ecological impact of the mining industry in the course of all processes connected to surface mining, mineral processing, and waste dumping. The modern method used in managing noise and dust emission in mines involves a good comprehension of the type of source. It also involve the use of effective and present-day measures of mitigation and engaging in best practice in managing noise and dust for their emission reduction to a level below restricted values. Impact identification of dust and noise, evaluation, and control are part of impact assessment and management process strategy, and they have several interrelating and contending activities.

Minimization of AMD by controlling waste rock dumps

In the course of the process of burning mine dump, in the area that has hot gaseous emissions contacting the ambient air, some of the mineral phases comprising of fluorine, selenium, arsenic, iron, lead, and tin, together with other chemical elements get condensed. This occurrence create mats of concentrated efflorescent minerals on the surface of the wastes. In addition, highly detrimental organic condensates and organic components that are soluble in water are also found on the surface of the wastes. Large number of different mineral phases such as pure metals, phlogopite, letovicite, mascagnite, metalloids and their alloys are produced during the course of burning processes. The dispersion of trace elements in the unburnt portion of the dump is primarily governed by the organic matter content, sulfides, silicates and carbonates. On the other hand, their dispersal is primarily governed by the content of silicates, phosphates and sulfates, in the burnt

[8] Bermúdez-Lugo, O. The mineral industry of Sierra Leone. Miner. Yearb. Area Rep. Int. Rev. 2012 Afr. Middle East 2015, 3, 33

portion of the dump. Furthermore, metals and metalloids takes place in the form of oxides and oxidized alloys.[9]

Recovery of Mineral and Energy Resources from mine wastes

Generally, mine wastes are considered to be of no importance during production, though mine wastes can still have some treasured mineral and energy resources imbedded in them. Hence, the composition and the quantity of mine waste exclusively depend on human decisions. Usually, these decisions are established by putting the economic into considerations. The adjustment of the cut-off grade that segregates ore from waste rock, and the extent of recovery that segregates a mineral concentrate from tailings and leached ore depend on the working costs and the prices of metal. For every stage in the course of mining operation, a portion of the treasured metal being extracted is lost as a result of process inefficiencies. In addition, some treasured materials are lost due to the fact that they are not of economic interest. Hence, the need to reprocess mine wastes in order to recover the lost treasured metal and other valuable materials. Valuable materials in the wrong concentrates can be taken as impure materials..

Global perspectives on the management of mine waste

The prospective environmental threat of mine waste that spawned from mining processes, together with a growing societal awareness of the need to effectively treat mine waste, have resulted to an advanced importance of global research. However, until date, there is no complete analysis of the developments in this area research. Aznar-Sánchezet al. recently filled this gap by analyzing the dynamics of the research into mining waste and its sustainable management from 1988 to 2017 on a global scale.

CONCLUSION

Mine dumps are responsible for the risk of contaminated soil, air and surface waters used for drinking, irrigation and domestic usage. The undesirable effects of mine dumps is evident in the release of toxic substances that resulted in huge health challenges such as asthma. The management of acid mine drainage in mine dump is a very vital strategy to avoid environmental pollution and the spread of disease. Technologies that involves the re-use, recycling and reprocessing have the capacity to generate income to offset the costs of remediation and build a financial asset. The source of reducing and recycling of waste and novel methods for waste management presently used in mining was discussed for some countries. Putting environmental laws, regulations and standards into practice and enforcing them is also another way of controlling waste rock dumps in order to minimize of AMD. Some prediction approaches for the control of mineral exploration and environmental assessment will also help in curbing the problems of mine dump and tailing.

[9] SLEITI. Sierra Leone Extractive Industries' Transparency Initiative (SLEITI) Report. Extractive Industries' Transparency Initiative, Sierra Leone SLEITI 2016. Available online: htttps://eiti.org/document/sleiti-3016- report. (accessed on 15 February 2020)

Different techniques and methods have been developed for monitoring radioactive encountered during the course of mining. Studies have shown that novel techniques have significant contributions in enhancing radiological safety of population and environment. Furthermore, monitoring system and the use of management techniques will assist in combating the impact of mine dump, stockpiles and tailing on the environment as it will offer the required information needed for assessing the performance and the degradation state of barrier systems. In addition, it will monitor areas where model developments used in predicting contaminants will presumably be released and offer information on the determination of the needs for facility maintenance and rehabilitation.

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