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Assessment of The Respirable Dust Concentration of The Mine Tailing Area In Comparison With The Non Mining Area

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Abstract : *Mining is one of the most hazardous of professions and gold mining is considered one of the worst environmental pollutants. Gold mining is often associated with positive economic benefits, however it may also have negative impacts on the environment and human health. Long duration of mining in KGF has been associated with dumping of mine tailings approximately 32 million tons of sand dumped into 15 dumplings over 8 Km in the mining areas of KGF. Mine wastes in the form of rock fragments and mill tailings have been stacked in huge piles and heaps in KGF, occupying about 15-20% of the lease area seen as mine tailings. Particulate matter concentration beyond the permissible limit at KGF has indicated influence of tailings on air pollution on the environment. The aim of the study is to report the assessment of the area dust exposure of people to airborne respirable dust concentration in mine tailing area in comparison with non-mine tailing area. Air samples was measured. A total of 12 dust samples were collected from the 4 mine areas based on the proximity of the mine tailing and 07 dust samples were collected from non-mining area in the month of June 2017. In the present study Respirable area dust concentration was significantly higher in mine tailing compared to non-mine tailing area. The current study shows there is a significant increase in mean area respirable dust concentration in mine tailing area compared to non-mining area*

Keywords : *Air sample. Mine tailing, Particulate matter, Permissible limit Respirable dust.*

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I. Introduction

Kolar Gold Fields **(KGF)** was one of the major gold mines in India and was considered the world's second deepest gold mine. It produced 800 tons over the last 100 years. Champion Reef Mine was recognized as one of the deepest mines in the world, 3.2km below the surface. The decline came with the closure of Bharat Gold Mines in 2001, after almost 2,000 years of gold mining.[1]

KGF is unique, in that the families lived in close proximity to the mines while they were functional and continue to live there near mine tailing after their closure. Mine dumps are major generators of windblown dust and are one of the main sources of air pollution with potential adverse health implications for the nearby residents.[2] Many studies have shown that particulate matter concentration beyond the permissible limit at KGF has indicated influence of tailings on air environment.[3] Particulate matter is a term used for solid particles or a mixture of solid particles and liquid droplets suspended in the air. Air sampling is capturing the contaminant from a known volume of air, measuring the amount of contaminant captured, and expressing as milligrams per cubic meter (mg/m3) [4] In Indian coalmines the Directorate of Mines Safety (DGMS), Govt. of India, has prescribed a dust concentration of 3 mg/m3. The sampling guidelines recommended by the National Coal Board.(NCB) Mines Research Establishment (MRE) Gravimetric Dust Sampler (GDS). [4]

II. Objectives

- To determine the area dust exposure of the people living in the mine tailing region
- To determine the area dust exposure of the people living in the non -mine tailing region.
- To compare the dust exposure of the area dust with the mine tailing and non –mine tailing region

III. Materials And Methods

KGF consists of 35 wards under the municipality among which 16 wards are under the Bharath Gold Mines Limited. As seen in fig (1) We selected four areas in the exposed area for air sampling depending on the presence of the mine tailings as Champion reef, Marikuppum Ooragum and Coromandel and another area at Kolar that showed similar socio-economic features with that of exposed area as control areas. Even though the control area belonged to the same district as the exposed area, it is more than 10 km away from the mine tailing area.

A total of 12 dust samples were collected from the 4 mine tailing areas based on the proximity of the mine tailing and 07 dust samples were collected from non-mining area during the month of June-August 2017.Institutional ethical clearance was obtained & written informed consent was obtained to perform the area dust sampling from the concerned authorities. Samples were analyzed in the registered office of National Health of Miners Health KGF.

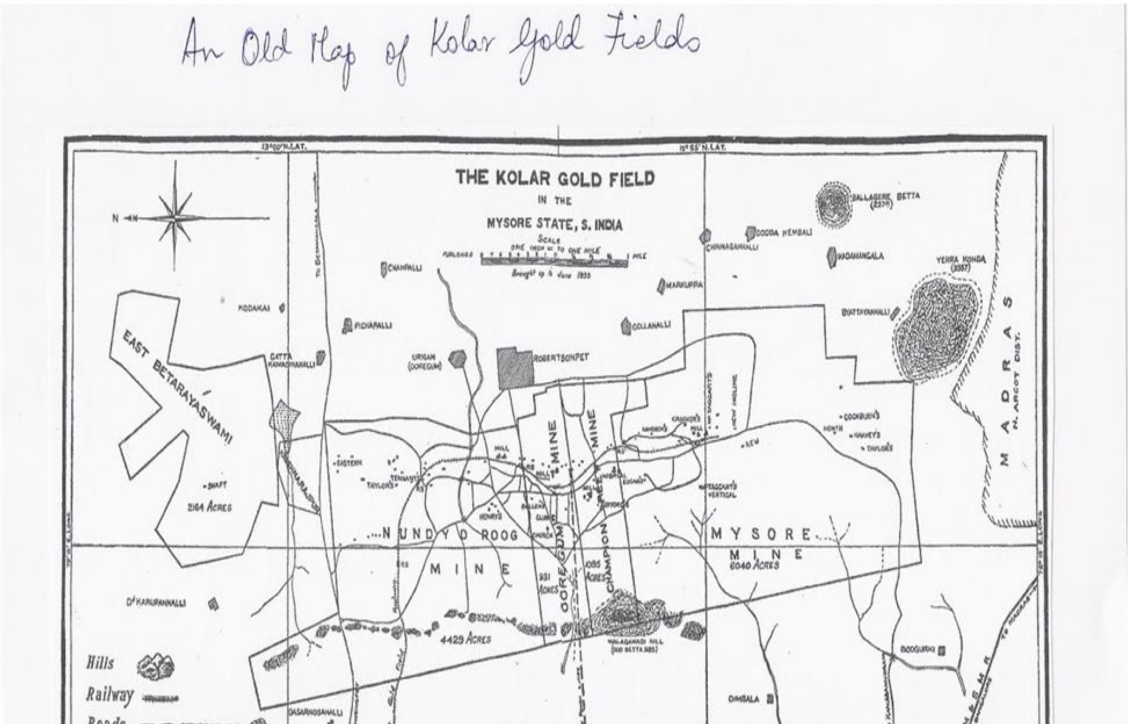
The respirable dust was collected by using respirable dust sampler Side Kick Ex51 having 37 mm filter cassette holder which holds Polyvinyl Chloride (PVC) filter of 37mm diameter, having a pore size of 5.0µm. Pre calibration of Side Kick 51Ex personal respirable dust sampler was carried out by using DRYCAL DCLITE BIOS calibrator in NIMH (National Institute of Miners Health) laboratory.

During the field study pre & post calibration of samplers were done with the help of rota meter to maintain a constant flow rate of 2.2 l/min. Both Aluminium cyclones & plastic cyclones were used for collection of respirable fraction of dust below 4µ in diameter by using its respective cassette holders as per the requirement while using Side Kick 51Ex as respirable dust samplers.

Sampling head holders were used to keep the cassette, cyclone, and coupler together to facilitate the entry of air to enter only from the cyclone inlet. Digital single pan analytical balance (Shimadzu having range of 0.001 mg to 5200 mg) was used for pre and post weighing of the PVC filters.

The respirable dust sampler Sidekick Ex51 when used as an area dust sampler has a correlation factor of 1.13 with gravimetric dust sampler GDS MRE 113A dust samples. Hence the dust concentration result obtained for area respirable dust samples, by using Side Kick Ex51, is divided by 1.13 to get the equivalent MRE respirable dust concentration in mg/m3 in case of area samples.

For area dust sampling Side Kick-51Ex was placed in the periphery of 5 to 15 m of the dust generating source in the mine. After sampling for 8 hrs. the Side Kick 51Ex was re-checked for its constant flow rate of 2.2 l/m with the help of Rotameter. The constant flow rate of 2.2 l/min was also noted in the data sheet. The collected samples were carefully preserved and taken to the laboratory for further analysis by weighing the filters, calculating the dust concentration.[5]



Map of Kolar Gold Fields showing the mine tailings

The SPSS version 22.0 was used for the statistical analysis. The quantative data were presented as a mean (range). Independent t-test was applied to compare the measured area dust concentration in mine tailing and the non-mine tailing area. Level of significance was set at p<0.05.

IV. Results

Area	Initial Weight of Filter Paper (mg)	Final Weight of Filter Paper (mg)	Flow rate (l/min)	Duration (hr) mean	Respirable dust concentration Mean range	Exceeding Permissible limit
Champion reef	12.12	14.58	2.2	8.08	2.11(1.11-3.66)	22%
Marikuppum	11.51	13.36	2.2	7.33	1.63(0.98-1.31)	Nil
Ooragum	11.43	12.95	2.2	6.58	1.56 (1.39-1.78)	Nil
Coromandel	12.05	13.09	2.2	6.51	1.07 (0.81-1.42)	Nil

Table 1. Area Dust levels (mg/m3) in different areas of the mine tailing area as obtained by Gravimetric Dust Sampler (MRE 113A) at KGF

The mean respirable dust concentration was highest in champion reef which was 22% exceeding the permissible limit.

Area	Initial Weight of Filter Paper (mg)	Final Weight of Filter Paper (mg)	Flow rate (l/min)	Duration (hr) mean	Respirable dust concentration Mean range	Exceeding Permissible limit
Gandhinagar	12.07	12.52	2.2	8.00	0.62 (0.08-0.67)	-------
Gandhinagar	11.75	12.42	2.2	8.00	0.56 (0.16-0.75)	-------

Table 2 Mean Area Dust levels (mg/m3) in different areas of the non -mine tailing area as obtained by Gravimetric Dust Sampler (MRE 113A) at Kolar

In this study the mean respirable area dust concentration was significantly higher in mine tailing area compared to none mine tailing area. (p <0.003).

V. Discussion

Kolar gold mine has been closed for nearly 15 years and huge mine tailing are present which has given rise to increase in the environmental pollution risks. Thus the present study was undertaken to estimate the respirable area dust concentration in the mine tailing and the non-mine area.In the present study Respirable area dust concentration is significantly higher in mine tailing compared to non-mine tailing area.

Our results are similar to the study done by Hu et al that living near mine dumps is a major risk for exposure to particulate matter.[6] During 1881-80, the gold production in KGF was about 47g/t of ore.[7] However, during the closure of KGF mine Bharath Gold Mines Ltd (BGML) had nearly 33 million tonne of tailing sand with the gold content of 0.72g/t. This mine dumps consists of crashed sand-like waste material which is generated by extraction and grinding methods of ground ore during mining.[8] The material contains a complex mixture of metals, dust particles, or particulate matter that is released and transported to the surrounding communities by air, soil, or water contamination.[9]

With sparse vegetation covered and exposure to wind generated minimal dust presents an intermittent but persistent environment hazard. With sparse vegetation cover and the reworking of older tailing storage facilities (TSFs) for their residual gold content, exposure to wind generated mineral dust presents an intermittent but persistent environmental hazard for nearby residents.[10,11]

The respirable dust concentration is more in Champion reef i,e 22% exceeding the permissible limits(Table-1). This production of increased respirable dust has led to increased health risks. Over the time there is gradual increase in the residential area around the tailings which has lead to increased concern for the protection of public health. Thus it is important for the stakeholders & the public to play an important role in improving the vegetation & also to take preventive measures to suppress dust frequent water spraying.

The dust surveys may be carried out on a regular basis at least once in six months to meet the statutory guidelines of DGMS and to know the prevailing condition of respirable dust from time to time. This would also bring about more awareness among the community people staying in this areas.

VI. Conclusion

The current study shows there is a significant increase in mean area respirable dust concentration in mine tailing area compared to nonmining area. Thus it is necessary to monitor the exposed area by taking necessary steps to by periodic water sprinkling & covering of peripheral boundary by vegetation or artificial barrier is necessary for arresting the dispersion of dust due to prevailing wind speed which might reduce the health effects for the residents living nearby the mine tailing areas.

We suggest that biologic monitoring be considered a first choice to monitor the possible health effects of residents living near abandoned mines. Further studies using more sensitive measurement of exposure and health effects would reveal the health impact of heavy metal exposure from abandoned mines.

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