



Resource Potentiality, Mining and Mineral Economics of Marbles from Rajasthan

KEYWORDS

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ABSTRACT Rajasthan is the principal producer of marble in the country. The state has more than 1200 million tones of marble reserves, distributed in 32 districts. Majority of Rajasthan marble belongs to dolomitic in composition. There are more than 1900 mining leases in the state where mining of is done by manual and semi-mechanised means. The unsystematic and unplanned mining is creating considerable environmental and pollution problems in the marble belts of the state. The ability of marble to receive polish, its durability and aesthetic value render it as the most preferred decorative stone as such, the market for marble slabs and tiles is growing steadily due to the increasing use of it in residential construction, commercial establishment, public buildings, hotels and resorts etc. In the present paper an attempt has been made to study the resource potentiality, mining practices, eco-environmental scenario, and mineral economics of the marbles of Rajasthan.

INTRODUCTION

Marble is considered as a valuable mineral resource and comes under the category of dimensional and decorative stone. Texturally marble is recrystallized (metamorphosed) limestone but in commercial terminology, however, marble is any soft rock capable of extraction as blocks sawed and taking good polish. Marble is widely used as ornamental, building and decorative stone. It is being used as a building and monumental material since ancient time in India. The world famous Taj Mahal of Agra, Victoria Memorial of Kolkata, Temples of Delwara and Ranakpur in Rajasthan and many more are the living examples of its decorative and ornamental utilities. The use of marble has to stay as the latest fashion in today's architectural design. The extensive use in residential and commercial building has increased its demand many folds. Its suitability for any purpose depends chiefly on fascinating colours, shades, lustre, and designs.

MARBLE DEPOSITS IN RAJASTHAN

Marble occurrences are widely distributed in India. However, occurrences of economic importance are limited to few states only, namely Rajasthan, Jammu & Kashmir, Gujarat, Chattisgarh, Haryana and Uttarakhand (DMG, 1989; IBM, 2015).

On the basis of available data, IBM has prepared a mineral inventory of marble reserves and resources as per UNFC system as on 1.4.2010. The total resources of all grades of marble in the country are placed at 1,931 million tonnes. Of these, only about 276 million tones (14%) fall under 'reserve' category and about 1655 million tonnes (86%) under 'remaining resources' category. Gradewise, about 27% resources fall under unclassified and not-known grades, 55% under off-colour grade and 17% under white colour grade. The available data on marble resources reveal that about 64% resources are in Rajasthan and 21% in Jammu & Kashmir. The remaining resources are distributed mainly in Gujarat, Chhattisgarh, Maharashtra, Haryana, Uttarakhand and Sikkim in descending order (IBM, 2015).

The total resource of all grades of marble in the state of Rajasthan is about 1,231 million tones of good quality marble in India. There are many varieties of marble, depend-

ing up on the colour, composition, texture, shades and structure. Marble of one type or another occurs in almost all the geological horizons right from Precambrian to Tertiary rocks in Rajasthan. Out of 32 districts, marble deposits are being exploited in 20 districts. The state is the leading producer of marble and contributes more than 90% of the total country's production. (Dwivedi, 1991; DMG, 1996; DMG, 2001; Jha, 2003; DMG, 2014, IBM, 2015). Table 1 given the important marble deposits and their reserves in the state.

Table 1 : Important marble deposits and available reserves

S. No.	Deposit/belt	District
1.	Agaria, Amet, Kilwa, Morwad, Dharmita, Katre, Parvati, Koyal, Morchana, Arana,	Rajsamand
2.	Makrana, Borawad (White), Chosira Dwagri (Pink), Kumari	Nagaur
3.	Kesariaji (Rikhabdeo), Odwas	Udaipur
4.	Babarmal (Devimata)	Udaipur
5.	Tripura Sundari-Talai-Odabagi-Bhimkund- Vithaldeo, Prithvipura, Paloda,	Banswara
6.	Andhi-Bhainslana	Jaipur
7.	Jhiri-Sariska	Alwar
8.	Selwara-Dhanvan-Koteswar	Sirohi
9.	Jahajpur-Kekri	Bhilwara
10.	Kalyanpura-Narwar-Saradhana	Ajmer
11.	Patan-Rampura	Sikar
12.	Umar	Bundi
13.	Sabla, Nandli-dad, Peeth, Manpur, Dachki	Dungarpur
14.	Mandal, Deh	Chittorgarh
15.	Bar-Sendra Sarangwa, Sevari, Kundal	Pali
16.	Mooisagar, Amarsagar, Habur, Naripa	Jaisalmer
17.	Pachori Chadi, Moriya Munjasar	Jodhpur

Marble of one type or another, occurs in almost all the horizons right from Precambrian to Tertiary rocks in Rajasthan. Table 2 shows the geological distribution of marble deposits in Rajasthan (Gupta, 1980; Roy, 1988; Jha, 2003).

Table 2 : Showing Geological Distribution of Marble Deposit in Rajasthan

Age/Super-group	Group	Deposits
Mesozoic (Jurassic)	Jaisalmer Group	Yellow marble of Jaisalmer
Delhi Super Group	Ajabgarh Group	Sikar district, Bhainslana, Pali, Jaipur, Sirohi
	Alwar Group	
	Raialo Group	White marble of Makrana (Nagaur), (Jamwa, Ramgrah) Jaipur, Alwar
Aravalli Super Group	Udaipur Group	White marble and Green marble deposits of Rishabhdeo, Dungarpur, Rajsamand, Babarmal, Banswara, Selwara, Kherwa, Perwar (Sirohi)
Archaeans	Pre-Aravalli Group	White marble Bhilwara, Bundi, distt.(Umar area).

CLASSIFICATION OF MARBLE DEPOSITS

On the basis of mineralogical composition, the marble of Rajasthan can be grouped as calcitic, dolomitic and serpentine marble. Majority of Rajasthan marble belongs to dolomitic in composition. The Makrana marble is the best representative of calcitic marble in the state. Besides, marble deposits of Selwara, Serwa, Perwa (Sirohi distt.), Jaspura-Daroli (Udaipur distt.) and Oda-Bassi (Banswara distt.) are also of calcitic nature. The deposits of Tripura Sundri (Banswara distt.), Andhi-Sankotra (Jaipur-Dausa distt.), Jhiri (Alwar distt.) and Rajsamand district are of dolomitic category while that of Rishabhdeo, Kherwara and Dungarpur is serpentine marble (DMG, 2000).

Bureau of Indian Standards (IS:1130:1969) has classified marble into 10 groups on the basis of colour, shades and patterns. Rajasthan is the most favourable state where all the 10 varieties specified below are occurring.

1. Plain White Marble 2. Panther Marble 3. White Veined Marble 4. Plain Black Marble 5. Black Zebra Marble 6. Green Marble 7. Pink Adanga Marble 8. Pink Marble 9. Grey Marble 10. Brown Marble.

Few other types of marble are also occurring in the state, which have not been included in the BIS classification e.g. 1. Yellow Marble (Jaisalmer), Fossiliferous Marble (Jaisalmer), Teak-wood Marble (Phalodi), Dendritic Marble (Churu) and Pista Marble (Andhi).

MINERAL STATISTICS OF MARBLE

Total No. of mining leases in the state : 1910
 Area under mining of marble : 3298.50 hector
 Total production (2013 – 2014) : 132.09 Lakh tons
 Total Sale Value of produced marble : Rs. 1354.88 Crores
 Mineral Revenue earned by government : Rs. 240.67 Crores
 Total Direct Employment in Marble sector : 31773 persons

MINING AND PROCESSING

Mining of marble is different from conventional mining practices. In conventional mining method, mined out minerals are obtained in small-size fractions whereas in mar-

ble mining, large size intact blocks without minor cracks or damages are extracted. Mining of marble is done by manual, semi-mechanized and mechanized means. Now a days, majority of mines adopt the semi-mechanized method of mining. The various stages in mining marbles are as follows (Jha, 2003):

- The removal of overburden is generally carried out with heavy earth-moving machinery.
- After removal of overburden and capping, the marble outcrop is exposed for block recovery. In manual operation, a line of shallow holes is made and by driving in wedges with feathers by continuous hammering (Photo 1). This creates a fracture along the already drilled holes, and the block is made free from all the sides. The block than either pulled by chains or pulley system or is pushed by driving logs. In the semi-mechanized operation, jackhammers, slim drills, line drilling machines are used for drilling holes in a predetermined line. Quarry front cut is made by using slim drill machines, diamond wire saw, quarry master, diamond belt saw machines and chain saw machines (Photo 2). The remaining operation is more or less similar to manual mining except for lifting and pulling where cranes, winches, dozers, etc. are used.
- Processing of marble is done in two stages. The first stage of processing involves cutting the blocks into 2 to 3 cm thick slabs by using gang saws, wire saws and circular saws (Photo 3). In marble tile plant, the required thickness of tiles is 10 or 12 mm. For cutting, circular saws are used. In general, the slabs are sold as it is but in case of tiles, they are polished using various pneumatically-operated or other polishing machines, such as, line polishers, trimmed and cut to size, buffed and chamfered using different types of machines before being sold.

MINING AND ENVIRONMENTAL ISSUES

Among the various physical and biological factors, mining of natural resources is also an important factor that creates considerable environmental and pollution problems. The impacts of mining operations on environment begin with exploration activities, extended through extraction and processing of mineral and continue up to closure of operations. Mining activities are posing threat to the eco-environment system. Mining and processing of mineral resources may have considerable impacts on various components of the environment. However, the intensity of impacts varies from mineral to mineral, methods of mining, scale and concentration of mining etc. Mining operations whether it is open cast or underground, large or small, metallic or non-metallic, mechanized or non-mechanized, it creates considerable negative impacts on bio-geo-physical and social environment (Lodha et al, 1995). During the present study 40 mines of marble at different localities were covered to study the existing and possible environmental conditions in mining areas. All the surveyed mines were open pit mines coming under the category of small-scale mines. The daily production ranges from 30 tonnes to 70 tonnes per day. Most of the mines were semi mechanized in nature having few mining machinery and equipment like jackhammer, drills, tractor compressor and derrick crane. Generally marble recovery is 50 to 60% and remaining material is either khanda, waste, overburden. However, at six mine sites the recovery of marble was around 80% or more. This improved recovery was attributed to systematic development of the mine site by the owner and deployment of modern mining machinery like diamond wire saw and chain saw. The Important Environmental Problems

observed in marble mining areas are Land degradation, Deforestation, Soil contamination and Removal of Top-soil, Pollution of surface and groundwater, Mineral dust pollution, Noise pollution and vibration, Change in Land use, Change in hydrogeological conditions and Occupational health hazards (Agrawal, 1993; Arora, 2001, Jha, 2003, Agrawal and Samar, 2010). The state of environment in the survey mines are summarized in Table 2 (See Photos 4 to 8).

Table 2: State of Environment in Marble Mining Areas

Environmental Protection Measures	Percentage of Mines
Mining as per given Mine Plan	20.0%
Disposal of waste / overburden on demarcated or barren land	30.0%
Proper storage of Top-Soil	12.5%
Plantation at mine sites and Restoration of Flora	17.5%
Protection from Dust Pollution	15.0%
Availability of DGMS Approved Safety Equipments to the mine workers (to prevent occupational Health)	10.0%
Availability of Facilities at mines (Drinking water, Shelter, First-Aid, Rest Room)	22.5%
Regular Medical Examination of Mine workers	7.5%
Regular Maintenance of Mine-machinery	20.0%

DOMESTIC AND EXPORT – IMPORT SCENARIO

The ability of marble to receive polish, its durability and aesthetic value render it as the most preferred decorative stone. World over, the market for marble slabs and tiles is growing steadily due to the increasing use of it in residential construction, commercial establishment, public buildings, hotels and resorts etc. Polished marble is widely used for wall paneling and facades. In India, the domestic demand for marble is also increasing day by day. The use of marble is being made all over India from middle class home to high-class society and by various commercial organization, government and public institutions. The increasing interest in the use of marble can be understood by the fact that prior to 1980 the consumption of marble in construction of residential building was only 5 to 8% of the total area. At that time marble was mainly used either in hotels or in places of worship. A survey study on marble demand was carried out by A.F. Ferguson and Co., New Delhi (IBM, 1993) stated that the marble consumption now a days has increased considerably in the residential building where about 20 to 25% of total area is covered by marble tiles and slabs. Similarly, commercial, private and government building are using 30 to 35% of marble in total constructed area. The demand for marble however, is more in big cities compared to towns and villages.

India now occupies important position in the export of marble. Initially i.e. during early 1990's the Indian marble production was not enough to meet the local demand, however, later on, due to the technological advancement in mining and processing sector and special attention by the government, marble production has gone up and efforts are now being made to harness the export of polished marble slabs and tiles. Exports of marble were 372,368 tonnes in 2012-13. Out of total marble exported in 2012-13, exports of dressed marble were 261,940 tonnes, and exports of other marbles were 110,428 tonnes. Exports were mainly to China (28%), Egypt (13%) and Nepal (11%). The total value of exports was Rs. 543 Crores (IBM, 2015).

To fulfill the growing domestic needs and also to process raw blocks for internal and external trade, marble was also

imported from important marble producing countries. Imports of marble were 757,752 tonnes in 2012-13. Out of these, Imports of dressed marble was 618,389 tonnes which shared 82% imports in 2012-13 while the remaining 18% imports were of other marbles. Main suppliers of marble were Italy (46%), followed by Turkey (22%), China (8%), Oman (6%), and Egypt (4%). The total imports were Rs. 2031 Crores (IBM, 2015).

CHANGE IN MARBLE SCENERIO DURING LAST 65 YEARS

At the time of independence, Makrana was the sole producer of marble in the state. The total marble production in 1950 was 17620 tonnes and revenue earning through marble was Rs. 1.78 lakh. Since then, a tremendous change has been occurred in the marble scenario of the state. A number of new marble deposits have been located, explored and exploited in various parts of the state and today it is being produced in 20 districts. The marble industry in Rajasthan has flourished after 1980's as indicated by continuous increase in production, number of leases and revenue. The marble production which was only 17620 tonnes in 1950 has been increased to 132.09 Lakh tons and revenue from Rs. 1,17,880/- to Rs. 240.67 Crores in 2012-2013. Such a drastic change in marble scenario during last 68 years of independence has generated job opportunities manifold. A large number of persons are engaged in marble mining and marble based industries. This has uplifted the socio-economic status of the people working in marble mines and associated with marble industries.



Photo 1: Conventional method of marble block recovery



Photo 2: Use of diamond wire saw for marble block recovery



Photo 3: Diamond gang saw for cutting of marble block



Photo 4: Unsystematic mining of marble at Makrana



Photo 5: Land degradation due to disposal of marble waste



Photo 6: Change in Land Use by disposal of waste in agricultural fields



Photo 7: Unsafe work conditions of mine labours causing occupational health problems



Photo 8: View of systematic marble mine

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