

## **Geological and Environmental Status of Makrana Marble Mining Area, Nagaur District, Rajasthan and Strategy for Sustainable Development**

### **INTRODUCTION**

Makrana (27°02'25" N latitude, 74°43'44" E longitude) is situated at the eastern margin of the Thar Desert and has an ancient marble mining history. The Makrana marble has made a perceptible dent in marble industry because of its blockability, whiteness, high CaO 50-56 %, low MgO 0.90–1.77 %, as compared to other marbles of Rajasthan, good polishing character and lustre. It is fine grained and exhibits stable, well distributed colours, pleasing and attractive designs and patterns. White and Albata varieties of Makrana marble are preferred over other marbles for monumental and sculpture work. Makrana marble is calcitic marble. It is known for the best quality monumental marble, comparable to world famous marbles of Carrara, Italy and Pentelinkar, Greece. Long history of conventional and unscientific mining poses severe threat to life, public property and continuation of mining in the area.

### **GEOMORPHOLOGICAL AND GEOLOGICAL SET-UP**

Geomorphologically, the area is represented by strike ridges, sand sheets, anthropogenic overburden mounds, slurry dumps and deep pits. Drainage in the mining area is mostly internal. Major part of the area is covered by mobile to semi stable, NNW-SSE to NE-SW trending sand dunes which overlie calcareous sand pseudo-conglomerate, kankar or gypsum bed of Quaternary period. Marble is exposed on surface in the central part, whereas overburden varies upto 15 m in the northern and the southern parts of the area.

General slope in the mining area is towards west and northwest. Ground water in the area occurs under water table condition. Mining at present is below water table in old mines.

Water table is 30-40 m below ground level. Ground water from the mines is released in open lands and agricultural fields.

Makrana marble deposits belong to the Ajmer Formation of the Kumbhalgarh Group of the Delhi Supergroup (GSI 1997). Five prominent marble bands have been delineated in the area from geocoded satellite imagery of February 1998. From east to west these bands are known as (1) Devi-Gunawati range (2) Dungri range (3) Pink range, (4) Makrana Kumhari range, and (5) Borawar Kumhari range with band I and II (Natani 2001). The different marble bands have formed due to tight isoclinal folding (Paliwal et al., 1997). The mining ranges are known by different names in different blocks (Fig. 1). During the study period (1997-98) cluster of 800 mines/quarry licenses were reported in the area (Verbal communication DMG, Makrana) extending from Matabhar in the north to Bilu-Mored in the south (approximately 13 km) along the strike and from Gunawati in the east to Borawar in the west (about 1.6 km) across the strike. New mining areas were coming up in Matabhar, Kalanada, Kolhadungri and Bilu-Mored villages.

#### **MINING RELATED ACTIVITIES AND THEIR IMPACT ON ENVIRONMENT**

Open cast mining, marble processing, solid waste generation and its disposal, trading and transport of marble blocks, slabs and irregular marble pieces (khandas), and art and craft work are important mining and mining related activities in Makrana marble mining area (Table-1).

**Table-1: Mining and mining related activities in Makrana marble mining area**

1	Mining	Includes pitting, blasting and excavations.
2.	Processing	Includes edge cutting, buffing, polishing tile making and processing waste from crushing and chip making plants.

3. Waste disposal Includes disposal of overburden strata comprising soil, silt, aeolian sand, calcareous sand, mine muck and mining waste comprising of pegmatite (Shaly)\*, calc silicate rock (Bhanwara)\*, dolomite (Jhond)\* and quartzite,
4. Slurry disposal Includes disposal of marble slurry.
5. Transportation Mainly by trucks, water tankers, slurry tanks mining machinery, donkey carts etc.
6. Arts and Crafts Includes activities of sculpture making, monumental work, flower vases, kitchen ware, idols, table tops and other handicraft items.
7. Trading Daily traffic of buyers, brokers etc. and interaction of seller, buyers and brokers.

\*Names prevalent in local mining community for marble waste

Quarrying is by conventional rope and bucket method and the quarries run along the strike and dip of marble bands. Large scale land transformations (Photo-1a&1b), unscientific mining and ignorance of safety rules (Photo-2a-d), un segregated waste dumps (Photo-3a&3b), improper and incompatible land uses(Photo-4), improper land use and encroachment on water bodies (Photo-5) have caused drainage blocking, land degradation, pounding and flooding of water, visual impact, loss of aesthetics, pollution, health and safety hazards.

### **ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY**

The impact assessment was done by means of a semi quantitative graded matrix to assess the overall impact of mining and related activities on environment. Matrix method basically incorporates a list of project activities or actions, which affect the environment (listed in columns in matrix table) and environmental parameters (listed in rows) as shown in the Table-3. Environmental parameters were weighted so that they could be correlated to each other in terms

of relative importance. Positive and negative signs were assigned to the impact value of each parameter to show beneficial and adverse impacts respectively. The impact values were assigned as per scheme shown in table-2.:

**Table-2: Impact value and impact nature**

Impact Value	Impact nature	Remarks
0	No impact	
1	Slight impact	
2	Appreciable impact	+ sign denotes beneficial impact
3	Significant impact	- sign denotes adverse impact
4	Major impact	
5	Severe / Permanent impact	

Impact value of each parameter was multiplied by the weightage values allotted to the corresponding parameter. This gave final score in terms of environmental impact units. Summing up the final score gave environmental impact assessment of the entire project / mining area. Significance of total environmental impact score is given in assessment value index (Table- 5).

The environmental impact assessment followed identification and quantification of impacts. The project activities which have impacts on various environmental parameters in Makrana are enumerated in Table-1 along with parameter importance values) and environmental impact matrix (Table-4).

**\*Table-3: Importance value of Environmental Parameteres- Makrana Mining area, Nagaur district; Rajasthan.**

Environmental Parametres	Ranking					Total	Weightage	Parameter Importance Value (PIV)
	1	2	3	4	5			

1. Soil and Land use				*	5	5/30	165
2. Water resources			*		3	3/30	100
3. Air and Noise				*	4	4/30	130
4. Flora and Fauna		*			2	2/30	70
5. Socio economics				*	5	5/30	165
6. Civic amenities			*		3	3/30	100
7. Health and Safety				*	4	4/30	135
8. Aesthetics			*		3	3/30	100
9. Human Settlements and historic buildings	*				1	1/30	35
					Σ 30		

**Table-4: Environmental impact Matrix of Makrana mining area, Nagaur district, Rajasthan (without mitigative measures)**

PIV	Environmental Parametres ↓	PROJECT ACTIVITIES							Total impact score  (TIS)
		Minin g	Process ing	Waste disposal (overburden & mine muck)	Slurry disposal	Transporta tion	Arts & crafts	Tradi ng	
		1	2	3	4	5	6	7	
165	Soil and Land use	-4	-3	-4	-4	-1	o	-1	-2805
100	Water resources	-3	-2	-2	-2	o	o	-	-900
130	Air and Noise	-3	-3	-3	-3	-2	-1	-1	-2080
70	Flora and Fauna	-1	-1	-1	+1	-1	+1	-1	-210
165	Socio economics	+5	+5	+2	+3	+5	+5	+5	+4950
100	Civic amenities	o	O	-1	-1	-1	+2	+2	+100
135	Health and Safety	-3	-1	-2	-2	-2	o	-1	-1485
100	Aesthetics	-4	-2	-3	-3	-2	+5	-2	-1200
35	Human Settlements and historic buildings	-3	+2	-1	-1	-1	o	o	-245

3875

**Table-5: ASSESSMENT VALUE INDEX**

TIS	Impact Assessment
upto (-) 1000	- No appreciable impact on environment
(-) 1000 to (-) 2000	- Appreciable impact on environment; but not injurious in general. Mitigation measures important.
(-) 2000 to (-) 3000	- Significant impact on environment. Major environmental control measures to be taken.
(-) 3000 to (-) 4000	- Major injurious impact on environment, Major environmental control measures to be taken and / or site selection for the proposed project to be reconsidered within the buffer zone.
(-) 4000 and above	- Alternative site for the proposed project to be selected outside the buffer zone.

## **CONCLUSION**

Significant conclusions emerging out of this study are:

1. Increase in spread of mining area, waste dumps and built up land is indicated in temporal analysis of visually interpreted aerial photographs of September 1967 and January 1976 and Geo coded satellite imagery of February 1998. This increase is at the expense of agricultural land, open lands, ponds and pasture land over last 20-30 years.
2. Occurrence of marble in steep dipping parallel bands and small lease holds prevent mechanisation. Due to small and deep mining pits, disposal of waste is not restricted to the excavated area only. Waste dumps dot the mining area throughout from Mata Bhar in the north to Bilu-Mored in the south and from Gunavati in the east to Borawar Kumhari in the west.
3. Unmechanised mining on small lease holds and blasting results in high waste generation and resource wastage in the area.
4. Mining muck, over burden dumps and slurry dumps are not segregated in the area (Photo-3). Slurry disposal is done on contract basis due to which contractors dispose of the marble slurry in open lands, agricultural land, ponds and even on road side near the processing plants without giving due regard to aesthetics and pollution aspects.

5. Mining waste, municipal waste and marble processing waste (Marble slurry) are not segregated in the area (Photo-3). Designated waste disposal sites are not properly selected and are insufficient.
6. Aforestation and compensatory forestry have not been undertaken in the mining area.
7. No effort has been made for stabilisation of waste dumps. Waste dumps have developed rills and gullies (Photo 6 and 7). Washouts from waste dumps and slurry dumps are contaminating soil and ground water resources in the immediate vicinity of waste dumps (Photo-7). Soil samples show slight increase in Ca, SO<sub>4</sub>, Na, TiO<sub>2</sub> and Mg content of soils in the immediate vicinity of dumps. Ground water samples show appreciable increase in Ca, SO<sub>4</sub>, NO<sub>3</sub>, Mg, TDS and SiO<sub>2</sub> values of the water samples of mine pit water and slurry laden water.
8. Kala Nada source of drinking water till 1970 is severely polluted due to dumping of municipal and industrial waste in the nallah bed. Excess water from Kala Nada is diverted in to Kala Nada and Nahar range mines during rainy season to prevent submergence of Kala Nada area causing ground water contamination in the area and poses severe threat for the health and hygiene of people living in Makrana and adjoining villages (Photo- 8 and 9).
9. Improper mining and non-enforcement of safety rules and mining laws is causing loss of life and public property in the area. Incidents like Chack Dungri railway line collapse (Photo-10) can again occur in near future if safety rules are not followed strictly and preventive measures are not taken.
10. Though the Government receives revenue of thirteen hundred million rupees per annum from the mining and related activities, there is no improvement in basic civic amenities like roads, good schools, park, potable drinking water supply, hospitals, electricity etc.
11. Complete lack of vegetation screens and indiscriminate dumping of waste is causing air and noise pollution (Photo-11) in the core area.
12. Mining and related activities have significant impact on soil, land use, water, air, noise, flora, fauna, health, safety and aesthetics of the core area; the impacts are marginal or negligible in the buffer zone. However, mining and related activities have major beneficial impacts on socioeconomics of the entire region and Rajasthan state. Mining has appreciable adverse impact on

human settlements in the core area and slight beneficial impact on provision of civic amenities in the core area.

13. Total environmental impact score of mining for the area is (-3875) indicating major injurious impact on environment. Since, mining is location specific activity, major environmental control measures are required to be taken for mitigation of hazards, restoration of natural ecosystem and sustainable development of the mining area. Few remedial measures have been suggested for sustainable development of the area.

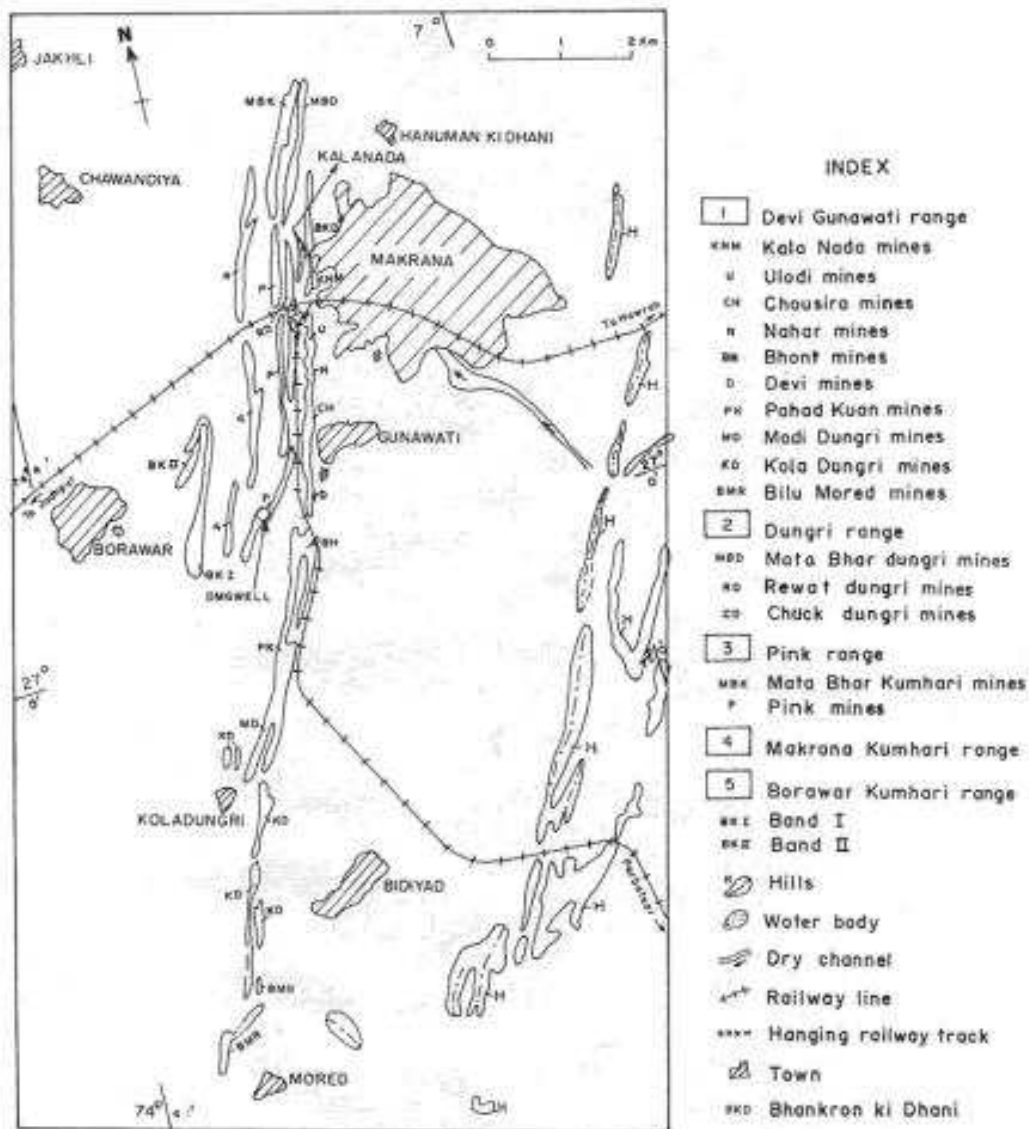


Fig -1 Disposition of marble mining ranges – Makrana, Nagaur district, Rajasthan





**Photo 1a: Large scale land transformation, Kolha Dungri mine, Makrana mining area, district Nagaur.**



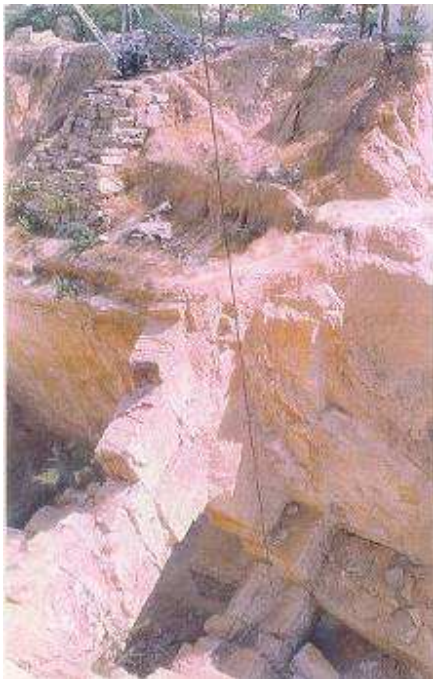
**Photo 1b: Land transformation due to construction of PHED office building in talav area near Transport union office, Makrana mining area, district Nagaur.**



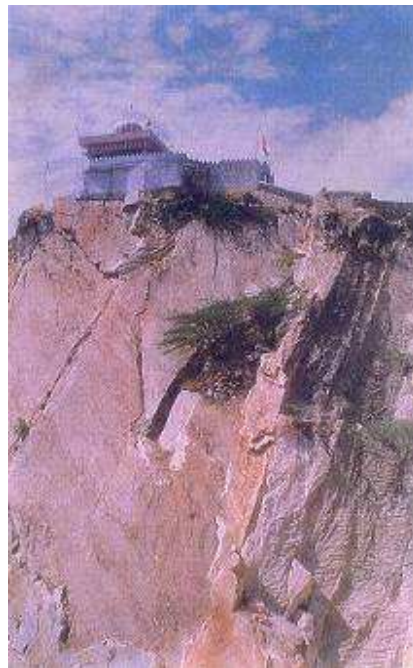
**Photo 2a: Undercut in marble band below Gunavati Borawar bypass, Makrana**



**Photo 2b: Rat hole mining, Devi mine, Makrana**



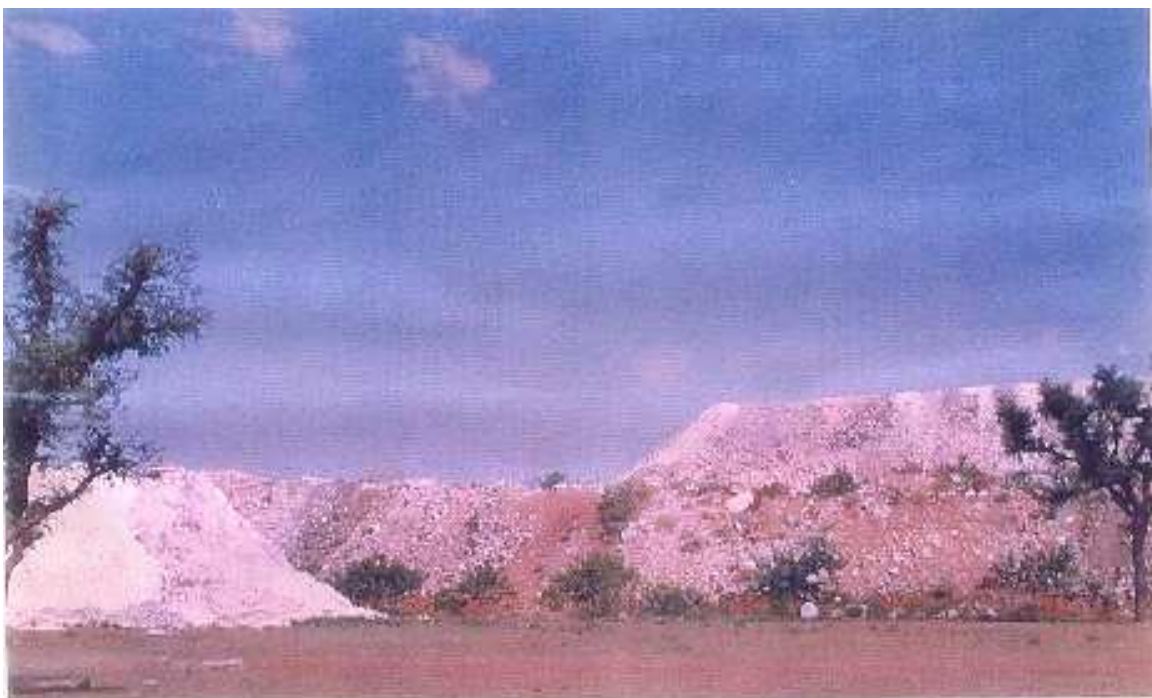
**Photo 2c: Removal of safety pillars Chukdungri mines, Makrana**



**Photo 2d: Unscientific mining posing threat to Devi temple, Makrana**



**Photo 3a: Un-segregated waste at designated waste disposal site near railway crossing, Manglana Makrana road, Makrana**



**Photo 3b: Un-segregated waste dumps, Bilu Mored mining area, Makrana**



**Photo 4: Mosaic showing incompatible land use, Borawar mining area, Makrana**



**Photo 5: Mosaic showing drainage blocking and land transformation, near Transport union office, Makrana mining area, district Nagaur.**



**Photo 6: Un-vegetated waste dumps showing development of gullies, Makrana mining area, district Nagaur.**



**Photo 7: Washouts from Un-vegetated waste dumps leading to soil pollution, Makrana mining area, district Nagaur.**



**Photo 8: Water pollution due to sewage, domestic and mining waste, Kalanada range mines, Makrana, district Nagaur**



**Photo 9: Overflow drains in Kalanada range mines to protect Mosque and school building from flooding leading to ground water pollution, Makrana marble mining area, district Nagaur**



**Photo 10: Hanging railway track due to unscientific mining and ignorance of safety rules, Chukdungri mines, Makrana marble mining area, district Nagaur**



**Photo 10: Mining and related activities causing air pollution in Borawad Industrial area, Makrana marble mining area, district Nagaur.**