ENVIRONMENTAL IMPACT ASSESSMENT STUDY OF OSTAPAL CHROMITE MINES AREA IN INDIA

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Abstract

Mining of Chromite Ore has influenced the nearby surrounding with Cr(VI) contamination. Increase in the amount of Cr(VI) in water, soil and air sources is proved to be a vital source for environmental pollution. In this connection an environmental impact assessment studies has been undertaken to estimate the concentration of Chromite pollution in soil as well as water quality near a mining area of Ostapal Chromite Mining area. The study revealed that investigation of the water sources shows an appreciable derivation of the parameters from its initial standard. In addition to the above fact, it has been observed that the nutrient content of the soil has been deteriorated in and around these mining areas where a comparatively low potassium, nitrogen and phosphorus has been obtained in the range of 59(kg/ha), 68(kg/ha) and 1.8 (kg/ha) respectively. The investigation also revealed that with the development of acidic property in surface water, many constituents get leached out and travel to different soil sources by disturbing its chemical composition as well as by decreasing the soil fertility drastically.

Keywords Chromite overburden, nutrients, heavy metal contamination, pollutants, Chromium(VI).

Introduction

Chromium is a member of group VI elements in periodic-table and it abundant in nature. It has three stable oxidation states such as +2, +3 and +6. Chromium in +6 oxidation state is reactive and mobile in water with carcinogenic characteristics. Chromite ore carries Cr(III) as the major constituent when Cr(III) takes one more molecule of oxygen, it reaches a higher valiancy state of Cr(VI). Hexavalent chromium is 2000 times toxic Cr(III) (1-9). Chemically active forms of Chromium (VI) are CrO_3 and $CrO^{-2}{}_4$. It is a strong oxidizing agent which react with organic matter to form Cr(III).

About 95% of the Chromite deposit of the country is present in Odisha. Out of these deposits about 187 million tons are available in the Sukinda Region and nearly. In the open cast mining processes, the Chromite over burden released along with rock minerals are dumped in the open ground which is mainly responsible for environmental contamination by converting Cr(III) to Cr(VI). These Cr(VI) when get leached into the water bodies and soil, pollutes these sources in higher extent. Water contamination with Cr(VI) has contributed to the surface and river water pollution. The contaminants are taken care by some natural bodies such as clay minerals, metal oxides and organic matters. Studies have been carried out (10-16) to reduce Cr(VI) into Cr(III) in presence of ferrous ions. Also some of the soil bacteria can be a medium to remove chromium from contaminated sources. The increase in chromium concentration in surface water bodies when undergoes oxidation in presence of silicates, the oxidic species moves towards the ground water. With the continuous release of Cr from mining areas, it is entering to the Dhamsala River increasing the Cr content in the sediments and water sources of Brahmani River. Oxidization of Chromite contributes a threat to the environment. Ostapal chromite mine is a part of the FACOR (Ferro Alloy Corporation) Dhenkanal with the following specific features.

In the present study, an attempt has been made to monitor the environmental impact of the open cast mining at Ostapal Chromite Mine taking into consideration the water and soil sources. During the study variation in physic chemical composition of the water and soil sample have been investigated thoroughly.

Materials and Methods

Ostapal Chromite Mine is situated at Gurujang, Kaliapani, Jajpur. The general environment of this mining area is humid and the temperature remains in the range of 26-44^{0}C throughout the year. FACOR, Ostapal holds a area of 72.843 hectares with an Effluent Treatment Plant. The mine drainage water is treated in the ETP which is having a design capacity of 25920 m^3/d. The ETP outlet is at a distance of 835 m from DhamsalaNalla. During open cast mining, the surface soil with certain rock materials get deposited at the dump areas. To get rid of ground water contamination this water are pumped out on the surface and used to water the agricultural lands situated nearby. This treated water is used for bathing and household purposes as well.

Sampling of Water and Soil

During the study, ten soil samples and ten water samples are collected from various locations in and around Ostapal mining area. Soil samples were collected from the overburden dumps and nearby agricultural lands and water sample from the mining site as well as nearby pipelines with the following specifications.

The collected samples were stored properly in plastic bags and bottles.

Results and Discussions

The overburden sample has been analyzed for textural analysis and the detail is represented in

Table-3. The color of the soil varies from light yellowish brown to black. The nutrient composition of various soil samples are represented in Table-4

The data revealed that the soil sample has less nutrient content as compared to the standard value. The pH almost remains alkaline due to contamination. The chemical composition of the soil is given in Table-5. All the metals and constituents are present in their oxidic form. The nitrogen, phosphorus and potassium content are in the range of 75 to 98 kg/Ha, 2.2 to 3.8 kg/Ha and 68 to 222 respectively with organic carbon content of 0.027 to 1.67. The mineralogical composition of soil samples and their chemical composition have been given in Table (5). The data revealed that the metals are present in soil in the form of their oxides. According to the report sample OBD-5 has constituents present in their maximum concentration.

For water samples, the pH is found to be acidic and in some areas CW-7 and CW-8. pH has reduced drastically up to 4.9. The temperature of the water sample remains within 30^0C. The conductivity remains in the range of 0.72 to 1.04.

Conclusion

The above study revealed that mining activities are a major source for water and soil pollution simultaneously. It influences the environmental water and soil quality depending on the nature of pollutants and variation in composition. It is necessary for each mining sector to install proper mitigation, treatment plant during processing of different ores. During chromite mining as a vital pollutant chromium (VI) has assigned.

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FACOR (Dhenkanal)

	Kathpal Chromite Mine	**Ostapal Chromite Mine**
Mapping Scale	1:2000	1:2000
	1:500	
	1:200	
Area (in Sq.km)	113 (Hec)	72.84 (Hec)
No.of boreholes	82	5
Meterage drilled	1651.5	394.6
Total mineral reserves of chromite as estimated	0.82 million tonnes with 44% Cr_2O_3	53.94 million tonnes with 37.8% Cr_2O_3

Table-1 (a)- Soil Sample Collection

A: Samples collected from the overburden dumps	**Date**	**Age of the OB**
OBD-1	11.12.11	1year
OBD-2	12.12.11	5 years
OBD-3	12.12.11	8 years
OBD-4	13.12.11	12 years
OBD-5	13.12.11	15 years
B. Sample collected from nearby agricultural lands	**Date**	
AL-1	11.12.11	
AL-2	11.12.11	
AL-3	11.12.11	
AL-4	13.12.11	
AL-5	13.12.11	

Table-1(b)- Water Sampling Detail

CW-1	Water from dumping area
CW-2	100mtr. far from dumping area
CW-3	Ag Land
CW-4	AL
CW-5	AL
CW-6	AL
CW-7	AL

CW-8	AL
CW-9	AL
CW-10	Agricultural Land

Table-2 Methods to determine the Physico-chemical parametric study of soil and water sample

Parameters	Instrument
Chemical Composition	XRF
Nutrient Content	AAS
pH	pH Meter
Electrical Conductivity	Conductivity Meter
Total Alkalinity	Phenolplalhatein Indicator
TDS	Evaporation Method
DO	Sodium Thio Sulphate Method
TSS	Fibre Filterpaper
BOD	Wrinkler's Method
COD	Std. Ferrous Ammonium Sulphate Method
TH	EDTA/Eriochrome Black T Method
Calcium	Flame Photometer
Potassium	Flame Photometer
Mg	Flame Photometer
Na	Flame Photometer
Cl^-	Pot. Chromate/Silver Nitrate
SO_4^{-2}	Spectrophotometer using Stannous Chloride/Barium Chloride
PO_4^{-3}	Spectrophotometer using Stannous Chloride/Barium Chloride
Total Dissolved Metals	AAS

Table-3 Representing the textural composition of various soil samples

Sample Specification	% Sand	% Slit	% Clay
OBD-1	71	25	4
OBD-2	75	19	6
OBD-3	69	28	3
OBD-4	72	23	5
OBD-5	73	25	2
AL-1	62	29	9
AL-2	67	23	10
AL-3	63	29	8
AL-4	65	22	13

AL-5	69	22	9

Table-4 representing the nutrient composition of soil samples

	pH	N(kg/Ha)	P(kg/Ha)	K(kg/Ha)	Organic Carbon (wt%)
OBD-1	6.8	75	2.8	68	1.67
OBD-2	6.1	94	2.7	82	1.13
OBD-3	8.3	83	3.1	97	0.98
OBD-4	7.5	92	2.2	175	0.87
OBD-5	6.6	89	3.6	90	0.56
AL-1	6.7	81	3.3	236	0.41
AL-2	7.2	98	2.9	222	0.32
AL-3	7.6	91	3.4	110	1.41
AL-4	8.4	87	2.6	180	0.39
AL-5	8.9	80	3.8	206	0.27

Table-5:- Chemical Composition of the Soil Sample in WT%

Chemical Composition	OBD-1	OBD-2	OBD-3	OBD-4	OBD-5	AL-1	AL-2	AL-3	AL-4	AL-5
Al_2O_3	10.7	12.5	11.3	9.4	18.9	17.1	12.6	16.8	13.1	8.
SiO_2	36.8	39.1	43.8	41.9	49.4	35.8	40.7	42.0	37.1	40.6
MgO	12.47	16.3	14.2	13.98	9.8	10.9	17.4	20.8	19.1	22.7
Fe_2O_3	5.77	6.78	9.43	10.02	4.61	7.4	8.91	5.41	6.9	7.9
CaO	2.098	1.99	3.01	2.74	1.07	1.24	1.38	2.2	1.6	1.8
Na2O	0.178	0.222	0.194	0.347	0.468	0.417	0.391	0.28	0.15	0.34
K_2O	0.307	0.248	0.259	0.291	0.244	1.981	0.224	0.31	0.2	0.31
TiO_2	0.343	0.525	0.547	0.278	0.37	0.43	0.491	0.25	0.33	0.39
V_2O_5	0.039	0.0618	0.042	0.048	0.031	0.05	0.059	0.04	0.06	0.02
Cr_2O_3	21.48	10.44	11.79	4.48	2.98	6.7	7.99	12.4	15.1	3.18
MnO	0.095	0.069	0.08	0.153	0.085	0.07	0.108	0.091	0.081	0.072
NiO	0.059	0.013	0.041	0.019	0.023	0.019	0.033	0.021	0.03	0.041
PbO	0.011	0.009	0.006	0.0086	0.0095	0.0065	0.0073	0.0067	0.0089	0.0099
ZnO	0.0138	0.0063	0.0046	0.0078	0.0141	0.0113	0.005	0.0089	0.0091	0.0067
CuO	0.0084	0.0067	0.0051	0.0078	0.0069	0.012	0.0081	0.0061	0.0073	0.0099
Moisture	0.9	1.8	6.4	9.3	10.2	5.2	4.7	8.6		7.1

Table-6- Physico-Chemical Characterization of the Water Sample in WT%

Water sample	pH	Temp ^{0}C	Conductivity	Total Alkalinity	TS(mg/l)	TSS	DO	BOD	COD	TH	Ca	Mg	Cl^{-}	SO_4^{-}	PO_4^{-3}	Free CO_2	Iron	Total Cr
CW-1	6.3	28	0.78	308	631	49	2.4	5.4	27.1	206	26	172	398.1	308	0.66	41	1.08	1.08
CW-2	5.9	29	0.93	284	809	77	3.5	11.8	21.8	248	24	158.8	204.9	278	0.78	33	1.12	0.99
CW-3	5.8	26	1.04	212	1004	83	3.2	14.8	23.9	312	31	199.4	364.8	349	0.45	27	0.98	0.78
CW-4	6.5	27	0.85	254	998	74	2.9	7.9	28.1	272	46	256.7	381.5	236	0.52	37	0.84	1.63
CW-5	6.8	28	0.72	138	747	91	4.1	11.2	25.8	304	45	232.1	349.3	331	0.38	32	1.77	1.86
CW-6	7.4	26	0.97	234	943	63	3.8	9.4	26.4	195	49	208.4	296.9	110	0.83	28	1.58	0.93
CW-7	5.3	29	0.73	172	812	98	5.0	13.1	29.7	221	29	189.7	212.6	152	0.89	40	1.41	0.86
CW-8	4.9	30	0.89	183	745	84	4.6	10.7	24.9	199	36	176.3	207.1	175	0.74	22	1.67	1.26
CW-9	5.8	28	0.84	194	932	76	4.1	12.3	23.3	213	37	141.9	236.7	139	0.68	29	1.13	1.37
CW-10	6.1	29	0.81	294	1017	81	4.8	12.7	29.3	234	50	155.5	318.8	261	0.61	31	1.39	1.16