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Environmental Scenario of Chromite Mining at Sukinda Valley – A Review

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Abstract

Sukinda valley in Jajpur district of Odisha contains about 98% of chromite reserve and it is exploited mostly by opencast mining process since 1950. Hexavalent chromium is a highly toxic form of chromium metal mainly used in different industrial applications for its anticorrosive properties.Due to open cast mining process lots of over burden are being generated and leaching from this over burden adds the hexavalent chromium to ground water regime. Ground water in the valley is encountered at a shallow depth in semi-confined aquifer. Hexavalent chromium is carcinogenic beyond permissible limit (0.05mg/l). Therefore there is a threat of contamination of hexavalent chromium to the ground water regime of the valley as well as to the environment. This article reviews the environmental degradation of Sukinda valley due to chromite mining activity.

Keywords: Chromite mine, Hexavalent chromium, Environmental impact, Sukinda valley.

1. Introduction

Mineral reserves are the industrial and economic backbone for a country. The state of Odisha is endowed with vast mineral deposits like coal, chromite, iron ore, manganese ore, bauxite etc.India is the second largest producer of chromites in the world and 98% of total chromite reserves of the country are available in Odisha. Chromite is the principle ore of the element chromium. It is a key industrial mineral used for manufacturing stainless steel because of its very high melting value. It has a wide range of uses in metallurgical, chemical, refractory industries. The properties of chromium that makes it most versatile and important are its resistance to corrosion, oxidation and hardenability. In metallurgical industry, chromite is used for manufacturing low and high carbon, Ferro chrome and charge chrome which are used as ingredient in making stainless steels and special alloy steel.

The South Kaliapani chromite mining area alone contributes about 97% of the total chromite reserve of the state (IBM, 2010).The chromite ore belt at Sukinda is spread over an area of approximately 200 sq. km. in Jajpur district and is well-known chromite hub in the world (Das et al., 2010). Chromite, the only economic ore of chromium, is one of Odisha's important mineral resources, with approximately 183 million tons of deposits, located in Sukinda Valley. Though it greatly contributes towards the economic development, but at same time deteriorates the natural environment (Tiwary et al. 2005) and is listed asthe fourth most polluted place in the world (Blacksmith Institute report, 2007).There are 20 opencast and 2 underground mines in Sukinda valley. The location of the mines is presented in Figure 1. The opencast mines in Sukindagenerate millions of tonnes of waste rocks which contaminate the water bodiesused for drinking purposes. Almost a quarter of the nearby areas have got pollution load. The major culprit is hexavalent chromium, carcinogenic if inhaled or ingested.

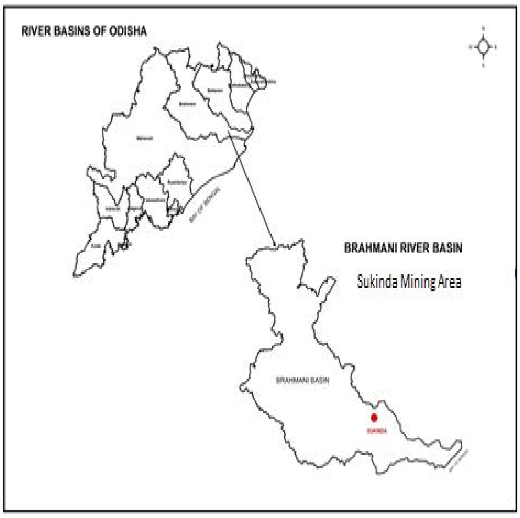

Figure 1: Location of Sukinda Valley.

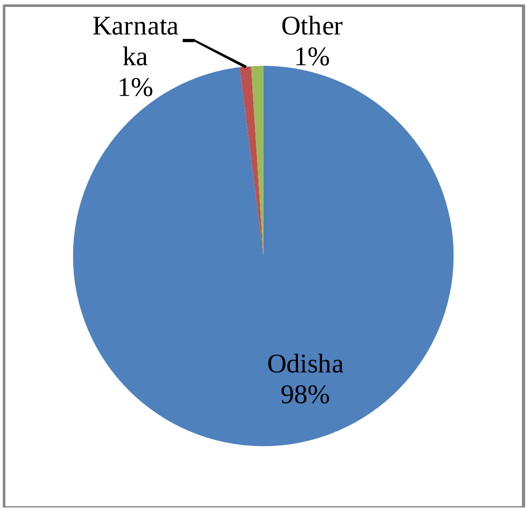

Figure 2: Production of chromite in 2011.

2. Environmental Impact of Chromite Mining in Sukinda Valley

Chromium exists in two stable states, i.e. hexavalent chromium (Cr^{+6}) and trivalent chromium (Cr^{+3}) of which (Cr^{+6}) is the most toxic form. Trivalent chromium does not induce any harmful effect, when fed in water or food to living organisms. Cr^{+6} beyond a certain concentration are toxic which have many adverse impacts on environment. As a result of growing open cast mining activities in the area, the environment in the vicinity is under threat. In the Sukinda mining area, around 7.6 million tons of solid wastes have been generated in the form of rejected minerals, over burden material/waste rock and sub-grade ore that may be resulting in environmental degradation, mainly causing lowering in the water table as well as deterioration in surface and ground water quality ((Mohanty and Patra, 2011;Tiwary et al. 2005). According to Indian standards the permissible limit of hexavalent chromium for portable water is 0.05 ppm and for industrial discharge water is 0.1 ppm (CPCB, 2012)

In Sukinda area, the lateralization process involving oxidation and alternation of the serpentines creates alkaline pore water which facilities the generation of Cr^{+6} from inert chromites and causes hazardous chromium pollution of water (Das and Singh 2011). The ground water in Sukinda valley occurs at a depth of 8 to 11metres, and when it comes in contact with atmospheric air and chrome ore during mining, it gets contaminated with hexavalent chromium beyond permissible limit (Pattanaik et al. 2012).

Higher concentration of hexavalent chromium in Sukinda was noticed in the 1990's and many studies have been done on this issue since then. Hexavalent chromium is highly mobile and can readily move through soil and ground water. It originates out of leaching of overburden causing threat of pollution to the ground water regime of Sukinda valley. Consequent upon closure of the mines, heavy seepage of ground water will accumulate in the pits gradually and at the end of mine closure it convert into large water reservoirs. Huge overburden dumps stacked nearer to quarry is susceptible for erosion by surface run off and carrying hexavalent chromium into Dhamsala nala, a tributary of the river Brahmani, life line for an estimated 2.6 million people in the district. Ground water is affected by mining by depletion of ground water table and by pollution of aquifers. The major environmental problem in Sukinda is the pollution of Dhamsala nala. Discharge of mine effluent in to Dhamsala nala without proper treatment increases hexavalent chromium at some stretches of the nala. The environmental impacts of chromite mining in Sukinda valley are;

2.1 Presence of hexavalent chromium in mine drainage water

Open cast mining in the Sukinda valley is carried out at a depth below ground water table resulting seepage of ground water into the mine pit. Large volumes of seepage water are the source of a serious hazard. Even though chromium in chromite is in trivalent state, some hexavalent is always formed due to certain chemical reactions. Many mines also have chrome ore beneficiation plants, where chromium content in the ore is concentrated through washing and shorting. Washing from chrome beneficiation plants can be a source of Cr^{+6}.

2.2 Dust generation

Large amount of dust is generated during the chromite mining activity, particularly from drilling, blasting and transportation. Stacking and loading of both ores and chromite overburdens also generate some amount of particulate matter. The dust is, though mostly, chromite particles but sometimes may also contain traces of hexavalent chromium which have adverse impact.

2.3 Overburden generation

Open cast chromite mining generates large quantity of over burden. Overburden generation from the mining activities in Sukinda valley for the year 2005 is given in Table 1. If it is not protected/treated properly then runoff from these over burden can pollute the nearby surface as well as ground water bodies due to leaching of hexavalent chromium.

2.4 Loss of biodiversity and forest

Most of the chromite deposits are located in forest areas. Chromite mining thereforecauses loss of forest cover and decrease the plant as well as animal diversity.

Table 1: Overburden Generation in Sukinda Valleyin 2005.

Sl. No.	Name of the mine& Company	Overburden generation in Million Cum/year	Overburden dump area in Ha
1	Saruabil,M.L. Mines Pvt. Ltd.	0.37	62.02
2	Sukinda,TISCO	5.4	79.8
3	Kaliapani ,OMC	0.1	-
4	Kamarda , B.C. Mohanty& Sons	0.2	17.74
5	South Kaliapani , OMC	3.0	48.1
6	Sukrangi , OMC	0.03	-
7	Ostapal FACOR	0.47	17.18
8	Chingudipal , IMFA	-	4.38
9	Sukinda , IMFA	0.60	45.0
10	Kaliapani, Balasore Alloys	0.48	22.41
11	Kaliapani , Jindal Strips	1.2	32.06
12	Tailangi , IDCOL	0.54	9.995
13	Mahagir , IMFA	0.20	4.49
14	Kathpal , FACOR	0.03	27.25

3. Hexavalent Chromium Toxicity and Health Hazards

Hexavalent chromium contamination has generally been assumed to be anthropogenic, since it is used in a number of industrial applications, including mining, electroplating, tanning, industrial water cooling and petroleum refining (Das and Mishra 2008). Cr^{+6} is extremely toxic and is considered by the World Health Organisation (WHO) and United States Environmental Protection Agency (USEPA) to be a human carcinogen. It is a strong oxidizing agent, is potentially mutagenic, carcinogenic, potent inducers of tumours in experimental animals, immunotoxic, neurotoxic, reproductive toxic, genotoxic and can include a wide spectrum of DNA damage, gene mutations, sister chromatid exchange and chromosomal aberrations (Das and Singh 2011). It has been noticed that workers in the chrome ore manufacturing developed lung cancer more often than rest of the population.

The IBM-BRGM report indicated that most wells and water course in Sukinda valley were contaminated by hexavalent chromium up to a value of 3.4 mg/lt. in surface water and 0.6 mg/lt. in ground water, against a permissible limit of 0.05 mg/lt.

In February, 2004 a cancer detection camp was organised by the Indian Metals and Ferro Alloys Ltd., (IMFA), in which 227 persons from six nearby Gram Panchayats were examined. Four persons were suspected of cancer- one each for breast, tongue, mouth and uterus cancer. Similarly, a TB detection camp was also organized in December 2004, where out of 354 persons (from eight nearby Gram Panchayats), 58 suspected patients were examined, but no case of TB was detected (Das and Singh 2011).

4. Remedial Measures

The conventional methods of reducing hexavalent chromium to trivalent chromium by ferrous sulphate in a controlled pH are usually adopted by mine owners. Several remedial measures have been suggested by scientists and researchers for removal of the toxic hexavalent chromium in Sukinda valley. The most widely used method is adsorption to remove chromium metals from mine discharge waters. A variety of natural and synthetic materials has been used as hexavalent chromium sorbents, including activated carbons, biological materials, zeolites, chitosan and industrial wastes such as red mud, fly ash, blast furnace slag etc.

A number of bacteria's such as Micrococcus luteus, Serratia marcescens and Acinetobacter calcoaceticus are used for reduction of hexavalent chromium in Sukinda mining area.Out of these bacteria's, only Acinetobacter calcoaceticus showsa reduction of 70.53 % hexavalent chromium at pH 8.0 and temperature 30^0C/ 24 hr. (Mishra et al., 2010).

In the year 2012, Civil Engineering Department of IIT Kharagpur have prepared common effluent treatment plant (CETP) for reduction of hexavalent toxicity in Sukinda valley area. By this CETP process all the waste water from mines come to a common effluent drainage system, then after treated for removal of toxic hexavalent chromium.

5. Conclusion

The persistence of Cr(VI) in water has serious implications both for human and aquatic fauna due to its toxicity. The present mining activities and its expansion in future are expected to increase the Cr(VI) content in both surface as well as ground water. With some environmental management system, management policy and environmental laws the adverse environmental impacts can be mitigated to some extent. Regulatory authorities and environmental scientists should formulate an acceptable and economically viable strategy so that at the beginning of the activities the possible adverse impacts could be regulated. Stringent measures are required to prevent leaching mainly from stockyards, over burden dumps and abandoned quarries. Post mine closure monitoring of ground as well as surface water is desired. Sincere effort is required for fixing of Cr(VI) by bacteria as laboratory tests by many researchers are found to be encouraging.

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