A Study of the Impact of Marble Mining Activities on the Air Quality In Village-Sabalpur, Tehsil-Makrana, District-Nagaur Rajasthan (India)

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ABSTRACT

Mining is an industry that involves the exploration and removal of minerals from the earth, economically and damage to the environment. The mining related phenomenon has an insightful and ample persuade on the earth's natural environment. On the one side mining industries increase the comfort of human life while on other hand; it pollutes the natural ecosystem. To assess the impact on air one of the marble mine was selected in Village-Sabalpur, Tehsil-Makrana, District-Nagaur Rajasthan (India). Ambient air quality monitoring was conducted in summer seasons 2013 & 2014 for 7 locations in the core & buffer zone of the project site for parameters like PM_{10}, $PM_{2.5}$, SO_x, NO_x. The data on pollutants concentrations were processed for different statistical parameters like arithmetic mean, minimum & maximum concentration and various percentiles values. The monitoring results shows that all the parameters studied were found within the permissible limit except $PM_{10.}$ PM_{10} for all the 7 Stations were found between **113.6 ± 10.12** to **153.7 ± 12.84 in** Summer Season 2013 and **99.97** to **140.2±4.84** in Summer Season 2014 respectively. The minimum concentration was recorded in the Village-Bidiyad **113.6 ± 10.12 & 99.97± 4.49** in 2013 & 2014 and maximum in Village-Bilu i.e.**153.7 ± 12.84** in 2013. **&** In the Summer Season 2014 the minimum concentration viewed in **99.97 ± 4.49** maximum in Village Mored i.e **140.2 ± 4.84.** We concluded that in Summer Season 2013 the production of dust occurs from many operations in the mining like quarrying and by processing viz. drilling or blasting from deposit beds, loading and transportation, crushing of stones, etc. So, the air pollutants are on maximum side. But in 2014 results are reduced with the comparison to the Summer Season 2013 because when the mine digs deeper the most of the air pollutant concentration were encircled in the mine.

Keyword: Air Quality, Nagaur, Mining, Marble, NO_x, Particulate Matter, SO_x

INTRODUCTION

Rajasthan is having a huge range of minerals in which construction stones is an important place. The most important building stone is marble which occupies a distinctive location among the other building stones due to the amusing look and easily carved. Variety of marble occurrence is widely spread in our Country.

Mine quarrying and mineral processing industries are considered as the major cause of environmental pollution. The main problems in the mining industry are always associated with the management of air pollution; mine dumps .Unsystematic techniques without any mitigative measures cause adverse environmental changes. Mining actions and waste product produces a major impact on surrounding environmental ranging from localized surface and ground water contamination to damaging effect of airborne pollutants on the regional ecosystem. Mining industry has deteriorated quality of resources in the State of Rajasthan and these industries are becoming centers of pollution sources which need timely actions at government level so that natural resources can be protected. Mining and related activities have a profound and wide influence on the earth's natural environment. Mining industries enhance comfort of human life on one hand while on other hand; it pollutes the air and water.

Government of India has made obligatory for large mining projects to draw up elaborate plans for protection of environment and for prevention and control of pollution. Such requirement is not insisted in case of small mines in general. Air pollution (marble dust) from the marble mines forms a thin layer of deposition over the adjacent agricultural fields. On the one hand mining has led to development in all the sectors viz. social, economic, transport, educational and industrial but on the other hand it led to many serious concerns related to physical, chemical and biological environment. From the last few years the mining rate has increased several times. It results in the loss of biodiversity of both flora and fauna and physiographic features of the concerned region. Mining operations in any area left bad sign for decades or even forever. It results in creation of so many environment related problems and health hazards.

The study has been conducted within the buffer zone called as the study area, seven monitoring locations (Including mine site) has been randomly selected to assess the impacts of marble mine by air pollution.

MATERIALS AND METHOD

Study area

Nagaur is situated almost in centre of Rajasthan and stretch to N latitudes 26°25"and 27°40" and east longitudes 73°10" and 75°15".Nagaur covers a region of 17178 sq.km and surrounded by various districts.

Since a long Makrana a well known place in Tehsil Parabatsar of Nagaur district for the production of quality marble. The marble resources extend to a strike length of about 12 Kms. having a width of 1.6 Km situated in the west of Makrana town. It is trending NNE-SSW with steep dips from 50 to 70° towards ESE. In this belt there are six parallel to sub-parallel bands of marble having 2 to12 meters, found between Borawad and Makrana. In the main Makrana belt 50 M.T reserves of marble is estimated. Because to the different physical characteristics of marble like the color, pattern, grain size etc. Makrana marble belt has been divided into 14 blocks.

Table1 and Fig.1 Shows Important Marble deposits and available reserves in Rajasthan. Fig. 2 shows the Monitoring location of the Study area.

Table 1: Important Marble deposits and available reserves in Rajasthan

S. No.	Name of Block	Type of marble	Grain size	Grade
1	Bhermala	Pink, White, Adanga	Fine	I & II
2	Rawat Dungri	Adanga	-	II
3	Kala-Nada Talab	Dark Pink	coarse	I of II
4	Dhobi Dungri	Adanga	coarse	III
5	Kurmari Nadi	Adanga	coarse	III
6	Ulodi	Adanga pink	coarse	III
7	Chaurasa	White	fine	I
8	Range Bhot	Adanga	-	II
9	Chak Dungri	Adanga	-	II
10	Pink Range	Light pink	-	-
11	Paharkuan Range	White adanga	-	-
12	Modi Dungari Range	Adanga	-	II
13	Kala Dungri Range	Adanga	-	II
14	Boarwad Range	-	Coarse	II

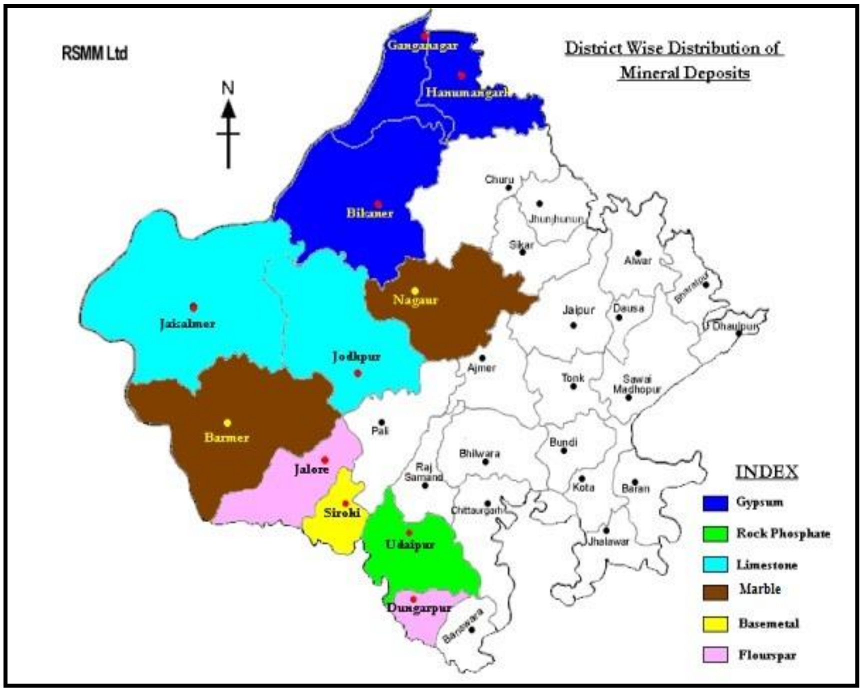


Fig.1: Shows the District Wise Distribution of Mineral Deposits in Rajasthan

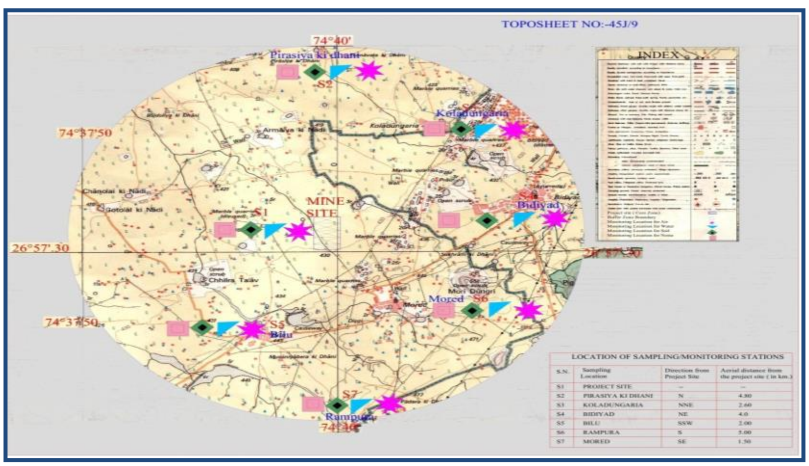


Fig. 2: Monitoring Locations of the study

The environmental impacts from the mining activity on air have been assessed. Ambient air quality monitoring was done to determine the general back ground at the concentration levels. Air qualities were monitored as per standard methods in the 10 km study area to observe pollution trends throughout the region. It helps in providing a data base for evaluation of effects of a project activity in that region. It will be also useful in ascertaining the quality of air environment in conformity to standards of the ambient air quality.

Monitoring was done during summer season (April, May and June) for two seasons (2013 & 14) from the study area. Results are shown in Table 2 to 9 and graphical representation of the same is shown in Fig. 3 to 10.

The data on pollutants concentrations were processed for different statistical parameters like arithmetic mean, minimum & maximum concentration and various percentiles values.

RESULTS AND DISCUSSION

Ambient Air Quality: To know the ambient air quality at a larger distance i.e. in the buffer zone of 10Km. radius, air quality survey has been conducted at different location.

Analyze the Particulate Matter PM_{10} in the ambient air.

With the standard (IS 5182, part-23) method for measurement of Respirable particulate matter PM_{10} in the ambient air with the help of appropriate cyclonic particle fractionation device (APM-860 BL, Lata Envirotech Model).Observed values are shown in Table 2 & 3 for two seasons.

Table 2: Observed values of PM_{10} Summer Season 2013 of the selected sampling locations

Station	Location	Analysis Results	Control(µg/ m3)
S1	Project Site	131 ± 9.01	100
S2	Village- Mored	151.4 ± 7.77	100
S3	Village Bilu	153.7 ± 12.84	100
S4	Village Koladungaria	145.0 ± 15.28	100
S5	Village Bidiyad	113.6 ± 10.12	100
S6	Village Rampura	136.7 ± 7.29	100
S7	Village Pirosiya Ki Dhani	116.5 ± 11.42	100

Mean ± SE (Standard Error), n=6

Table 3: Observed values of PM_{10} next Summer Season of the selected sampling locations

Station	Location	Analysis Results	Control(µg/ m3)
S1	Project Site	124.2± 5.24	100
S2	Village- Mored	140.2 ± 4.84	100
S3	Village Bilu	138.6 ± 8.81	100
S4	Village Koladungaria	113.1 ± 5.89	100
S5	Village Bidiyad	99.97 ± 4.49	100
S6	Village Rampura	109.7 ± 4.86	100
S7	Village Pirosiya Ki Dhani	116.9 ± 4.78	100

Mean ± SE (Standard Error), n=6

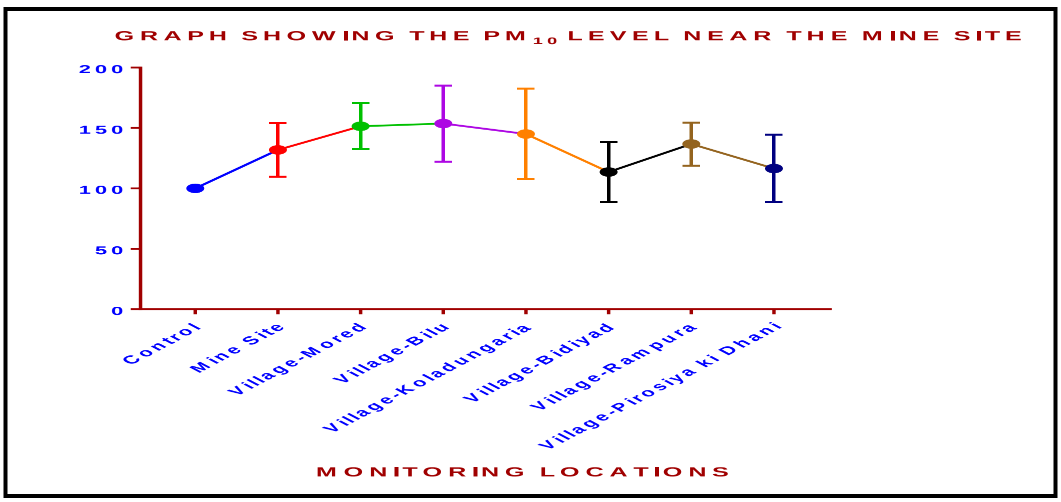


Fig. 3: Showing the PM 10 level near the mine site in Summer Season 2013

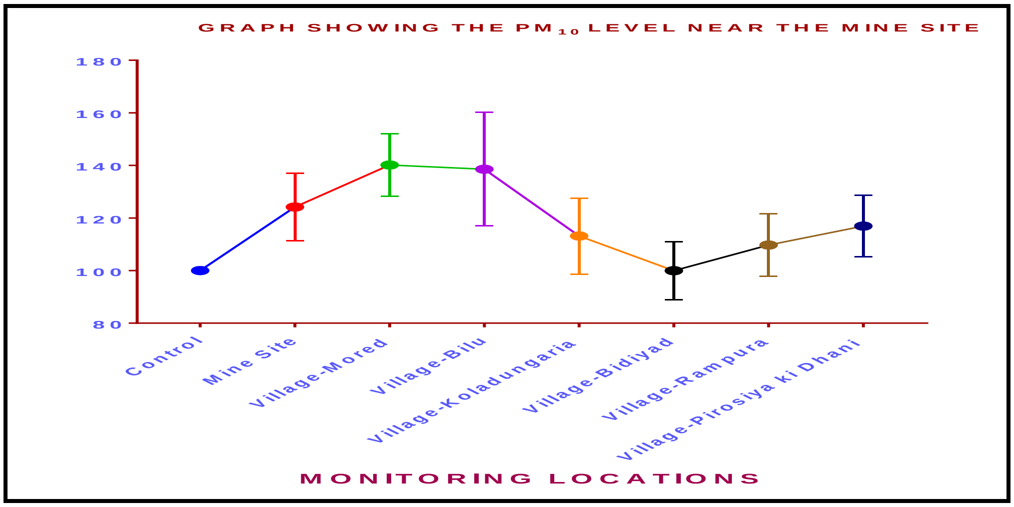


Fig. 4: Graph Showing the PM $_{10}$ level near the mine site in Summer Season 2014

Analyze the Particulate Matter $PM_{2.5}$ in the ambient air

PM $_{2.5}$ refers to fine particles that are 2.5 micrometers (µm) or smaller in diameter size. With the standard (IS 5182, part-23) method for measurement of respirable particulate matter $PM_{2.5}$ in the ambient air with the help of appropriate cyclonic particle fractionation device (APM-860 BL, LataEnvirotech Model). Observed values are shown in Table 4 & 5 for two seasons.

Table 4: Showing the results of PM $_{2.5}$ Summer Season 2013 of the selected sampling locations

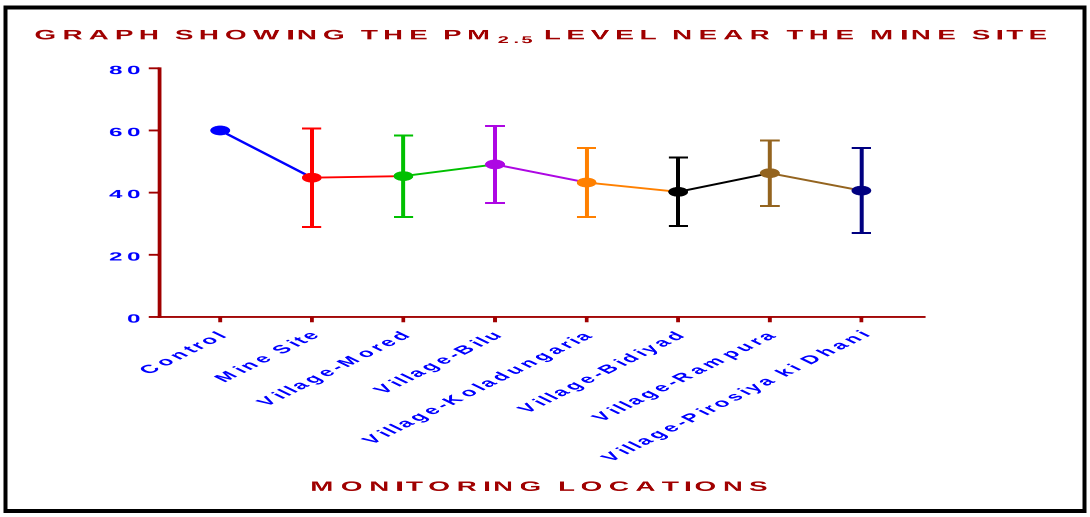
Station	Location	Analysis Results	Control(µg/ m3)
S1	Project Site	44.82 + 6.44	60
S2	Village- Mored	45.32 + 5.36	60
S3	Village Bilu	49.09 + 5.03	60
S4	Village Koladungaria	43.30 + 4.56	60
S5	Village Bidiyad	40.33 + 4.46	60
S6	Village Rampura	46.27 + 4.30	60
S7	Village Pirosiya Ki Dhani	40.70 + 5.56	60

Mean ± SE (Standard Error), n=6

Table 5: Showing the results of PM $_{2.5}$ Summer Season 2014 of the selected sampling locations

Station	Location	Analysis Results	Control(µg/ m3)
S1	Project Site	44.14+ 4.81	60
S2	Village- Mored	42.03 + 3.89	60
S3	Village Bilu	43.64 + 5.53	60
S4	Village Koladungaria	43.59 + 5.35	60
S5	Village Bidiyad	35.35 + 4.25	60
S6	Village Rampura	42.08 + 3.60	60
S7	Village Pirosiya Ki Dhani	38.58 + 3.59	60

Mean + SE (Standard Error), n=6



Fig, 5: Graph showing the PM 2.5 Level near the mine site in Summer Season 2013.

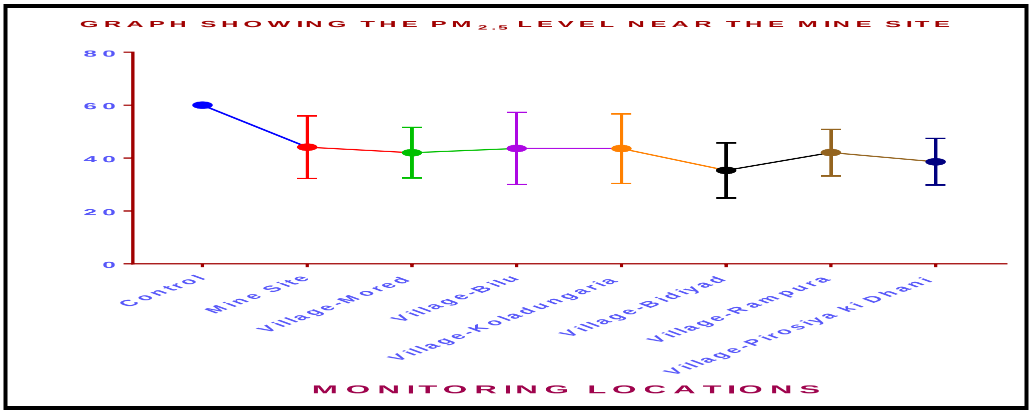


Fig. 6: Graph showing the PM 2.5 Level near the mine site in Summer Season 2014.

Analyze the oxides of Sulphur concentration in the ambient air.

With the standard (IS: 5182 Part 2 Measurement of Air Pollution: SO_2 by improved West & Gaeke Method Sulphur di oxide from air is absorbed in a solution of potassium tetrachloro-mercurate (TCM). A di chlorosulphitomercurate complex which resists oxidation by the oxygen in the air is formed. The complex is made to react with pararosaniline and formaldehyde to form the intensely colored rosaniline methyl sulphonic acid. Observed values are shown in Table 6 & 7 for two seasons.

Table 6: Showing the results of SO_X Summer Season 2013 of the selected sampling locations

Station	Location	Analysis Results	Control(µg/ m3)
S1	Project Site	55.07 ± 9.22	80
S2	Village- Mored	65.88 ± 10.03	80
S3	Village Bilu	56.68 ± 8.56	80
S4	Village Koladungaria	60.68 ± 6.04	80
S5	Village Bidiyad	62.51 ± 5.72	80
S6	Village Rampura	45.80 ± 7.50	80
S7	Village Pirosiya Ki Dhani	55.61 ± 7.70	80

Mean ± SE (Standard Error), n=6

Table 7: Showing the results of SO_X Summer Season 2014 of the selected sampling locations

Station	Location	Analysis Results	Control(µg/ m3)
S1	Project Site	53.41 ± 7.06	80
S2	Village- Mored	56.73 ± 10.41	80
S3	Village Bilu	55.57 ± 7.1	80
S4	Village Koladungaria	57.41 ± 4.85	80
S5	Village Bidiyad	54.26 ± 5.03	80
S6	Village Rampura	49.20 ± 5.11	80
S7	Village Pirosiya Ki Dhani	57.00 ± 5.94	80

Mean ± SE (Standard Error), n=6

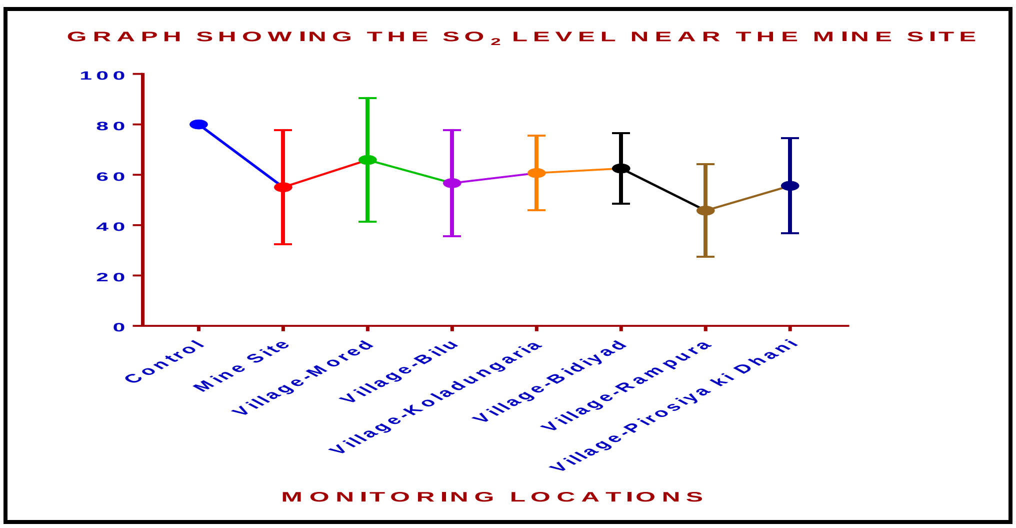


Fig. 7: Graph showing the SOx Level near the mine site in Summer Season 2013

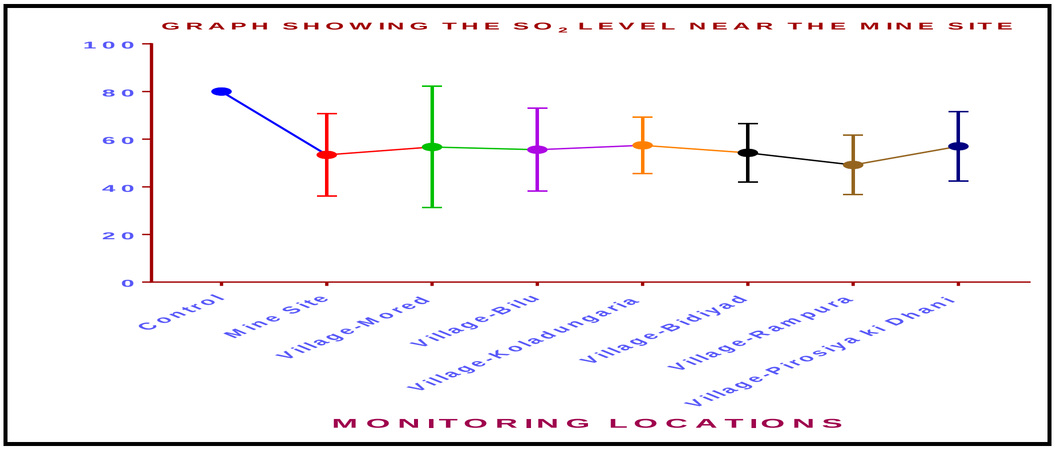


Fig. 8:Graph showing the SOx Level near the mine site in Summer Season 2014

Analyse the Oxides of Nitrogen concentration in the ambient air.

It was analysed with the modified Jacobs &Hochheiser method . The concentration of nitrite ion (NO_2) produced during sampling was determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulphanilamide and N-(1-napthylethylenediamine dihydrochloride (NEDA). Observed values are shown in Table 8 & 9 for two seasons.

Table 8: Showing the results of NO_X Summer Season 2013 of the selected sampling locations

Station	Location	Analysis Results	Control(µg/ m3)
S1	Project Site	41.85 + 9.58	80
S2	Village- Mored	58.56 + 9.44	80
S3	Village Bilu	64.40 + 8.76	80
S4	Village Koladungaria	61.51 + 10.25	80
S5	Village Bidiyad	53.42 + 11.44	80
S6	Village Rampura	52.94 + 10.99	80
S7	Village Pirosiya Ki Dhani	45.46 + 11.28	80

Mean + SE (Standard Error), n=6

Table 9: Showing the results of NO_X Summer Season 2014 of the selected sampling locations

Station	Location	Analysis Results	Control(µg/ m3)
S1	Project Site	38.11 + 4.86	80
S2	Village- Mored	40.67 + 8.65	80
S3	Village Bilu	55.23 + 6.33	80
S4	Village Koladungaria	58.83 + 6.83	80
S5	Village Bidiyad	46.94 + 7.34	80
S6	Village Rampura	47.98 + 8.06	80
S7	Village Pirosiya Ki Dhani	45.12 + 8.26	80

Mean + SE (Standard Error), n=6

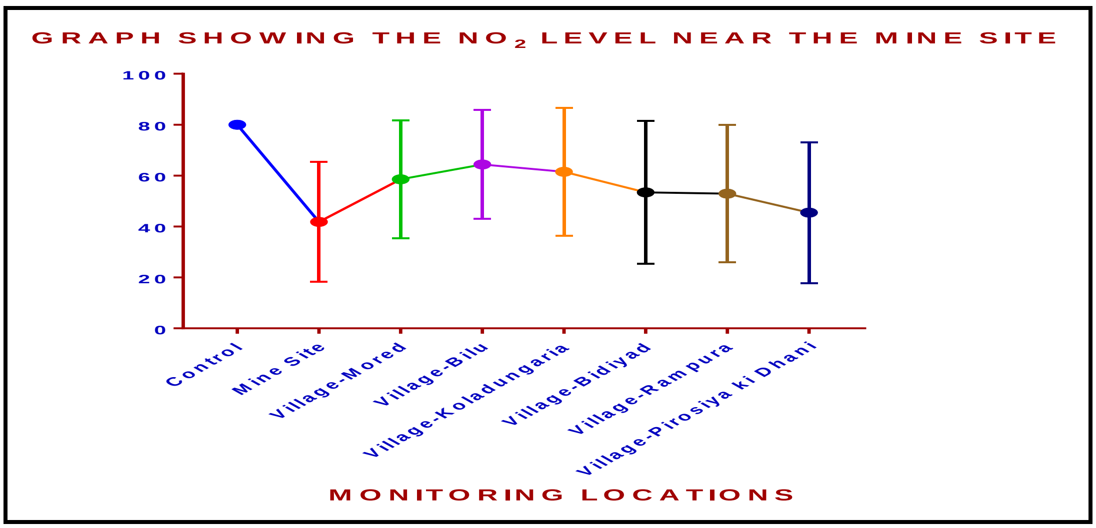


Fig. 9: Graph showing the NOx Level near the mine site in Summer Season 2013

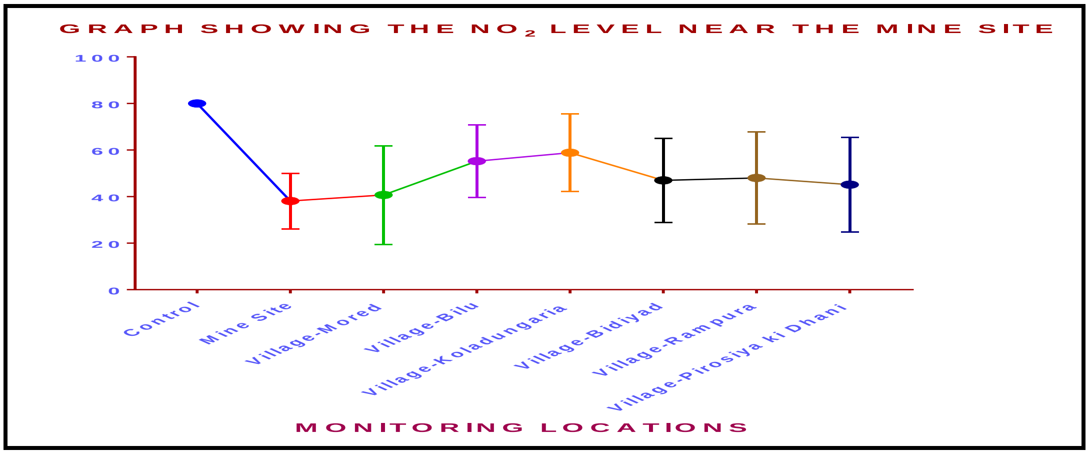


Fig.10: Graph showing the NOx Level near the mine site in Summer Season 2014

There is Number of steps in the Mining like drilling; blasting, hauling, collection and transportation which cause environmental pollution. In the present study 7 samples were collected from one of the marble mine and the nearby study area in Nagaur district. To observed the pollution trends in the region with respect to quantifying the impact of mine in the surrounding area.

PM_{10}: Ambient Air Quality Monitoring varied the concentration of PM_{10} from all the 7 AAQM Stations were found between 113.6 ± 10.12 to 153.7 ± 12.84 in Summer Season 2013 and 99.97 ± 4.49 to 140.2 ± 4.84 in Summer Season 2014 respectively. The minimum concentration was observed in the Village-Bidiyad i.e 113.6 ± 10.12 and maximum in Village-Bilu i.e.153.7 ± 12.84 in 2013. In the Summer Season 2014 the minimum concentration viewed in 99.97 ± 4.49 maximum in Village Mored i.e 140.2 ± 4.84. From the present study it shows that the values showed that the samples are above the maximum permissible limit as recommended by CPCB.

$PM_{2.5}$: $PM_{2.5}$ for all the 7 AAQM Stations were found in range between 40.70 ± 5.56 to 49.09 ± 5.03 and 35.35 ± 4.25 to 43.64 ± 5.53 in Summer Season 2013 & 2014 respectively and all samples found within the permissible limit by CPCB. The maximum concentration was found in the Village-Bilu i.e 49.09 ± 5.03 and minimum concentration was recorded in Village-Bidiyad i.e 0.70 ± 5.56 in Summer Season 2013 whereas in Summer Season 2014 the maximum concentration was recorded in Village Bilu i.e 43.64 ± 5.53 and the minimum concentration was observed in Village-Bidiyad i.e 35.35 ± 4.25.

SO_X: The SOx concentrations were varied to be in the range of 45.80 ± 7.50 to 65.88 ± 10.03 in Summer Season 2013. In the Summer Season 2014 the concentration were found to be in the range of 49.20 ± 5.11 to 57.41 ± 4.85.In the 2013 the minimum concentration was observed in the Village – Rampura i.e 45.80 ± 7.50 and the maximum concentration was surveyed in the Village-Mored i.e 65.88 ± 10.03. Whereas in the Summer Season 2014 the minimum concentration was observed in the Village- Rampura and maximum concentration were found in the Village-Pirasiyo ki Dhani i.e. 57.41 ± 4.85. It can be figured out that all the samples are within the permissible limits by CPCB.

NO_x: Nox Concentrations were varied to be in the range of 41.85 ± 9.58 to 64.40 ± 8.76 and 38.11 ± 4.86 to 58.83 ± 6.83 in Summer Season 2013 & 2014.In the Summer Season 2013 the minimum Concentration was observed in the Mine Site i.e 41.85 ± 9.58 and maximum concentration was recorded in the Village- Bilu i.e 64.40 ± 8.76 whereas in the Summer Season 2014 the minimum Concentration were recorded in the Mine Site i.e 38.11 ± 4.86 and the maximum concentration were recorded in the Village-Koladungaria i.e 58.83 ± 6.83.

From the present study we can observe that dust from mining of marble is a major source of air pollution. From the results we can observe that air parameters showed a negative correlation with the mining. By Analysis of Variance (ANOVA) evaluated that Results were statistically significant for PM_{10} in which P Value is 0.0264 and the R square is 0.4631in summer season 2013 which shows the significant matching (P<0.05)* From the Control Village- Mored whose adjusted P Value is 0.0116 & Village Rampura was significant the P Value is 0.0366 and the Village Pirasiya Ki Dhani was significant the P Value is 0.0258.Mine Site was significant with Village- Mored the P value was 0.0145 and the Village-Bidiyad the P Value was observed is 0.0365.Village Mored was found significant with Village- Bilu, the P Value is 0.0468 and the Village Rampura-0.0354.

However, in the Summer Season 2014 the results were found statistically significant (P<0.05) **.In which the P Value is 0.0012 and the R square is 0.6544. From the Multiple Comparisons we have observed that Bilu was significant with Village Mored the adjusted P Value is 0.0042 and the Village-Rampura is the P Value is 0.0275.Village Mored were significant with Village- Koladungaria the P value is 0.0449 and the Village- Bidiyad 0.0132.Village Bilu was significant with Village Bidiyad the P Value is 0.0257 and the Pirosiya ki Dhani the P value is 0.0354.

From the $PM_{2.5}$ study we have observed that $PM_{2.5}$ was showed a statistically significant matching (P<0.05) **. In which the P Value is 0.0081 and the R square is 0.2688. From the Control Village-Koladungria the P value is 0.0124 and the Village- Bidiyad 0.0145 and the Village – Rampura was significant. Village- Koladungaria was found significant with Village-Bidiyad 0.0265 and the Village-Bilu 0.0314. Village- Mored was found significant with Mine Site 0.0124 and the Village-Pirosiyo ki Dhani 0.365.

From the Summer Season 2014 we have observed that results showed the statistically significant matching (P<0.05)*. The P Value is 0.0202 and the R square is 0.4392. From the Control the results are significant with Village-Bidiyad 0.0204, Village- Rampura-0.0386 and the Village-Pirosiyo ki Dhani 0.0181.Village Mored was significant with Village- Koladungaria 0.0264 and the Village-Rampura is 0.0146. From the results we can found that they are above from the permissible limit.

Hence the impact of mining was occurs on the local workers, peoples etc.

The SOx Concentration showed a significant result in 2013 (P<0.05)*. The P value is 0.0292 and the R Square is 0.2202 and in the Summer Season 2014 in which the results is also significant (P<0.05)* in which the P Value is 0.0338 and the R square is 0.2045. In the 2013 the Control is significant with Village- Bidiyad 0.0245, Village- Rampura 0.0345 and the Village- Pirosiya Ki Dhani 0.0139.Mine site is found significant with Village- Koladungaria 0.0368 and the Pirosiyo ki Dhani 0.0489.From the 2014 we have observed that Control is found significant with Village- Koladungaria 0.0499, Village- Bidiyad 0.0345 and the Village- Rampura 0.0174.Village Bilu is observed significant with Village- Bidiyad 0.0236 and Village- Rampura 0.0478.

From the Nox study we have observed that results were found significant (P<0.05)* in which P Value is 0.0258 and the R square is 0.2465 in the Summer Season 2013.The Control was found significant with Mine Site 0.0148, Village- Bidiyad 0.0254 and the Village-Pirasiya ki Dhani 0.0278. Village-Mored was observed significant with Village- Bilu 0.0314, Village- Rampura 0.0258 and the Village-Pirasiyo ki Dhani the adjusted P Value is 0.366.

In the Summer Season 2014 the results observed statistically significant matching (P<0.05)* in which the P Value is 0.0276 and the R square is 0.4138. In which control is significant with Mine site 0.0035, Village- Rampura 0.0254, Village- Bilu 0.0314 and the Village- Pirosiyo ki Dhani 0.0258.Village-Koladungaria was found significant with Village- Mored 0.0254 and the Village Bilu.

From the above study we have seen that results are found statistically significant means the parameters are found from above the control limit the major cause of air pollution in the mining area is the dust pollutants which is the major concern for health hazards. The dust particulates generated from the mining process which get absorbed in the lungs, causes various diseases like black Lung, silicosis and pneumoconiosis etc.

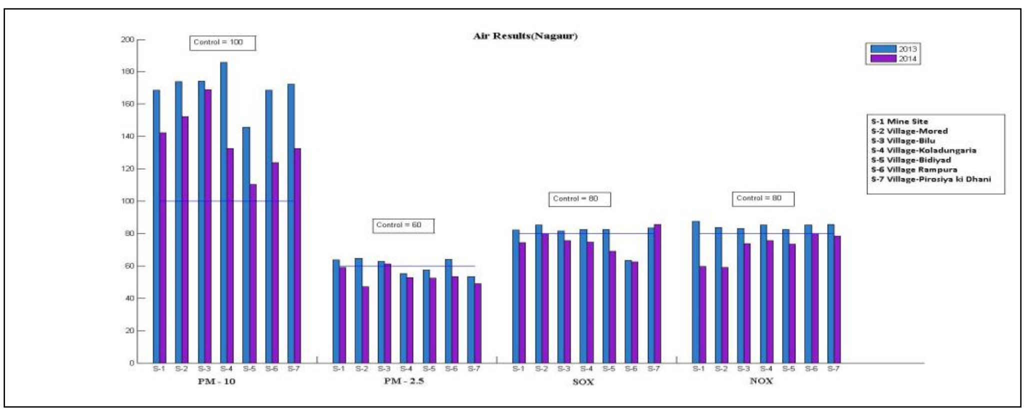


Fig.11: Comparative Studies Showing the Results of Air in Summer Season 2013 & 2014

CONCLUSIONS

The monitoring results of PM_{10} were found across the permissible limits. The study reveals that in Summer Season 2013 the dust emission occurs from many operations in the stone quarrying and processing viz, drilling or blasting from deposit beds, loading and transportation of rocks at crushers, open conveyors, primary, secondary and tertiary crushing of stones, screening transporting rock by belt conveyors, storage and loading of the crushed materials etc. So, the air pollutants were found at the high side. But as we observed that in Summer Season 2014 results are reduced with the comparison to the Summer Season 2013 because when the mine digs deeper the most of the air pollutant concentration were encircled in the mine. The most severe hazards of the air pollution are marble slurry& marble dust .Marble Slurry is produced at each step of marble mining. But when the slurry gets dry, it causes air pollution and the related problem. It causes respiratory ailments in the nearby residential areas because the fines of marble slurry flew with air blows creating the serious health problems. From the study we can say that slurry was generated during processing is approx 10 % from the stone quarried process. The block received from the quarries generated approx 20%-25 % and in the polishing process during 5% to 7 %. Slurry of particle size is less than 80μm even the major amount of the particulates remains suspended on the ground surface and does not settle its one of the most important reason of Air Pollution.

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Conflict of Interest

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