Jaisalmer Golden Limestone and Sandstone: A Heritage Stone Province from the Desert of Western India



ABSTRACT

The yellow limestone and sandstone of Jaisalmer, famous as golden stones, have been extensively used in architectonic heritage of western India. The golden yellow limestone and sandstone built architectonic heritage impart an exquisite character to Jaisalmer city, which is popularly known as 'The Golden City'. The yellow limestone and sandstone, well exposed around the Jaisalmer city, belong to the Jaisalmer Formation of Jurassic age. The Jaisalmer stones are golden-yellow and largely comprise alternating limestone and sandstone with minutely variable carbonate and siliciclastic contents. Jaisalmer limestone is hard, compact with low porosity and smooth surface. The quarrying of ornamental yellow limestone and sandstone have been going around the city of Jaisalmer since decades. The yellow limestone and calcareous sandstone are commonly traded as yellow marble and generally used as flooring tiles, wall claddings, counter tops and most importantly as an ornamental stone. The yellow limestone and sandstone of Jaisalmer Formation from India can be designated as 'GHSR' (Copper et al., 2013).

PETROGRAPHY

- The limestone has been classified into carbonate microfacies varying from oolitic, peloidal to bioclastic grainstone, wackestone and packstone (Mahender and Banerji, 1990; Singh, 2006; Pandey et al., 2012; Ahmad et al., 2017).
- The golden-yellow to grey coloured, dominantly fine to medium grained, well-bedded, hard Jaisalmer Formation sandstones are largely classified as calcareous arenites by Mahender and Banerji, (1990); Singh, (2006); Pandey et al., (2014); Patra et al., (2014) and Ahmad et al., 2017 and references therein).
- The Jaisalmer limestones comprise 42% to 51% calcium oxide (Srivastave and Ranawat, 2015).

INTRODUCTION

- The Heritage Stone Sub-commission is doing a pioneering work of designating natural stones of significance as 'Global Heritage Stone Resource' from around the globe which have been used in the historic past and have been part of culture and heritage of human civilization.
- The yellow Jaisalmer limestone and sandstone of Jaisalmer Formation have been extensively used in the making of the architectural monuments in and around Jaisalmer city.
- The Jaisalmer Fort, commonly referred to as 'Golden Fort', was built in Jaisalmer limestone and sandstone and is currently listed as a UNESCO world heritage site.
- This stone is still being quarried from the nearby quarries and is preferred as building stone in this part of India.
- The extensive use of the Jaisalmer stone in historic past has encouraged us to promote the Jaisalmer sandstone and the Jaisalmer limestone to be nominated as 'Global Heritage Stone Resource' and together as 'Global Heritage Stone Province' as per the Terms of Reference defined by the Heritage Stone Sub-commission (Marker, 2015).



Figure 4. a. Hand specimen of Amarsagar Jain temple Stone. Photomicrographs of the Figure 5. a. Hand specimen of Vyas cenotaph. Photomicrographs of the same under b. PPL same under b. PPL c. XPL. The stone is a coarse grained calcareous sandstone with c. XPL. The stone is peloidal to bioclastic grainstone. This shows variation in grain size more than 50 percent quartz grains in calcareous cement. Fossils like gastropods (1) from fine to coarse (bottom to top) indicating progradation. Fossils like bivalves (1), (mud-filled), ostracods, ?bryozoa, broken shell fragments of bivalves (2) and burrows ostracods, forams, burrows are present. are present.



from Gadisar lake side d. aerial view of Jaisalmer city from Jaisalmer fort. (photos: Gurmeet Haveli d. elephant carved out of yellow limestone at the entrance of Nathmal ki Haveli. Kaur and Anuvinder Ahuja)

Figure 9. a. Entrance of Jaisalmer fort b. side view of Jaisalmer fort c.view of Jaisalmer fort Figure 10. Havelis in Jaisalmer a. Patwon ki Haveli b. Salim Singh Ki Haveli c. Nathmal ki Figure 11. a. Gadisar Lake Cenotaphs (chhatris) b. Vyas Cenotaphs c. Bada Figure 12. a-b. Lodurva Temple c-d. Amarsagar Jain Bagh Cenotaphs d. Close up view of Bada Bagh cenotaphs e. Kuldhar (photos: Gurmeet Kaur and Anuvinder Ahuja) Abandoned village f. Close up of Kuldhar village ruins.(photos: Gurmeet Kaur and Anuvinder Ahuja)

CONCLUSIONS

- The Jaisalmer yellow limestone and sandstone have been used since 11th century.
- The monuments built in the past several centuries and decades have survived on account of the stones texture and durability.
- The stone is being continuously quarried from the areas in the vicinity of Jaisalmer city for building purpose and is extensively used nationwide.
- The modern resorts and palaces constructed in locally available stone using traditional architectural designs contribute to the preservation of rich heritage of Jaisalmer.
- The wide use of aesthetically vibrant golden Yellow limestone and sandstone in many architectonic heritage built in the past allows us to nominate the two golden stones of Jaisalmer as 'Global Heritage Stone Resource' and together they can be designated as 'Global Heritage Stone Province' as they are geologically related in space and time.

Parminder Kaur¹, Gurmeet Kaur¹, Seema Singh¹, Om Bhargava¹, Kireet Acharya², Sanchit Garg¹, Amritpaul Singh¹, Rakesh Giri Goswami³, Anuvinder Ahuja⁴ and Jaspreet Saini¹

(1) Panjab University, Geology, Chandigarh, India (prm.cheema01@gmail.com),

(2) JM Environet (Ensyscon) Pvt. Ltd., Jaipur, India, (3) B-97, Saraswati Nagar, Jodhpur, India (4) F-90 D, Sec-57, SL3 Gurgaon, India



Figure 1. Geological Map of Jaisalmer Basin (modified after Pandey et al., 2012)

OBJECTIVES

- Quarries and deposits of Jaisalmer stone.

GEOLOGY OF THE AREA

- of Indian.
- rocks forms the basement of the Jaisalmer basin.
- et al., 2012 and references therein).



Legend

Baisakhi Formation

Badabag Member

Fort Member

Jovan Membe

Lathi Formation

Jajiya Member Oolitic and bioturbated limestone

Hamira Member Calcareous sandstones

Kuldhar Member Fossiliferous limestone, silty marls, shales

70°50'0"E

Badabagh

Amarsagar Lodurva

71°0'0"E

0 1 2 4 Kilometers

Siltstones, sandstones, shelly and sandy limestones, intraformational conglomerate Jaisalmer

andstones and fossiliferous and

Limestones (with reworked large coral heads and bioturbated), fine-grained sandstones

Figure 6. a. Hand specimen of Bada Bagh cenotaph. Photomicrographs of the same under b. PPL c. XPL. The sample is peloidal to bioclastic grainstonepackstone. It is characterized by spherical to sub spherical peloids present in are present.









Ahmad, F., Ahmad, A. H. M., & Quasim, M. A. (2017). Diagenetic features of Jurassic Fort Member sandstone, Jaisalmer formation, western Rajasthan. Journal of the Geological Society of India, 90 (3), 273-282 Cooper, B.J., Marker, B.R., Pereira, D. and Schouenborg, B. (2013). Establishment of the" Heritage Stone Task Group" (HSTG). Episodes, 36(1), pp.8-10. Das Gupta, S.K. (1975). A revision of the Mesozoic–Tertiary Stratigraphy of the Jaisalmer Basin, Rajasthan. Indian Journal of Earth Sciences, 2, 1: 77–94. Kachhara, R.P., Jodhawat, R.L. (1981). On the age of Jaisalmer Formation, Rajasthan, India. Proceedings of IX Indian Colloquium on Micropalaeontology and Stratigraphy: 235–247. Udaipur. Mahendra. K., Banerji, R.K. (1990). Petrography, diagenesis and depositional environment of Middle Jurassic Jaisalmer Carbonates, Rajasthan, India. Indian Journal of Earth Sciences, 17, 3/4: 194–207. Marker, B. (2015). Procedures and criteria for the definition of Global Heritage Stone Resources. Global Heritage Stone: towards international recognition of building and ornamental stones. Geological Society o London. pp. 5-10.

• To promote the Jaisalmer yellow limestone and sandstone around the globe.

• Highlight prominent architectonic heritage built in the Jaisalmer yellow stone.

• The Jaisalmer Basin is a sedimentary basin located in the northwestern margin

• The Pre-Cambrian Malani Igneous Suite (770-750 Ma) and the metamorphic

• The Jaisalmer Basin is divided into four formations (Fig. 1): Lathi Formation, Jaisalmer Formation, Baisakhi Formation and Bhadasar Formation (Pandey

• It comprises alternate sequences of yellow limestone and sandstone.

• Based upon the study of Narayan et al. (1961); Das Gupta (1975) and Kachhara and Jodhawat (1981), Jaisalmer Formation is further divided into six

Figure 7. a. Hand specimen of commercial variety Tariwala (Jaisalmer Limestone). Figure 8. a. Hand specimen of commercial variety Eta gold (Yellow Jaisalmer Stone). Photomicrographs of the same under b. PPL c. XPL. The sample is a fine grained peloidal limestone with calcareous cement. It is wackestone with a few grains of micritic to sparitic matrix. Fossils like echinoids, corals, foraminifers (1), bivalves angular to subangular quartz are embedded in fine to coarse grained matrix. The fossils in the rock are ammonites (1), bivalves and foraminifers. Oolites have subrounded quartz as nucleus.

Photomicrographs of the same under b. PPL c. XPL. The sample is a fine grained peloidal and oolitic limestone with calcareous and ferrugeneous cement. Forams (1), echinoids and broken shells of bivalves (2) are present.



Temple. The limestone and sandstone used in the temples are decorated by fine and minute ornate carvings.(photos: Gurmeet Kaur and Anuvinder Ahuja) temples.(photos: Gurmeet Kaur and Anuvinder Ahuja)



e. Minute carvings on walls, f. flooring g and h. jali work, i. intricate work on ceiling in Lodurva



top b. furniture c. fountain d. table e. stairs f. carved jalis. Gurmeet Kaur and Anuvinder Ahuja) (photos: Gurmeet Kaur and Anuvinder Ahuja)

Pandey, D.K., Choudhary, S.H.I.P.R.A., Bahadur, T.E.J., Swami, N., Poonia, D. and Sha, J., 2012. A review of the Lower-lowermost Upper Jurassic facies and stratigraphy of the Jaisalmer Basin, western Rajastha Volumina Jurassica, 10(10), pp.61-82 Patra, A., Singh, B.P. and Srivastava, V.K. (2014). Provenance of the late Paleocene sandstones of the Jaisalmer Basin, Western India. Journal of the Geological Society of India, 83(6), pp.657-664.

Narayanan, K., Subrahmanyan, M., Srinivasan, S. (1961) Geology of Jaisalmer. Unpublished report O.N.G.C. Dehradun, India

Singh, N.P., Sharma, M., Jha, N., Tewari, R., Saleem, M., Matsumaru, K., Ehiro, M., Kojima, S., Jauhri, A.K., Misra, P.K. and Kishore, S. (2006). Mesozoic lithostratigraphy of the Jaisalmer basin, Rajasthan. Journal

Palaeontological Society of India, 51(2), pp.1-25. Srivastave, N. and Ranawat, T.S. (2015). An overview of Yellow Limestone deposits of the Jaisalmer Basin, Rajasthan, India. Volumina Jurassica, 13(1), pp.107-112.

QUARRIES AND DEPOSITS

It is quarried from the areas around Jaisalmer city and the nearby quarries of Amarsagar, Lodurva, Bada Bagh, Moolsagar, Cipala, Jethwai and Hamira (Fig. 3) which provided the stone for the construction of architectonic heritage of Jaisalmer and surrounding region (Table 1.)

COMMERCIAL VARIETIES

current scenario :

• There are two commercial varieties in the

a. Tariwala Marble: Soft limestone that can be easily carved and is widely used for fine and intricate carvings, sculptures, jalis etc. **b. Eta Gold Marble**: Limestone with linear patterns of dark brown colour against the yellow background and is commonly used for flooring, wall cladding purposes.



presentation participates in OS

Figure 3. Quarries of Jaisalmer limestone and sandstone around Jaisalmer (photos: Gurmeet Kaur and Anuvinder Ahuja)

 Table 1. Monuments made in Yellow Jaisalmer Stone

no	Heritage buildings and monuments	Location	Rock type	History/age	Significant attributes
	Jaisalmer Fort	26° 54' 46.08" N 70° 54' 47.16" E	Yellow limestone	Built in 1156 A.D by Rao Jaisal Rajput and Islamic style of architecture	Known as Sonar Qila or Golden Fort Living fort
	Jain Temples	26° 54' 43.57" N 70° 54' 42.84" E	Yellow Stone	Date back to 12 th and 15 th century	Dilwara style architecture with human and animals carvings on walls
	Patwon ki Haveli	26° 54' 59.04" N 70° 54' 51.48" E	Yellow sandstone	Built by Guman Chand Patwa in 1805 and the five havelis constructed in time period of 50 years.	Cluster of five havelis famous for its art work on walls, jharokhas.
	Salim Singh ki Haveli	26° 54' 49.68" N 70° 54' 57.96" E	Yellow sandstone	Built by Salim Singh in 1815.	Roof built in form of Peacock
	Nathmal ki Haveli	26° 54' 56.93" N 70° 54' 45.71" E	Yellow Stone	Constructed by Maharawal Beri Sal in 19 th century	Elephant carved from Yellow stone at entrance.
	Gadisar Lake Temple and Chattris	26° 54' 30.57" N 70° 55' 23.12" E	Yellow Stone	Built in 1156 A.D by King Jaisal, renovated by Maharaja Garsi Singh in 1367 A.D.	Lake surrounded by Temple o Lord Shiva and carved Chhatris
	Mandir Palace	26° 54' 57.6" N 70° 54' 37.44" E	Yellow Stone	Built by Maharaja Jawahir Singh	Adorned with canopies, ornate balconies and exquisite stone carvings
	Jawahir Vilas	26° 55' 02.48" N 70° 54' 10.54" E	Yellow Stone	Built by Maharaja Jawahir Singh at end of 19 th century.	Typical Rajasthani architectur with chhatris and jharokhas.
	Vyas Chattri	26° 55' 20.64" N 70° 54' 23.76" E	Yellow Stone	Cenotaphs dedicated to Sage Vyas, author of Mahabharta	Made up of delicate carvings
).	Bada Bag	26° 57' 19.44" N 70° 53' 9.6" E	Yellow Stone	Constructed in early 16 th century by Maharawal Jait Singh and finally completed by his son Lunakaran	Garden famous for incomparable cenotaphs built as a tribute to rulers of Bhatti dynasty
•	Lodurva Temple	26° 56' 11.46" N 70° 52' 18.09" E	Yellow Stone	Jain temples rebuilt in 1970's	Delwara style architecture
2.	Amar Sagar Jain Temple	26° 55' 45.77" N 70° 52' 16.70" E	Yellow Stone	Constructed by Himat Rai Bafna in 1871 A.D.	Intricate carvings and Sikhara on second storey with Gakhada
3.	Shiv Mandir, Barmer	25° 44' 48.15" N 71° 22' 53.29" E	Yellow Stone	Built in 2016	Dedicated to Lord Shiva

Figure 13. a. floral carvings, b and c. Sculptures, d and Figure 14. Contemporary use of yellow stone as a. table Figure 15. Various utensils made up of yellow limestone. (photos

Figure 16. Modern buildings constructed in Jaisalmer Stone. (photos: Gurmeet Kaur and Anuvinder Ahuja)

Pandey DK, Fürsich FT and Alberti M (2014). Stratigraphy and Palaeoenvironments of the Jurassic Rocks of Jaisalmer Basin: Field Guide. Beringeria, Special Issue 9: 111 pp. ISSN 0937-0242.

ACKNOWLEDGEMENTS

I, Parminder Kaur, acknowledge the financial support by IGCP-637 to attend and present work at EGU 2019. PK is thankful to the Chairperson, Department of Geology, Panjab University, Chandigarh for the facilities to carry out research. Special thanks to Mr. Rajeev, Department of Geology, Panjab University for his assistance in making thin sections of the Jaisalmer sandstone and limestone.