

## Case Report

# Geology, Mining and Environment with an Overview of Sukinda Chromite Mines

Himadri Bhusan Sahoo\*

Department of Geological Survey of India, Karnataka, India

\*Corresponding author: Himadri Bhusan Sahoo, Geological Survey of India, Karnataka, India. Tel: +919437016424; Email: silu.himadri@gmail.com

Citation: Sahoo HB (2017) Geology, Mining and Environment with an Overview of Sukinda Chromite Mines. J Earth Environ Sci: JEES-125. DOI: 10.29011/JEES-125. 100025

Received Date: 10 July, 2017; Accepted Date: 17 July, 2017; Published Date: 26 July, 2017

### Abstract

Geology and mining are two essential components for economic growth of a country. Geology explores all kinds of minerals and rocks preserved in the earth's crust and mining exploits it, if economically viable and profitable. A country with more economic minerals (ore) has wider opportunities towards economic growth. Though in one side mining creates various positive impacts but on the other side it destroys the natural stability of the environment and at some cases, if no care is taken towards preserving environment, it causes serious issues viz. ecosystem malfunction, deforestation leads to loss of flora and fauna, degradation of land leads to soil infertility and toxic, water pollution by polluting surface water with acid mine drainage and groundwater by contaminating with toxic heavy metals, air pollution by emitting dusts, suspended particles and producing noises from blasting and other machinery works and serious health hazards for people living in the surrounding areas. Sukinda chromite mines located in Jajpur district of Odisha, India is one among those which has a high contribution towards economic growth for India but unfortunately suffers from above critical environmental consequences. In order to combat these environmental consequences, regulatory authorities and acts are made but failed to large extent to achieve the prime goal of mining with sustainable growth. Hence sustainable development (including simultaneous socio-economic development with environmental preservation) becomes a critical demand for better future of mankind and planet earth.

**Keywords:** Chromite; Contamination; Environment; Geology; Pollution; Sukinda chromite mines

### Introduction

Geology has been associated with human since the dawn of the human civilization or even prior to civilization starts. During Stone Age, humans use various stones for their day to day activities which indicate they had the knowledge of different properties of earth materials. With the evolution of human civilization and technology, geology got increasing attention and continues till date for many reasons, the prime purpose of which is to have a comfortable life style with a deeper understating of mother earth and universe. Geology and environment are intricately interconnected. Geology directly doesn't harm to the environment but when mining (those not concerned about its environmental consequence) comes into play, may create feeble to serious imbalance to its surrounding environment and malfunction the ecosystem. Mining of economic minerals are important for the economic growth and development

of a country so it should not be stopped. Humans have altered their environments in pursuit of self-improvement and better opportunities since ancient times, but the scope and impact of these changes are unprecedented today [1]. Nevertheless, technological advancements have yielded positive economic growth, improved standards of living, and provided new ways of protecting human health simultaneously contributed to widespread negative changes in the environment that include global climate change, deforestation, suburban sprawl, ecosystem loss, and increased health risks from exposure to radiation, toxicants, and stress [2].

### Regulatory authorities and ethics

Regulatory bodies are formed by Central government as well as State governments to regulate and mitigate environmental pollutions. Innumerable policies, laws, amendments, are made and conferences and summits are arranged each year with a better vision for a sustainable and healthy environment. Still we are (Mankind) unable to succeed and progress towards goal is sluggish. The

day to day degrading environment is indications of “Acts/Policies” are not implemented properly and were made for just dossier preparation, documentary, authorities’ website display and public information purpose. We humans are staying in various environments all over the world so it’s our prime duty to keep it healthy and better place to live and leave a legacy of sustainable earth for our future generation. Though it is the duty of every individual to keep the environmental clean, simultaneously statutory/regulatory authorities have the major responsibility for protection of the environment coming under their jurisdiction as they have the major role in sanctioning mining lease and construction of industries which in turn degrade the environment.

Like our very own house, it is the responsibility of every individual to keep the surrounding environment healthy for a better tomorrow with a sustainable earth. All want to stay in a clean house with the availability of fresh air circulation, unpolluted land/soil, pure and uncontaminated water and foods because these are the necessary ingredients for a healthy life which leads towards a happy life. It is impossible to get the above healthy ingredients of life without a clean and pure surrounding environment. This situation is worsened adjacent to mining zones and its surrounding areas (Particularly in India) for which proper and serious care need to be taken if at all the regulatory authorities have concern about environment, ecosystem and the society.

### **Sukinda chromite mines: A case study**

Let’s consider about ‘Sukinda chromite mines’ situated in Jajpur district of Odisha, India. Sukinda chromite mines produces ore of chromium (Cr) i.e. chromite ( $\text{FeCr}_2\text{O}_4$ ) which is the only economic source of chromium. Sukinda chromite valley of Odisha is the largest chromite deposit (193 million tons of total reserve) [3] in India and contributes 98% [4] of the country’s chromite ore which is produced by opencast mines. Due to its (Cr) special properties viz. enhancement of harden ability, resistance to corrosion and oxidation, it has a wide range of uses in refractory, metallurgical and chemical industries. Some of the major uses of Cr are manufacturing of charge-chrome, ferro-chrome which in turn are used for making stainless steel and other super-alloy steel.

### **Geology**

Chromite ore is most commonly associated with ultramafic rocks (ultramafic portions of layered mafic rock), which is very prone to alteration. Serpentinite is generally known as the altered rock, derived from silicon (Si) poor and magnesium (Mg) rich ultramafic rock by hydrothermal alteration/metamorphism [3]. Sukinda chromite belt has northeast-southwest strike and forming a V-shaped valley lying between the Daitari hill in the north and Mahagiri hill in the south [5]. Like Bushveld chromite deposit of South Africa, chromites occur in the form of stratiform type of deposit within the Sukinda ultramafic complex. The ultramafic rocks

intruded into the Precambrian metamorphites and were emplaced in two phases. Ultramafic body mostly represented by serpentinised dunite-peridotite with chromite bands and subordinate amount of pyroxenite devoids of chromite mineralization [6]. It extends for nearly 20 km length, from Kansa in the northeast up to Kathapal in southwest with width of about 2-5 km. The different varieties of chromite ore present in the area are massive, banded and spotted, laminated and friable which are predominantly stratiform in nature and was presumably formed in-situ by crystal settling [7].

Due to the occurrence of chromite, serpentinite derived soil contains abnormally high concentration of Cr which can adversely affect the environment and human health. Chromium mostly exists in two stable states in nature, i.e. hexavalent chromium Cr(VI) and trivalent chromium Cr(III). The toxicity and mobility of Cr depends on its speciation. The Cr(III) is mostly immobile and considered to be essential trace element for the living organisms; however, Cr(VI) is highly toxic as it is easily soluble and mobile [3,8] and adversely affect the environment beyond its permissible limit. The permissible limit of Cr(VI) has been set by different Organizations for different media viz. soil, drinking water, industrial sewage etc. According to Bureau of Indian standards (BIS) permissible limit of Cr(VI), for drinking water is 0.05 ppm and for industrial effluent is 0.1 ppm [4]. Cr(VI) a strong oxidizing agent, is potentially mutagenic, carcinogenic, potent inducers of tumors in experimental animals, immunotoxic, neurotoxic, reproductive toxic, genotoxic and can induce a wide spectrum of DNA damage, gene mutations, sister chromatid exchanges and chromosomal aberrations [9].

### **Major environmental consequences**

Sukinda was reported as the fourth most polluted place in the world by Blacksmith Institute of the USA [10]. Air, water and soils are severely contaminated by toxic substances mainly ‘Cr(VI)’ in and around the chromite mines [10]. In the Sukinda mining area, million tons of solid waste have been generated in the form of rejected minerals and overburden material resulting in environmental degradation causing lowering in the water table with deterioration in surface and ground water quality. Godgul and Sahu [12] noted that Cr(VI) concentrations ranged from 58 to 64  $\mu\text{g/l}$  in stream water, Not Detected (ND) to 17  $\mu\text{g/l}$  in well water, and ND to 1791  $\mu\text{g/l}$  in quarry water. Das and Singh [9] reported that increased concentration of Cr(VI) contamination has contributed a major health hazard affecting more than 2 lakh mine workers and inhabitants residing at the Sukinda chromite valley.

Toxic heavy metals like Cr(VI) enter food chains from polluted soil, water and air, and consequently cause food contamination, thus posing a threat to human and animal health [12]. One of the leading daily newspaper [13] of India reported improper disposal of waste in river water by the miners which causes threat to environment and ecosystem malfunction. For example, conse-

quences of Sukinda chromite mines is not only isolated within its surroundings but spreads over hundreds of miles by the Brahmani river, Odisha's second largest river that runs south of Sukinda valley due to improper disposal of mine wastes in its tributaries. Brahmani river is the most polluted river of Odisha because of excessive Cr (VI) exposure, which has multiplied the risk from cancer-causing carcinogenic substances for the 26-lakh people dependent on the Brahmani river. It is also reported more than 80% deaths in heavily mined areas are caused by chromite-related diseases and within 20 km radius of the Sukinda mines, people have no choice but to drink toxic water and inhale chrome dust and suffering from skin, cancer and gastroenteritis diseases frequently [13]. Some of the major consequences of Sukinda chromite mining are land degradation yielding low production, water contamination, the soil pollution with toxic substances, deforestation which in turn accelerates global temperature rise.

### Remedial measures

Background knowledge of the sources, chemistry, and potential risks of toxic heavy metals and their speciation/bioavailability in contaminated soils, water or air is necessary for the selection of appropriate remedial options. Remediation of soil contaminated by heavy metals viz. Cr is necessary in order to reduce the associated risks, make the land resource available for agricultural production, enhance food security, and scale down land degradation problems. Several remedial measures have been suggested by scientists and researchers for removal of the toxic heavy metals. Immobilization, soil washing, and phytoremediation are among the best available technologies for cleaning up heavy metal contaminated soils needs to be practiced in developing countries [14].

Adsorption technique is used by utilizing sorbents viz. activated carbon, biological materials, zeolites, ochre to remove heavy metals from mine discharge/contaminated waters [15]. Development of more efficient technologies is necessary for the treatment of contaminated water especially in and around the mining areas.

The United Nations Environment, Caribbean Office had published one article on 10th January 2017 entitled "Make a Resolution for the Environment" on its website [16] where it is mentioned that "Preserving the environment is not only a national/regional responsibility but also a personal one. Having recognized this, it is our duty to make a life-long resolution to positively impact our environment".

### Conclusion

It is obvious that mankind is progressing towards development by utilizing better mining technologies for ore exploitation but simultaneously destroying its very own environment and making it less sustainable for living in future. Policies, authorities, dialogues, debates and summits are essential for development but unless it is implemented/ obeyed properly it is of no importance for a sustainable earth.

Time has already alarmed us to think better on this aspect and make our legacy more sustainable for a better future because earth is not only for humans but for all other creatures existing and about to evolve in future. Nevertheless, government and regulatory authorities have much wider responsibility than any individual in preserving environment and making sustainable development for a country and globally as well.

### References

1. Watts N, Maiero M, Olson S, Hales J, Miller C, et al. (2012) Our planet, our health, our future. Geneva: World Health Organization. 1-58.
2. Cabrera LY, Tesluk J, Chakraborti M, Matthews R, Illes J (2016) Brain matters: from environmental ethics to environmental neuroethics. *Environmental Health* 15: 20.
3. Pattnaik BK, Equeenuddin SM (2016) Potentially toxic metal contamination and enzyme activities in soil around chromite mines at Sukinda ultramafic complex, India. *Journal of Geochemical Exploration* 168: 127-136
4. Mishra H, Sahu HB (2013) Environmental scenario of chromite mining at Sukinda valley-A review. *International Journal of Environmental Engineering and Management* 4: 287-292
5. Das S, Ram SS, Sahu HK, Rao DS, Chakraborty A, et al. (2013) A study on soil physico-chemical, microbial and metal content in Sukinda chromite mine of Odisha, India. *Environmental Earth Sciences* 69: 2487-2497.
6. Sahoo RK (1995) Chromite and nickel ore. *Geology and mineral resources of Orissa*. Society of Geoscientists and Allied Technologist, Bhubaneswar.
7. Chakraborty KL, Chakraborty TL (1984) Geological features and origin of the chromite deposits of Sukinda Valley, Orissa, India. *Mineralium Deposita* 19: 256-265.
8. McGrath SP (1995) Chromium and nickel. In: Alloway BJ (Ed.), *Heavy Metals in Soils*. Blackie Academic and Professional, London, pp. 152-178.
9. Das AP, Singh S (2011) Occupational health assessment of chromite toxicity among Indian Miners. *Indian Journal of Occupational and Environmental Medicine* 15: 6-13.
10. BI (2007) The world's worst polluted places, The top ten of the dirty thirty. Blacksmith Institute, New York 16-17.
11. Godgul G, Sahu KC (1995) Chromium contamination from chromite mine. *Environmental Geology* 25: 251-257.
12. He Z, Shentu J, Yang X, Baligar VC, Zhang T, Stoffella PJ (2015) Heavy metal contamination of soils: Sources, indicators, and assessment. *Journal of Environmental Indicators* 9: 17-18.
13. Priya Ranjan Sahu (2015) Odisha's Story about Pollution, Mining and the Environment.
14. Wuana RA, Okieimen FE (2011) Heavy metals in contaminated soils: A review of sources, chemistry, risks and best available strategies for remediation. *International Scholarly Research Network ISRN Ecology*, Volume 2011.
15. Sahoo HB, Tripathy S, Equeenuddin SM, Sahoo P (2014) Utilization of ochre as an adsorbent to remove Pb(II) and Cu(II) from contaminated aqueous media. *Environmental Earth Sciences* 72: 243-250.
16. The cleaner (2017) Make A Resolution for The Environment.