JOURNAL OF HARVESTING ENERGY
(Year) Volume / Issue: (2022) I / II
ISSN: 2583-3197
Page: 65-73
http://adyapublications.co.in/JHE.php

METAL MINE ENERGY SUSTAINABILITY

Dutta S.K[1*], Dutta S[2], Prasad S[3]

[1]Retired Ex. DDG, DGMS Hyderabad, India
[2]Mining Engineer, AKS University, Satna, India
[3]Assistant Professor, AKS University, Satna, India

Email Id*: sandeep0908024@gmail.com

ABSTRACT
Mining industries supply the majority of the materials used to construct infrastructure and everyday equipment, as well as to generate vast amounts of energy. Mining, on the other hand, is the human activity that has caused the most environmental harm and has been linked to enormous social ramifications and disparities. Regardless, mining is very important to our future. Several mining industries are evaluated, spanning from phosphate to uranium, as well as their current consequences and issues. In connection to environmental health and sustainable development, the mining industry's history and environmental cleanup, as well as contemporary mining and challenges, as well as future mining and society, are all investigated. It is determined that existing mining techniques must alter and contribute to more equitable community development, as well as greater natural resource and ecosystem protection, in order to be environmentally friendly and meet the goals of sustainable development.

Keywords
Metal Mining, Sustainable Energy, Contemporary Methods, Fuel Cell Cycle.

I. INTRODUCTION

From aluminium cans to electronic chips mining industries provide many of the basic elements for technology we use every day, including electronic chips in phones and computers. Metal mining evolved gradually over millennia, with periodic "rushes" for certain minerals (silver, gold, radium, and so on) corresponding with demand booms. Until recently, traditional mining techniques may be conveyed in a few of steps: hold a permit, collect the ore, trade the metal and then walk away and establish a new mine someplace else after the resource was depleted [1]. Not unexpectedly, mining is one of the activities of humans with the greatest consequences for the environment and society.

Received- 13/06/2022 *Revised-18/06/2022* *Published-27/06/2022*

Please cite this article as: Dutta S.K, Dutta S, Prasad S, “METAL MINE ENERGY SUSTAINABILITY”, Journal of Harvesting Energy, Volume 1 Issue 2 , pp 65-73, 2022.

A number of mining industries are addressed in this article to illustrate mining techniques, their consequences, and contemporary issues. Basic metals (such as Al, Fe, Mn, and Ni) and energy sources are mined (uranium) needs enormous expenditures and is capital intensive, and is mainly performed by large corporate firms. However, precious metals (e.g., Au, Ag, and Ta) are frequently sought by a heavy mineral sands mining in various places. All have significant environmental consequences [2]. Today, new mining operations must utilise lessons learnt from prior mining operations in order to meet social and development goals in a more efficient and ecologically sustainable manner.

This study examines the historical significance of mining operations and how essential they will be in the future, at least for some types of mining, as well as the implications of mining, mining trends, and how they will avoid jeopardising sustainable development.

II. MINING INDUSTRY

Mining is not a new industry; it may have started in the Neolithic (Eneolithic) eras to obtain the first metals for tool making. Many mines were exploited throughout Classical Greece and the Roman Empire for producing iron, lead, copper, gold and other valuable metals. Mining has evolved over time, with growing the quantity of fossil fuels and metals that have been removed in proportions generally proportionate to available labour and therefore to human population [3]. Mining could increase further in the nineteenth century thanks to technological advances, particularly in explosives and machines, and skyrocketed in the twentieth century. In the final part of the twentieth century, mining in the case of oil, metals and natural gas began in new and difficult conditions, such include ice-covered places and the ocean's deepest depths. This tendency will likely continue, and new boundaries may be crossed in the near future [4].

METAL MINING SECTORS

Basic metals, fossil fuels, and precious metals are the three categories of mining ores. Metals such as iron have long been mined, whilst others, such as aluminium, have just recently been mined. The overall amount of metals extracted and utilised in applications from the Earth's crust is immense [5].

Other metals, such as uranium and non-renewable energy sources, are mined for energy and are primarily or entirely consumed in their uses; hence, recycling is not applicable as previously stated (reprocessing may still be able to recover wasted uranium in the case of nuclear spent fuel). Although both base metals and fuels have finite resources on Earth, one distinction is that humankind may be able to survive on only a portion of the Earth crust resource for certain metals (base metals), whereas for other energy minerals and fossil fuels, the tendency is to use them until the earth crust deposits are completely depleted. If current consumption patterns continue, geological supplies of finite energy sources will be consumed, putting future growth and development at jeopardy [6].

BASE METAL MINING

Copper, nickel, iron, manganese, zinc, and other metals are included, although iron (Fe) and aluminium (Al) are the most often consumed metals and account for the majority of metals collected in society. Iron has been mined since the dawn of humanity, and vast amounts of the metal may be found in modern infrastructure. Although aluminium has only been produced since the eighteenth century, it currently plays a vital role in the economy and industry [7]. Take, for example, worldwide critical metal extraction, which climbed by more than 75% between 1970 and 2004, and global industrial mineral extraction, which increased by 53% during the same period. During this time, global aluminium consumption increased by more than threefold, from about 12.5 billion tonnes per year to 38 billion tonnes per year, while global ferrous metal consumption increased more slowly, reaching about one billion tonnes per year in 2014, up from more than threefold in 1974 [8].

The removal of overburden to get access to the metal ores accelerated the release of materials into the environment, resulting in environmental and human health consequences at every stage of extraction, usage, and cleanup. Metal consumption is larger in North America, the European Union, China, and India than extraction, which is tied to their economic growth. The opposite trend was observed in the rest of the world. Some metal reserves, such as iron, which makes about 5% of the Earth's crust, much outnumber what has been collected, ensuring that these resources will be available for a long time. Because this does not apply to all metals, metal recycling is necessary. Recycling non-alloyed metals is straightforward and consumes significantly less energy than mining, extending the life of the resource [9].

Base metal extraction is expensive, and it usually necessitates significant investment, the construction of extensive infrastructure, and has significant environmental consequences.

HEAVY MINERAL SAND MINING

The extraction of zirconium and Rare Earth Elements (REEs) including lanthanum, europium, tantalum, and erbium, which are used in mobile phones, computers, permanent magnets, and other things, has recently emerged into a new mining business. Rare Earth Elements (REE) production increased from around 1000 tonnes per year in the 1950s to 135,000 tonnes per year in 2009, before falling again. The overall upward trend will be continued to serve the electronics and telecommunications industries, as well as to assist the upcoming automation in industry, transportation, and services [10].

China has the highest REE resources and is the largest REE consumer. Outside of China, most REE mining rely on sand dune deposits around African coasts, in South Asia, and in Australia. Sand mining for heavy minerals is already underway off the shores of Bangladesh, India, Mozambique, and Senegal [11].

Wet screening and gravimetric separation are used to extract heavy minerals from sand dunes. In a dynamic fresh water pool, large barges drift around the dunes, rotating the sand. The sand fraction comprising low grade silica, hematite, and carbonates is returned to the beach in the back of the extraction barges. Gravimetric and magnetic technologies are used to extract the heavier minerals from the wet mineral concentration. Heavy mineral fractions such as zircon, garnet, and ilmenite are sent to metallurgical facilities capable of full metal separation as a result of the exploitation [12].

According to current study, heavy mineral sands mining have the potential to pollute the environment with radioactivity. In sand deposits, heavy REE minerals are usually associated with uranium and thorium, and zirconium and REE segregation raises the concentration of those naturally occurring radionuclides in the material fractions formed [13].

Given the rapid expansion of heavy mineral sands mining, developing conservation measures for affected coastal areas, as well as enforcing rules for worker and public radiation protection in connection with the extraction and management of these naturally occurring radioactive minerals, must become a top priority.

URANIUM MINING

Uranium mining is the extraction of radioactive ores that are valuable as a source of fuel for the nuclear power sector in developed countries. As with other energy commodities, the geographic distribution of uranium deposits and users does not coincide, and mined uranium is traded and transported globally. The world's uranium reserves were estimated to be 5.7 million tonnes, and at current consumption rates for a universe of around 450 nuclear reactors utilised for electricity generation, reserves might last over 90 years with current technology and 63,000 tonnes U/yr utilisation. This shows a higher level of resource certainty than is normal for most minerals [14].

Uranium mining is the first step in a succession of uranium-related industries known as the nuclear fuel cycle, which strives to supply suitable fuel for the nuclear industry. These industries are spread throughout various countries.

The mine's uranium ore is processed into yellow cake for export in an adjacent mill. This mining and milling process generates a significant quantity of mining waste and radioactive waste tailings, which contain the bulk of the radioactivity in uranium ore owing to uranium radioactive daughters. The environmental and long-term consequences of these uranium tailings must be properly studied.

Most uranium mining and milling historical sites across the world did not fulfil current radiological protection Safety Standards published by the IAEA and used globally for the safety of staff, members of the public, and the environment, even when simply considering short-term radioactive exposure. Several countries have looked at the environmental effects of past uranium and radium mines. In the United States, Germany, France, and Portugal, for example, tailings and acid mine drainage were discovered to be sources of radioactive contaminants that increased environmental radioactivity in water, soils, and agricultural items. Environmental cleanup efforts at several of these old uranium sites included the relocation of garbage piles, the covering of solid waste, the treatment of radioactive water, and even the replacement of tainted water sources with non-contaminated water brought in from outside. The cleanup of these residual sites is a costly undertaking that is frequently financed with government cash [15].

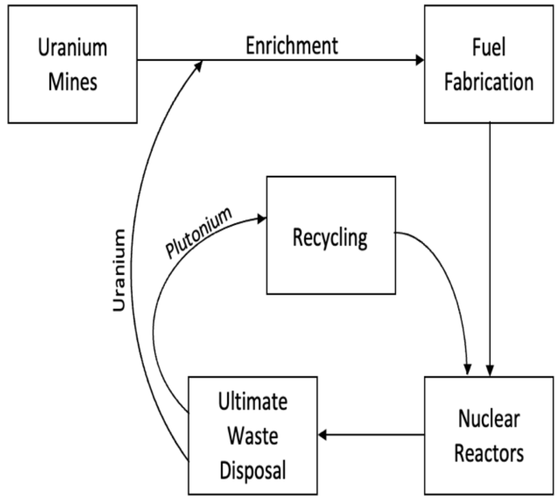

Figure 1: Uranium & nuclear fuel cycle

Concerns about nuclear power plant (NPP) safety, particularly in the aftermath of the nuclear disasters at Chernobyl and Fukushima, have cast doubt on the future of nuclear energy, and several countries have decided to abandon nuclear energy in favour of renewables, despite the fact that renewables may have significant life-cycle impacts and carbon emissions, and require mining for the necessary raw materials, such as REE. A number of African and Central Asian countries have expressed interest in nuclear energy and are planning to start uranium mining.

Typical radiation hazard found in underground uranium mines of India are: -

i) Gamma ray radiation should be within limit of 8 µGy/hr and Radon concentration shall be within limit of 1KBq/m^3.

ii) The Average Annual dose to regular and contractual workers of mine should be within the limit of 20mSv.

Figure 2: Yellow cake production process in uranium

The extraction and production of uranium may be done while adhering to occupational safety regulations that protect employees and the environment from radiation. For uranium mining companies, the current primary challenge is to manage mining and milling in such a way that radiation safety and environmental protection, including post-mine remediation, are considered into commodity prices, as well as to avoid contaminated legacy sites [16].

III. MINE'S ENVIRONMENTAL & SOCIAL IMPACTS

Mining has provided the bulk of the materials presently in the Technosphere, which is defined as the total of infrastructures that support the human population, such as buildings, machines, tools, and so on. According to latest estimates, the mass of the Technosphere might exceed 30 trillion tonnes [17].

The development of Environmental Impact Assessment (EIA) tools aimed at identifying the potential affects and damages caused by improvements in the environment and society has lately assisted in the forecast and evaluation of such projects' benefits, costs, losses, and repercussions. EIA variants have been developed, such as the Strategic Environmental Impact Assessment (SEIA), to aid in evaluating and planning beyond the scope of a single project, and the Radiological Environmental Impact Assessment (REIA) is required for projects containing radioactive materials, such as a uranium mine or nuclear power plant.

The most important implications are the need to address the legacy of uranium mining and to keep risk assessment systems open to review and development, particularly when dealing with the unusual. Metal mining from and near hydrothermal vents in the deep sea might be the next possibility, necessitating the development of EIA and risk assessment methods. At the moment, resolving the environmental repercussions of mining on these ecosystems may be nearly impossible. The implementation of safety measures and rules is a critical step in maintaining the deep ocean's sensitive ecosystems.

MINE SUSTAINABLE DEVELOPMENT

Mining on a large scale grew in popularity in the nineteenth and twentieth centuries, with unintended effects and hidden costs. For a long time, the health consequences of miners' workplace exposure to hazardous chemicals (lung cancer, silicosis, lead poisoning, and so on) were ignored. Until recent time, environmental repercussions on nature and populations in general were not adequately recognised.

As rich metal deposits were depleted and environmental controls were implemented, many mining companies shifted to developing nations where regulations were less rigorous. The adoption of enormous mining operations in emerging nations resulted in countless instances of immense riches for a small group of people, but the socioeconomic status and welfare of the vast majority of the population remained unchanged. Mining impacts, on the other hand, usually deteriorated their living conditions. The new host countries for mining enterprises, developing countries, are modifying and improving their legislation to ensure environmental and public health safeguards.

In addition to official and legal mining authorization, acquiring the social licence from the community, that is, their agreement and commitment to mine in their area, is an important aspect of corporate mining success. The corporate responsibility of mining companies has grown to include sharing the wealth gained by mining with communities, which has been done through investments in regional infrastructure such as schools and hospitals, as well as minimising the repercussions. Mining's future depends on following correct mining practises to protect the environment everywhere, as well as assuming social responsibility in the region's growth and contributing to the community's quality of life.

IV. MINE'S UNCERTAIN FUTURE

Future societies will have equal or even larger demands for water, food, and energy than we have now, hence the availability of these resources should be preserved for future generations. Current economic growth must not deplete existing resources or fail to identify alternate sources of supply, placing future generations at risk of starvation and extinction. This is the core of intergenerational solidarity ethics. Furthermore, as the Brundtland study "Our Common Future" explains, this would jeopardise sustainable development.

As a result, mining is a significant human activity that will continue to respond to social needs, such as repairing and enhancing the Technosphere, but now with the added responsibility that comes with knowledge: responsible resource management and the maintenance of healthy eco-systems capable of supporting human civilization with a high quality of life, both now and in the future.

Current mining issues include remediation of residual effects, adoption of enhanced water resource protection, and generally better environmental and human health care than in the past. Current and future mining ventures must interact with all stakeholders and have proper legal and social support in order to be successful. Locals, particularly in undeveloped and underprivileged areas, want to share and profit from mining's wealth.

Some mining projects have been successful in reaching mutually beneficial agreements with local communities, resulting in favourable socioeconomic and environmental outcomes. This has been done by allowing mine waste to be recycled, rewarding the community for participating in reforestation and clean-up projects contemporaneous with mining activities, and investing in local community capacity building. Although it is already late in many places, stakeholder collaboration and sharing is growing, which may lead to a brighter future for mining as we know it.

V. CONCLUSIONS

Lessons learnt from prior mining activities must be incorporated into new and ongoing mining operations, therefore addressing harmful collateral repercussions on the environment and public health. Because these effects are frequently linked to contamination from tailings produced during and after mining operations, mining project EIAs should consider the mine's entire life cycle, the assessment of negative impacts and societal benefits, and the liability and cost – and thus timely funding provisions – for post-mine environmental rehabilitation.

Because it is now clear that mining often releases enormous amounts of non-targeted chemical components into the biosphere, many of which are dangerous to the environment and humans (e.g. radioelements and toxic metals) and were previously ignored, current mining activities must strengthen processes for environmental and public health protection.

Because it is now clear that mining often releases enormous amounts of non-targeted chemical components into the biosphere, many of which are dangerous to the environment and humans (e.g. radioelements and toxic metals) and were previously ignored, current mining activities must strengthen processes for environmental and public health protection. This recommends that metal recycling should expand, and alternative energy sources should be investigated, in order to decrease environmental repercussions and traditional energy resource depletion. A component of internationally coordinated mineral resource extraction management appears to be essential today to minimise non renewable resource depletion and achieve global sustainable development.

REFERENCES

[1] Jain, R. Z. *Environmental Impact of Mining and Mineral Processing.* Elsevier, Butterworth-Heinemann, pp 146-149, 2016

[2] Reardon, A. C. *Metallurgy For The Non-Metallurgist, 2nd Edn.* ASM International, pp.197-210, 2011

[3] Fernandez-Lozano, J. G.-A.-M. *Using Airborne LiDAR Sensing Technology and Aerial Orthoimages to Unravel Roman Water Supply Systems and Gold Works in NW Spain* pp. 98-110, 2015, https://doi. org/10.1016/j.jas.2014.11.003.

[4] EB. *Encyclopædia Britannica Online*. Retrieved from Encyclopædia Britannica Inc.2017: https://www. britannica.com/technology/mining last accessed 27 October 2021

[5] Gordon, R. B. *Metal Stocks and Sustainability.* Proc. Natl. Acad. Sci. pp. 216-239, 2006

[6] Brown, L. R. *World On The Edge: How to Prevent Environmental and Economic Collapse.* W.W. Norton & Company, pp. 196, 2011

[7] Lima, I. B. *Rare Earths Industry: technological, Economic and Environmental Implications.* pp.222-236, 2016

[8] Schüler, D. M. *Study on Rare Earths and Their Recycling.* The Greens European Free Alliance. pp. 136-146, 2011

[9] Hore-Lacy, I. e. *Uranium for Nuclear Power. Resources, Mining and Transformation to Fuel.* pp. 210-230, 2016

[10] D. G. Rogich, G. R. *The Global Flows of Metals and Minerals* . USGS. pp. 40-72, 2008

[11] M. A. Reuter, C. H. *Metal Recycling: Opportunities, Limits, Infrastructure, A Report of the Working Group on the Global Metal Flows to the International Resource Panel.* UNEP pp. 670-710, 2013

[12] Carvalho, F. P. *Environmental Radioactive Impact Associated to Uranium Production.* Am. J. Environ Sci. pp. 120-131, 2011

[13] Carvalho, F. P. *Radioactivity and Water Quality in Areas of Old Uranium Mines*, pp.140-151, 2016

[14] Carvalho, F. P. *Exposure to Radionuclides in Smoke From Vegetation Fires* . Sci. Total Environment, pp.160-171, 2014

[15] Carvalho, F. P. (2016). *Preliminary assessment of Uranium Mining Legacy and Environmental Radioactivity Levels in Sabugal Region.* pp.40-51, 2016

[16] Jaskoski, M. *Environmental Licensing and Conflict in Peru's Mining Sector: A Path-Dependent Analysis.* World Dev, pp. 310-333, 2014

[17] Carvalho, F. P. (2017). *Mining Industry and Sustainable Development: Time For Change,* Food and Energy Security.pp.310-331, 2017