JAIPUR, RAJASTHAN - A POTENTIAL GEOPARK OF INDIA

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INTRODUCTION

Proposed Jaipur Geopark covers an area of 33 sq. km and is situated mainly in the old walled city of Jaipur which is popularly known as the Pink City and the City of Victory. Historical and culturally vibrant Jaipur city is the capital city of the Rajasthan state located in northwestern part of India. It was found by *Maharaja Sawai Jai Singh* II in the year 1727 and is known to be one of the oldest well-planned cities of India. Proposed Jaipur Geopark is significantly endowed with the brand of UNESCO'S world heritage city, glorious *Amer* Fort as world Heritage hill Fort along with world's largest *Jantar Mantar,* stone astronomical observatory. Geologically, the hilly terrain of Geopark area represents the oldest fold mountain range of India (part of North Delhi fold belt) with spectacular ground water bodies (Baories) among which the unique Chand Baori is the largest Baori of India. Remarkable palaces, cenotaphs, temples, and museums are constructed by heritage stones showcasing the rich history and culture of Jaipur and representing about 300 year old patronage of our ancestors. All this uniqueness with natural scenic sites and panoramic beauty of Jaipur attracts tourists from all corners of the world. The hilly terrain of rocks of Delhi Supergroup of Alwar sub-basin (except to the south) encircles the Jaipur city in the horse-shoes shaped outcrops. The importance of Jaipur Geopark immensely increases as old Jaipur city has also been selected as one of the heritage cities for Smart City Mission by Govt. of India. Under such a remarkable geological, historical, and cultural scenario with UNESCO brandings, twenty six geosites have been identified representing four geoheritage types of regional, national and international significance (Ruban, 2010 and Brilha, 2016). Accordingly, these are i. Geological, ii. Geomorphological, iii. Hydrogeological, iv. Archaeological type geoheritage. Combination of all these geoheritage types of educational and geotouristic values in one complex type geosite with existing tourism facilities puts the proposed area in a strong position to develop a dynamic and successful potential Jaipur Geopark in India.

LOCATION AND EXTENT OF GEOPARK AREA

Jaipur, the capital of Rajasthan state is located at about 260 km south-west of New Delhi in the north-western part of India. Jaipur Geopark covering an area of 33 sq. km. represents hilly terrain and plains situated to the west of the Great Thar Desert. Jaipur is well connected by rail and air to major Indian cities. Jaipur has an international airport connecting many important cities of the world through New Delhi. Jaipur is also well connected through NH 8 (now part of the express highway) to Delhi - Mumbai and by National Highway 248 (Fig. 1) to major cities of India through Haryana. All the identified geosites are connected with tar roads and are easy to access.

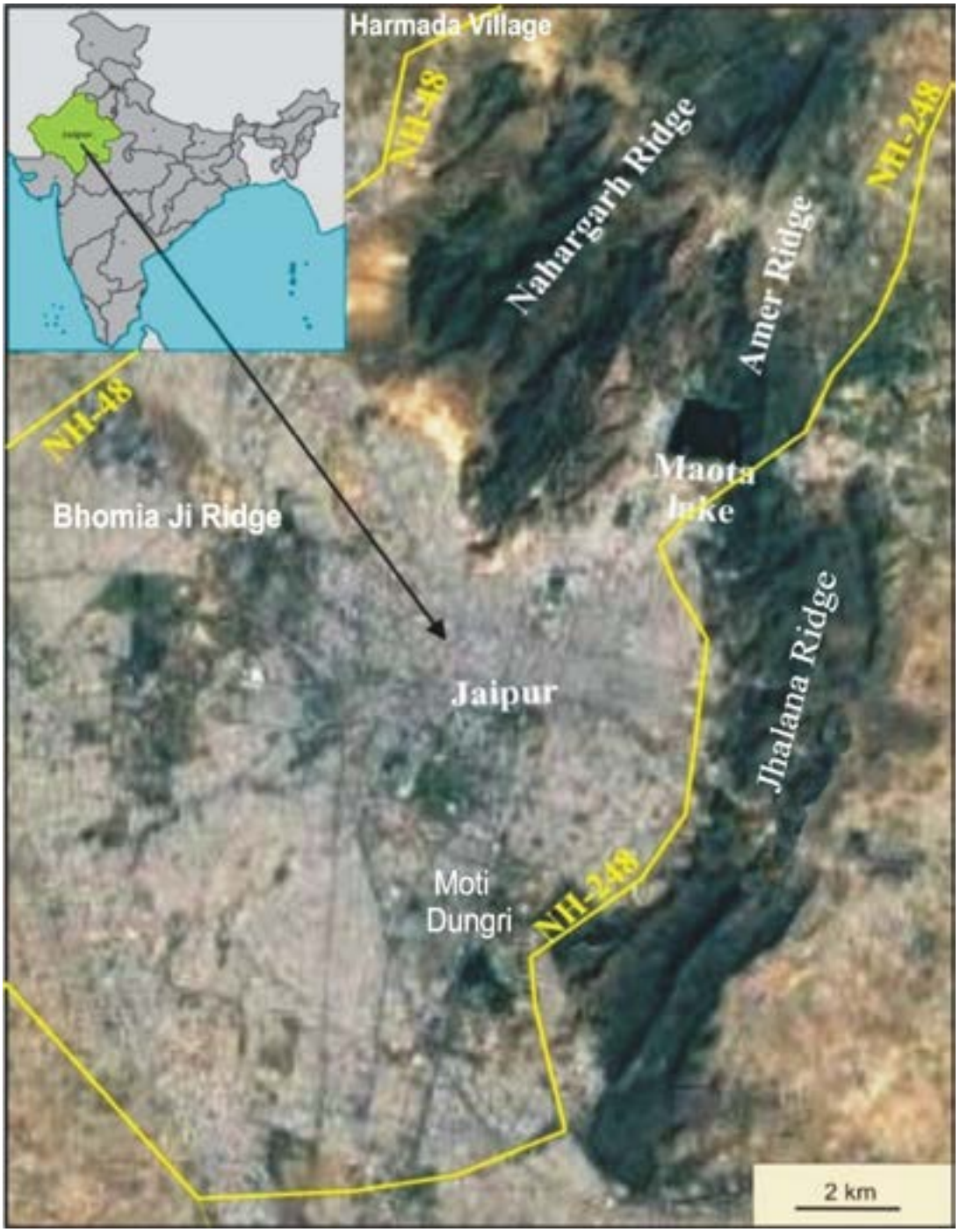

Fig. 1. Google image showing hilly terrain and settlements in the Jaipur Geopark area.

PHYSICAL AND HUMAN GEOGRAPHIC CHARACTERISTICS

Jaipur displays a mosaic of land features: rocky highlands, pediment zone, rocky peneplains, alluvial plains, and Aeolian plains. Rocky High lands feature continuous to discontinuous ridges and hillocks of rocks of Delhi Supergroup representing part of the north Delhi fold belt (NDFB; Fig. 2a and b). Many hillocks are more than 500m in height with *Jaigarh* hillock as the highest peak (648m). The area is also characterized by narrow to wide valleys, numerous small streams, and rivulets. Pediment zone is restricted to a narrow belt that runs along the hill trends comprising of colluvial as

well as dune sands. Alluvial Plains are characterised by a rich assemblage of recent to sub-recent alluvial materials mainly around the *Dravyavati* River. Some Aeolian sand and windblown sands occur around the northern part of the Geopark. In the plain areas, soils are mostly lateritic (red) and arid. All these features constitute the quaternary stratigraphy of the Geopark area.

Till the sixteenth century, the capital of the Jaipur state was *Amer*, which lies at a distance of 11 km from present Jaipur city. The construction of Jaipur city began in 1727 by *Maharaja Jai Singh* and took four years to complete the major roads, offices, and palaces. It is one of the oldest planned cities of India, wonderfully developed adapting the grid method of construction and following the rules of *Vastu Shastra*. The city was divided into nine blocks, out of which two consist of state buildings and palaces, whereas the remaining seven blocks were allotted to the public (Chisholm, 1911; https:\\en.wikipedia.org › wiki › Jaipur). In order to ensure the security of the city, huge fortification walls were built along with seven strong gates. Later, *Maharaja Ram Singh* of Jaipur painted the whole city pink to welcome the Prince of Wales and Queen Victoria in 1876. Subsequently, Lord Albert exclaimed Jaipur to be the 'Pink City', and hence the name. Later on, the city was ruled by several *Rajput* rulers. *Pratap Singh* (1764 - 1803), *Ram Singh* II (1835 - 1880), *Madho Singh* II (1861 - 1922), and *Man Singh* II (1911 – 1949) were among the main rulers who kept the heritage of the city alive. The city was attacked many times by *Marathas.* However Jaipur stayed under the rule of *Rajputs*. Significantly, it was one of the few parts of the country which never came under the rule of the British.

Geopark area of Jaipur has a semi-arid climate. There are three distinct seasons in a year. The winter season lasts from November to February with an average temperature of about 15-18° C with low humidity. December and January are coldest with 5-10°C temperature. Summers (March to June) record an average daily temperature of around 35 to 45°C in which May and June are the hottest. Rest of the months experience rainfall. The city has several industries including cloth, textile, electronics, computers, chemicals, plastics, wood, paper, leather, food, metals, and marble. Jaipur is a hub for gems and metal jewelry, various handicraft items, and camel leather *juttis* (foot wares). Jaipur is 10th among the most populated cities of India with a population of 66, 26,178, as per the 2011 census (https:\\en.wikipedia.org › wiki › Jaipur).

GEOLOGICAL ATTRIBUTES

Hilly terrain around Jaipur represents the southern part of Alwar sub-basin of the NDFB. The BGC, rocks of Aravalli Supergroup and Delhi Supergroup mainly constitute the regional geology of the area (Fig. 2a; Patel, 2018 and Mishra et al., 2020). The rocks of Alwar sub-basin had undergone polyphase deformation and resulted in complex outcrop patterns. The rocks are folded upright to isoclinal shallow to moderate plunging antiforms and complementary synforms trending NNE–SSW. These were subsequently refolded on NW–SE and ENE–WSW axial planes, resulting in axial culminations and depressions. Hilly terrain of the Geopark area is an expression of tectonic activities of the basin represented by four large and bold ridges with two other small hillocks encircling the Jaipur city. Among the four ridges, the first eastern one is *Jhalana* ridge (about 125 km long and 50 km max. width) trending roughly NE-SW; the smaller middle north-eastern one is *Amer* ridge (about 25 km

long and 15km max. width) trending N-S; the third one is largest *Nahargarh* ridge (about 175 km long and 75 km max width) trending roughly NNE-SSW and forth one is *Harmada* ridge (about 112 km long and 11 km max width). Among hillocks, *Bhomia Ji* hillocks in the west and *Moti Dungri* hill in the south-western part together with four ridges are formed horseshoe shaped in which southern part is open plains. The *Jhalana* and *Amer* ridges are separated by a large *Maota* Lake. The *Kanak Vrindawan* and *Amer* valleys are situated between *Jhalana*, *Amer*, and *Nahargar* ridges (Fig. 2b).

The ridges, valleys, and pediment areas of the Geopark area are geologically belonging to the rocks of Delhi Supergroup. The depositional age of these rocks ranges approximately from 1.7 to 1.5 Ga. The Delhi Supergroup in and around the Geopark area can be classified chronologically into three groups (Sinha Roy et al., 1995):

The Ajabgarh Group (Upper) – Dominated by mica schist, quartzite and phyllite.
The Alwar Group (Middle) – Consisting dominantly of quartzite rocks.
The Raialo Group (Lower) - Consists predominantly of carbonate rocks (marble).

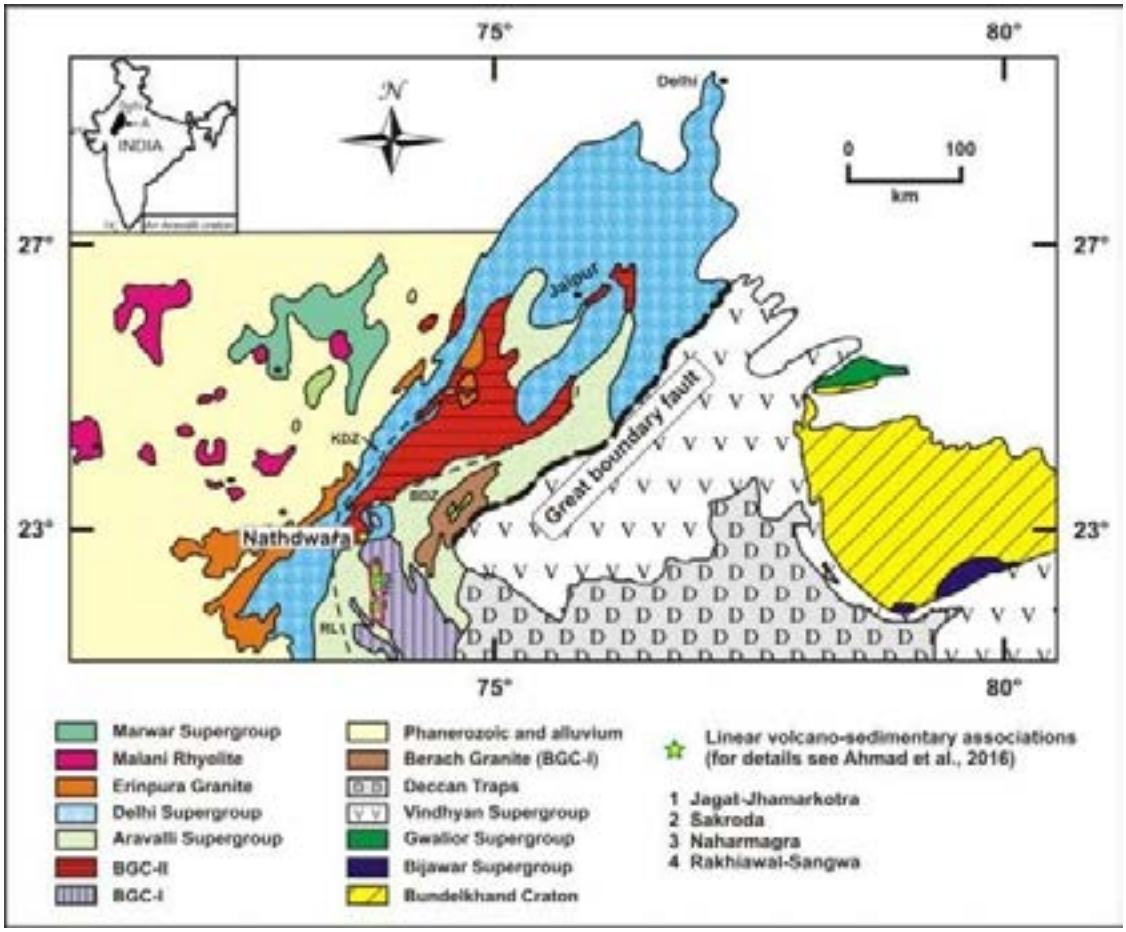

Fig. 2a. Regional geological map of Delhi fold belt (modified from Kaur et al., 2017 and Mishra et al., 2020).

The rocks of these ridges of Geopark area dominantly belonging to Alwar Group with minor occurrences of Railo Group around Andhi area and outer peripheral areas by Ajabgarh Group at foot hills of *Jhalana* ridge. All the ridges and hillocks are dominantly composed of quartzite with minor occurrences of dolomitic marble, mica

schist and minor conglomerate. Amer and Jaigarh ridges of the Geopark area are dominantly composed of quartzite and their variants. At *Nahargarh* ridge, quartzite at places is interbedded with mica-schist with dips towards east and west. Along the road that goes to *Jaigarh* and *Nahargarh* fort, there is profuse development of ripple marks and some unusual trace fossil like structures may be of biogenic nature in quartzite. Quartzite of all ridges is the metamorphosed products of sedimentary origin and is composed of medium to fine-grained quartz, with minor feldspar and muscovite. It shows the colour variation of white to light pink with reddish to dark brown stains of iron oxides. Thin bands of sheared schistose rocks ranging from a few centimetres to more than 1m in thickness can be seen within the easternmost quartzite hill near the Delhi Bypass road and SE of *Jaigarh* Fort. It is interpreted that these schistose bands represent mylonitic bands produced as a result of slippage along bedding faults during the deformation accompanying folding trends of the NDFB.

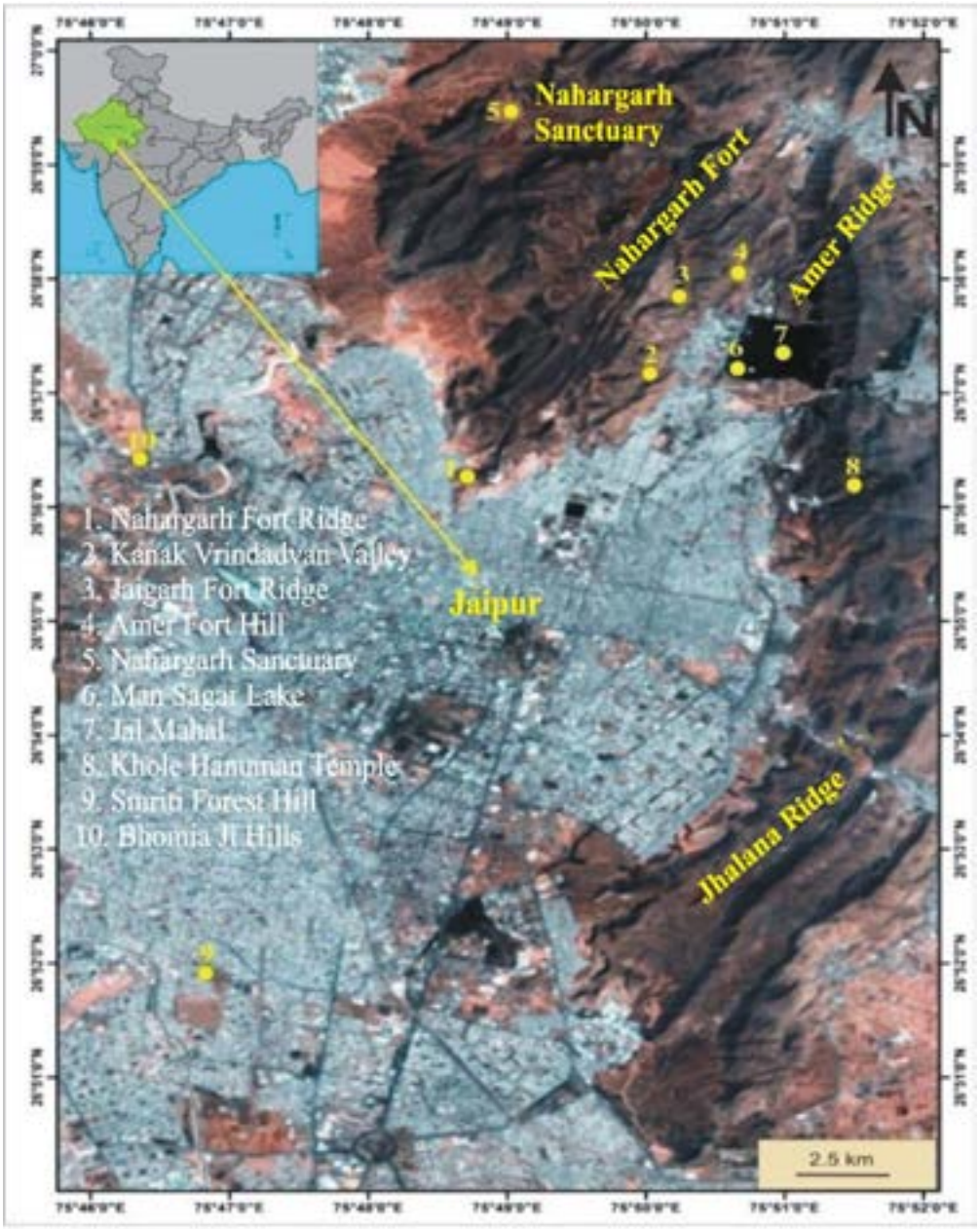

Fig. 2b. Google image showing hilly terrain and geomorphosites of Jaipur Geopark.

Structure

The geological disposition and deformation in ridges of the Geopark area define the major fold where the S0//S1 have a strike of NNE-SSW to NNW-SSE and dip both easterly and westerly, forming a major synformal structure in conformity with the tectonics of the Alwar sub-basin. The beds of quartzite to the east of *Amer* and towards north and east of Jal Mahal show steep westerly dips while beds to the west of *Amer* and *Jal Mahal* show a shallow easterly dip. Thus, the ranges to the east and west of Jal Mahal form the two limbs of an asymmetrical synform. The current bedding in the quartzite on either side of Jal Mahal indicates a normal sequence and hence the major fold can be considered as a syncline. The fold plunges moderately towards SSW. Minor faults are seen in the area within the quartzite of localised nature with minor displacement. A major NE-SW trending fault is inferred west of Amer near Man Sagar Lake where a distinct change in the strike of the quartzite band is noticed on either side of the Lake (Sinha Roy et al., 1995). The quartzite is extensively quarried along the dip slopes of the ridges particularly to the east of *Amer* and west of *Sarwa* village. These materials are being used extensively in Jaipur for construction of buildings and roads and destructed many geoheritage elements in them.

GEOHERITAGE OF THE GEOPARK AREA

The above discussed local geology and our field work reveal that thirty-two geoheritage sites can be recognised in Jaipur Geopark (Fig. 3). Based on Ruban, (2010) and Brilha, (2016), these geomorphosites / geosites can be categorised into four geoheritage types: geological (five geosites), geomorphological (two geosite), hydrogeological (thirteen geosites) and archaeological (i.e. geo-historical, nine and geo-cultural type, three). These four types of geoheritage of Jaipur Geopark are of international, national and regional significance. All together, these will provide an opportunity to create a more balanced development between geoheritage conservation, public education and socio-economic development. Present efforts will certainly help in promoting tourism through geotourism in the region. Among these geoheritage sites, twelve other sites (temples, small ponds, palaces, gardens and museum), which are situated in and around the present geosites, additionally increase the aesthetic values of the Geopark.

A. GEOLOGICAL TYPE GEOHERITAGE

1. *Moti Dungri* (Fig. 4)

Moti Dungri Hillock is situated in the heart of the Jaipur city about eight km from Jaipur railway station and ranges in height from 410 to 450m (Fig. 3). This small hillock is composed of grey to brownish colour quartzite of Alwar Group of Delhi Supergroup. It is a popular tourist attraction because of its rocks, natural beauty, fort, palace and famous *Ganesha* temple. The *Ganesha* Temple was built in the year 1761 under the supervision of *Seth Jai Ram Paliwal* at the top of the hillock. The layout and structure of *Moti Dungri* palace conform to the *Nagara* style and is based on the model of Scottish Castle using limestone, quartzite and marble rocks. At the foothill of *Moti Dungri*, a famous *Lakshmi Narayan* temple is constructed by heritage stone marble named and is famously knowm as *Birla* Temple. All these together impart additional historical and cultural values to this geosite.

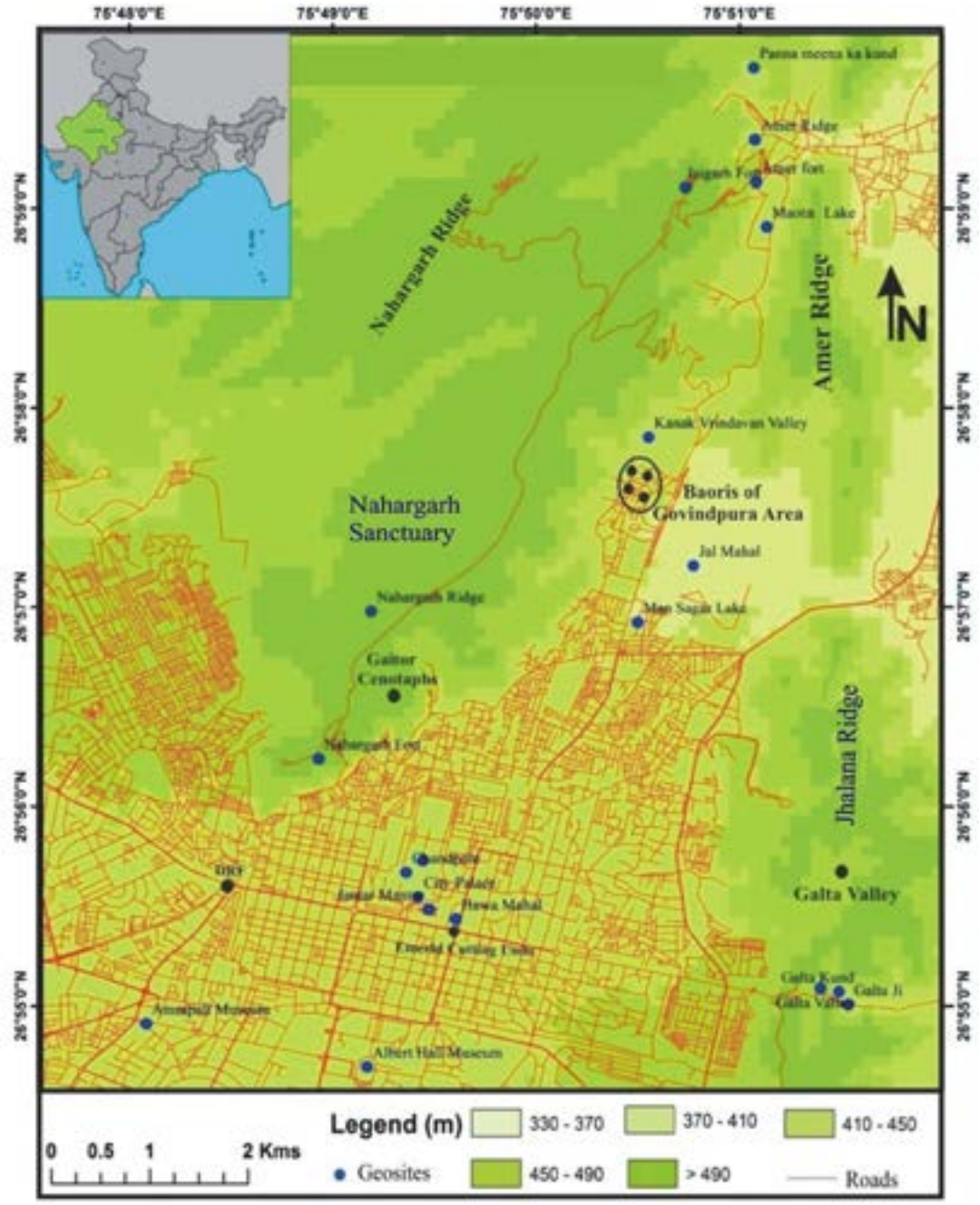

Fig. 3. DEM of the Jaipur Geopark showing various Geosites and Geomorphosites.

2. *Nahargarh* Ridge (Fig. 5)

Hilly terrain with higher elevations (Jaigarh, 648m) in the northern part of Jaipur is represented by many low to high flat-topped hills constituting the largest *Nahargarh* ridge in the Geopark area. The rocks exposed on this ridge have undergone polyphase deformation and represent the western limb of the main synclinal structure. The ridge is dominantly composed of quartzite of fine to medium-grained nature showing granoblastic texture. Northern part of Nahargarh ridge (7.2 sq. km) is a dense dry deciduous and tropical rain forest area known as *Nahargar*h Sanctuary. One can spot leopards and tigers with many other animals here. A small *Nahargarh* Biological Park houses many animals and other wildlife. Due to erosional processes, the southernmost

tip of *Nahargarh* ridge has acquired the shape of an eagle on which *Nahargarh* fort is situated (Fig. 2b and 3).

Fig. 4. Moti Dungri – Its fort and temple.

Fig. 5. Nahargarh Ridge and Jaipur city.

3. *Amer* Ridge (Fig. 6)

Amer ridge is located about 11 km from Jaipur on the Jaipur - Delhi National Highway. It is represented by many forested hills and hillocks with 370 to 450m height promontory that juts into *Maota* Lake. *Amer* ridge is dominantly composed of quartzite of Alwar Group. Quartzite rocks on the ridge represent the eastern limb of the main synclinal structure of Jaipur. A thick unit of mica schist is exposed interbedded with quartzite in the eastern most hillocks near the Delhi Bypass road showing the development of foliation, schistose and lineation structures. Quartzite exposed in the area is being extensively quarried near *Amer* and west of *Sarwa* village.

4. *Andhi* Marble Mine (Fig. 7)

Andhi marble mine area is located at *Andhi* - *Jamwa* -*Ramgarh* areas about 27 km from Jaipur city on Jaipur Alwar road covering about 254 hectares with reserves more than adequate to last next 100 years. *Andhi* marble is dolomitic in nature and belongs to Railo Group. The outcrops of marble mainly occur along the north-eastern periphery of *Jhalana* ridge. Beautiful white colour marble is crystalline and granular in nature and is mainly composed of calcite and dolomite. The area is also known for good processing facilities which make it the “Integrated Marble House of India".

5. Stone industries (The Trading Powerhouse of the Geopark area) (Fig. 8)

Besides processing industries of world heritage marble stone, the proposed Geopark area is also famous for gemstone and jewellery industries. Existence of the stone industries dates back to the early 1700’s when the Jaipur city was founded by *Jai Singh* II of *Amer*. During this period, great importance was placed on bringing in top craftsmen, including jewellers, to create fine products of precious stones for the royal family and to make the city a leading centre for producing fine-quality luxury stony products. As a result, Jaipur now combines traditional colour gemstone cutting and jewellery manufacturing hub and artisans with the most modern techniques. Jaipur is India’s second gem and jewellery exporting centre and tops in sales to foreign tourists. Around 90% of the world-wide emeralds are cut and processed and around 95% of small diamonds are processed in Jaipur for global consumption with precious and semi-precious gems make the Geopark area the main centre of economy in the world.

Fig. 6. *Amer* Ridge and Man Sagar Lake.

Fig. 7. *Andhi* Marble.

Fig. 8. The stone industry of Jaipur.

Fig.9. *Galta* valley, palaces and *Galta* pond.

B. GEOMORPHOLOGICAL TYPE GEOHERITAGE

1. *Galta* valley (Fig. 9)

Galta valley is surrounded by 370 to 490m high series of hills in a ring outline of rocks of NDFB. Dominantly, these hillocks are composed of quartzite of *Jhalana* ridge (Fig. 2b). *Galta* valley, with its enormous natural beauty, is endowed with a small Lake, dense forest, famous Sun Temple, and *Chour* Palace which provide additional cultural and historical values to the valley. A natural spring emerges high on the hill (about 500m), and flows downward filling two ancient Baories and a series of sacred seven ponds (groundwater bodies) making this valley a combination of very important geological, cultural and religious place in Jaipur. *Galta* pond is the holiest which never goes dry because through *gaumukh* (paleo- conduit) water flows continuously even in summers showcasing the knowledge of our ancestors. Monkeys are seen everywhere in this valley. Therefore it is also known as monkey valley.

2. *Kanak Vrindavan* Valley (Fig. 10)

It is located between Nahargarh and Amer ridge, half a km from Govindpura on the way to Amer Fort. *Kanak Vrindavan* valley complex is dominantly surrounded by quartzite hills endowed with the lush green forest and temples constructed by red sandstone. The temples were built around 275 years ago by Maharaja Jai Singh. The hilly terrain of this valley is locally known as *Lakshman Dungri* having another *Govind Devji* temple and famous *Khole Ke Hanuman Ji* Temple located in the south-western direction on *Jhalana* ridge (Fig. 2b). Valley's layout has been given a blend of *Mughal* and *Rajput* architecture and is divided into eight sections with a series of fountains of marble, intricate '*chhatries*' (cenotaphs), exquisite buildings

with *'jali'* (stone network carving) providing additional cultural values to the *Kanak Vrindavan* valley geosite (Fig. 2b).

C. HYDROGEOLOGICAL TYPE GEOHERITAGE

1. *Ramgarh* Lake (Fig. 11)

It is a naturally turned artificial Lake, situated near *Jamwa Ramgarh* village located about 25 km north-east of Jaipur. It covers 15.5 sq. km. area with nearly 4 km in length and 2 km in width. The Lake is surrounded dominantly by low to high ridges and hillocks of quartzite of Alwar Group. Opposite to the gate of the Lake, at the foot hill of quartzite section, there is excellent preservation of many types of sedimentary structures among which ripple marks are dominant and well preserved. Earlier, the Lake was the main source of water supply to Jaipur city and was a popular picnic spot, particularly after the rowing events held here in 1982 during the Asian Games. At the same time, the dense forest surrounding the Lake and the nearby area was declared as a wildlife sanctuary by the Government of India. Subsequently, during the next three decades, the water body has degraded due to negligence, pollution and encroachments. Rajasthan High Court in 2011 had ordered the district administration to clean and remove encroachments. This order helped in renovating and reviving the Lake to some extent. There are ruins of an old fort and temple of *Jamwa Mata* which reveal the glorious history of Lake and surroundings.

Fig. 10. *Kanak Vrindavan* valley and temple.

Fig. 11. *Ramgarh* Lake.

2. Dravyavati River Front (Fig. 12)

Earlier, known as *Amanishah Nala,* it originates from the western slope of Amer Ridge near *Jaisalya* village is now an important hydrogeological site of Jaipur. It flows through the Jaipur city over a length of 42 km collecting storm and waste water from *Naharika, Ambabari, Ganda Nala* to finally join the *Dhund* River. Looking to its degraded conditions, Govt. of Rajasthan in 2015 started renovation work with the construction of 85 check dams and 122 fall structures to name it as Dravyavati River Front (DRF). Under this work, three mega parks with thousands of species of plants, exhibition centers and audio-video rooms were built near *Shipra Path*, *Bambala Bridge and Pani Pech* along with 40 washrooms. With these efforts and development works, the glory of the River returned and now it is an art and cultural hub with several shops, open amphitheaters, cycling track with a walkway for jogging, smart polls with Wi-Fi, LED lights, CCTVs and environmental monitoring systems (Report of Ministry of Environment, 2015). This project proved to be a big river rejuvenation project which converts it into a riverine geomorphosites of modern time.

3. *Man Sagar* Lake (Fig. 13)

It is a natural cum artificial Lake named after *Maharaja Man Singh* who constructed it by damming the River *Dravyavati* almost at the junction of hilly areas of *Nahargarh, Amer* and *Jhalana* ridges (Fig. 2b). Initially, the dam was constructed using local quartzite across the eastern hilly terrain of Amer hills. Jal Mahal is situated in the middle of the blue water Lake. It has a water spread area of 300 acres and is surrounded by the rocks of NDFB on the north, west and eastern sides. On the southern side, 300m long and 30m wide dam has been constructed with an outlet for irrigation system. The catchment area of the Lake is 24 sq. km contributed by surrounding hilly terrain (Report on Man Sagar Lake, 2015). Two large streams drained water from *Nahargarh* and *Amer* ridge and brought in untreated sewage and sediment run-offs which polluted the Lake. Reserve forest area of the Lake catchment has several wildlife species such as deer, jungle cat, striped hyena, Indian fox, wild boar and leopards. Beautiful *Jal Mahal* in middle of the Lake, dam embankment, a curved road with greenery, impart spectacular look to make this site as an important tourist attraction of Jaipur.

Fig. 12. *Dravyavati* River Front.

Fig. 13. *Man Sagar* Lake and *Jal Mahal.*

4. *Maota* Lake (Fig. 14)

Below the superb *Amer* fort, lies the *Maota* Lake (*Mahavata* Lake) which swathes the pink city in its allure in the monsoons giving the residents and tourists a chance to capture this absolute visual delight. *Maota* Lake is located about 11km from Jaipur. The Lake collects rainwater flowing down from the nearby hills and *Amer* fort ridge. It was the main source of water for the *Amer* Fort and the common people of old *Amer* town. The Lake contains an island in the center known as *Kesar Kyari Bagh* or saffron garden. Another garden, the *Dil-Aaram Bagh* is situated on the northern end of the lake. These together make this site a most spectacular tourist place of Jaipur.

5. *Chand Baori* (Fig. 15)

Chand Baori situated in *Abhaneri* (*Abha nagri*), near Jaipur was built during the 9th century by the *Chauhan* ruler named *Raja Chanda of Nikumbha* dynasty. Visually spectacular, it is considered as the oldest, deepest and biggest step well in the world. This remarkable structure is square in shape having 13 stories and is 19.5m deep with a temple on one side, and the main gate is located in north. The northern side consist of a multi-storeyed corridor supported on pillars and two projecting balconies enshrining beautiful images of goddess *Mahishasurmardini* and Lord *Ganesha*. It has 3500 steps which are criss-crossed with double flights on three sides while the fourth side boasts of a pavilion with beautifully carved *jharokhas* (windows) and galleries supported by pillars and two projecting balconies. These civil engineering structures, with beautiful sculptures of the magnificent architecture of old patronage of the city,

not only make it a famous tourist place but also an important cultural and religious place of Jaipur. Presently, it is a famous film shooting location for the world (Singh et al., 2019).

Fig. 14. *Maota* Lake and *Amer* Fort.

Fig. 15. *Chand Baori.*

6. *Panna Meena Ki Baori* (Fig. 16)

The amazing ancient yellow colored step well complex of *Panna Meena Ki Baori* is situated on the Jaipur - Amer road towards the north foot hills of *Amer* ridge. It was constructed by Jai Singh in 16th century and is named after *Panna Miah*. It is an eight storied octagonal-shaped magnificent step well. The symmetrical arrangement of criss-cross manner stairs in all four sides with a room on its northern wall imparts a spectacular look to this step well. The recessed doorways and the octagonal gazebos represent the engineering and architectural marvel of old patronage of the city (Singh et al., 2019).

7. Baories of Govindpura area

a. *Parshu Ram Baori* (Fig. 17)

It is located in Govindpura area on the Jaipur - Amer road on the opposite side of *Jal Mahal*. The *Baori* is situated in the large historical complex housing a famous *Parshu Ram* temple. This temple is very famous in Jaipur having great religious values. *Parshu Ram* Baori is a small rectangular ground water body with beautiful symmetrically arranged steps with terrace on all the four sides. The *Baori* is constructed by sandstone having lush green trees all around, imparting a beautiful look to this geosite - like swimming pool of modern days.

Fig. 16. *Panna Meena ki Baori.*

Fig. 17. *Parshu Ram Baori.*

b. *Kale Hanuman Baori* (Fig. 18)

It is located near *Parshuram Baori* just opposite *Jal Mahal* near the famous *Kale Hanuman* temple. At the entrance of this *Baori,* a beautiful, three arch-shaped gateway with many small carved arches impart a beautiful look to this *Baori*. From the gate, steps are on one side while other three sides have several arched verandas; the top floor has balcony - like terrace bounded by carved *jalies* of sandstone. All these features impart a heritage look to this groundwater body.

c. *Cheela Baori* (Fig. 19)

Cheela Baori is located inside Govindpura area near the road that goes to *Amer*. It is an open linear structure with about 10m in length and 5m in width. It is situated at the foot hills of *Amer* ridge surrounded by several houses. It has almost dried up and is degrading very fast as the locals use it as a dustbin. It has two beautiful levels with three gateways, each of which has arched pillars and many steps of sandstone which impart a beautiful look to it.

Fig. 18. *Kale Hanuman Baori.*

Fig. 19. *Cheela Baori.*

d. *Naku Baori* (Fig. 20)

It is located near *Cheela Baori* inside *Govindpura* area near the road which goes to *Amer*. It is also an open structure having three levels. Each level has arched pillars and few steps of sandstone. This *Baori* has almost dried, its steps are broken and the whole structure is degrading very fast. Renovation work has been taken up to revive it because it is an important place for rituals for local people.

e. *Mahadev Baori* (Fig. 21)

It is located inside *Govindpura area* near *Naku Baori* on the road that goes to *Amer*. This beautiful *Baori* has three floors, each floor has three arches having steps on one side which are broken at many places. The northern side consists of multi-storeyed pavilions supported on arches, pillars and two projecting balconies, imparting a spectacular view to the *Baori.* On the top floor, a balcony is constructed with beautifully carved sandstone to have a Panaromic view of *Amer* hills. Presently, it is in a pathetic condition and needs urgent renovation.

f. *Rukmani Baori* (Fig. 22)

It is located in *Govindpura* area on the Jaipur - *Amer* road. This *Baori* is in good condition having a single floor with an arched gate constructed by carved sandstone. It is a compact structure and well protected by walls from all sides. The top steps take you down to the terrace from a small gate. All step-wells (groundwater bodies) of

Govindpura area showcasing water conservation and water harvesting systems are undoubtedly the heritage structures of old times that have fallen into disuse with the time. However, to preserve their heritage look and values, and also to revive these ancient water conservation systems, the Govt. of Rajasthan renovated all *Baoris* in the year 2016 under *Jal Swavlamban* scheme (Singh et al., 2019).

Fig. 20. *Naku* Baori.

Fig. 21. *Mahadev* Baori.

D. ARCHAEOLOGICAL GEOHERITAGE

The historical and cultural sites which are constructed by rocks are considered as geo-monumental geosite of archaeological geoheritage types. These geosites played a subordinate role in the promotion of geotourism in the Geopark area by imparting additional cultural and historical values (Brilha, 2016). Jaipur Geopark has many such sites that can be classified into two categories: a. Geo-historical and b. Geo-cultural. The monumental type sites are similar to geo-monumental geosites of *Sanriku* shrine of *Sanriku* Geopark, Japan.

a. Geo-historical Type Monuments:

1. *Amer* Fort (Fig. 23)

Amer Fort is situated on *Amer* ridge about eleven km from Jaipur railway station on National Highway that goes to Delhi. It was originally built by the *Meena* ruler in the ninth century. Later on, it was built over the remnants of the earlier structure during the reign of Man Singh in the sixteenth century and expanded by his descendant, Jai Singh I in the eighteenth century. Palaces and buildings of the fort are constructed by red sandstone and marble, influenced by *Mughal* architecture. Large rampants, series of large gates, four courtyards, attractive opulent palaces with four levels, and large *Jalebi Chowk* (ground) make it a massive and magnificent old civil engineering structure. A lush green garden with a hexagonal design was built on high platforms in the third courtyard. Looking to its glorious history, architecture, and planned civil engineering work, it was declared as UNESCO'S World Heritage fort in 2013 during the 37th session of the World Heritage Committee held at Phnom Penh, Cambodia.

2. *Nahargarh* Fort (Fig. 24)

Nahargarh Fort stands on the southern edge of *Cheel ka Teela* (Hill of Eagles) of Nahargarh ridge (abode of tigers). Situated about 18 km from Jaipur it is a monumental edifice of Jaipur built in the year 1734 by *Maharaja Madho Singh*. It consists of a huge gate, two temples, beautiful palaces, *Diwan-I-Aam, Madhavendra* palace, *Sheesh Mahal* (Glass Palace) and an open-air enclosure displaying

remarkable European, *Mughal*, and *Rajput* architecture. Another palace is utilized to house a wax museum having a life-like replica of many national heroes. There is an extended wall which connects it to *Jaigarh* Fort. Surrounding hills of the fort also significantly endorse a rare combination of three ecosystems - Aravalli Ecosystem, Desert Ecosystem, and Wetland Ecosystem named as *Nahargarh* Sanctuary and biological Park. The biological park houses Asian lions, Bengal Tiger, Leopard, Indian Wolf, Striped Hyena, Jackals, Wild Boar, Indian Gharial, Himalayan Black Bear, and Sloth Bear and is also famous for safari and adventure tours.

Fig. 22. *Rukmani Baori.*

Fig. 23. *Amer* Fort.

3. *Jaigarh* Fort (Fig. 25)

Jaigarh Fort (Victory Fort) is located 10 km from Jaipur at *Jaigarh* hill. It is a grand structure perched on the top of one of the highest hillocks of *Nahargarh* ridge. It was built by *Jai Singh* II in 1726 to protect the Amer Fort. The beautiful palaces were designed by Mr. Vidyadhar, a famous architect of the old time. The fort premises have a length of three km along the north-south direction and a width of one kilometre. It was constructed 400 m above the Amer Fort. The fort is highly fortified with thick walls of red sandstone. In this massive civil structure, there are two beautiful palaces, two temples and a central watch tower which impart a royal look to the fort. It is a famous tourist place of Jaipur and also a favourite place for nature walk groups.

Fig. 24. *Nahargarh* hill and Fort.

Fig. 25. *Jaigarh* hill and Fort.

4. City Palace complex (Fig. 26)

The city palace complex was constructed with the establishment of Jaipur by *Jai Singh* II in 1727. Initially, the city palace was the ceremonial and administrative place of the Maharaja of Jaipur. This heritage monument boasts a blend of *Mughal*, European and *Rajput* architecture which resulted in a magnificent building. The complex is also the location of religious and cultural buildings as well as a patron of arts, commerce and industries. It now partly houses a museum named as *Man Singh* museum and the other part continues to be the home of the royal family. Other palaces in the complex include the *Chandra Mahal* and *Mubarak Mahal* along with various other buildings like Lile museum, the famous *Govind Dev* temple of great religious significance and a library. On display at the City Palace Museum are rare manuscripts, *Mughal* and *Rajasthani* miniature arts, weapons and antique items used by the royal family earlier.

5. Royal Gaitor Cenotaphs (Fig. 27)

Royal Gaitor (means resting place of the departed souls) is a magnificent walled funerary complex of the royal family situated in a beautiful small valley surrounded by quartzite hills of Nahargarh ridge. It is constructed of white marble with a majestic appearance reflecting typical *Rajput* and *Mughal* style of architecture. There are three sets of different marble cenotaphs with well carved tombs. Gleaming domed pavilions make them a real hidden gem of architectural beauty and craftsmanship. Ample greenery, small valley and hilly terrain make the environment of this place a calm, cool and peaceful site of Jaipur.

Fig. 26. City Palace.

Fig. 27. Gaitor Cenotaphs.

6. *Jal Mahal*, or Water Palace (Fig. 13 and 28)

The splendid *Jal Mahal* is situated in the centre of the *Man Sagar Lake*. It is an architectural beauty of the *Rajput* style with a five storied palace of red sandstone. The top floor is exposed having rectangular four cenotaphs (*Chhatries*) on each corner erected over cremation platforms of some of the *Kachhwaha* rulers of Jaipur. Because of water logging, the palace had suffered subsidence in the past and also partial seepage which has been repaired under a restoration project of the Government of Rajasthan in 2003. Under this project, a convention centre, art gallery, multiplex, entertainment centre, arts and craft village, hotels, restaurants, food courts, and

gardens at bank of the Lake were developed and it is now the most attractive tourist place of Jaipur.

7. *Chand Pole* or Moon Gate (Fig. 29)

Almost three centuries old *Chandpole* offers spectacular views of the world famous old pink market and glimpses of the Rajasthani culture in the walled city of Jaipur. Besides the plethora of palaces, forts, lakes and Baories, the Geopark area is also the ultimate shopping paradise of India**.** The *Chandpole* market is most famous because of its alluring Rajasthani quintessential products including textiles, handicrafts, brass works and precious stones. The market is architecturally and symmetrically developed having shops with a *verandah*s on both sides stretched up to *Choti Chopar*. *Johari Bazaar* (jewellery Market) inside *Chand pole* is one of the oldest markets known for its vibrant ambiance, premium quality gemstones, jewellery of gold, silver, diamonds, emeralds and rubies. Adjoining *Bapu Bazaar* is mainly famous for leather items and *Mojari* (footwear of camel leather) with Rajasthani *sarees* and *lehenga*s, perfumes, metal, sandstone and marble handicrafts items.

Fig. 28. *Jal Mahal.*

Fig. 29. *Chand Pole.*

8. *Hawa Mahal* (Fig. 30)

Pink coloured *Hawa Mahal* (Palace of Winds) is situated near the city palace inside the walled Jaipur city. It was built by *Maharaja Pratap Singh* in 1799. The purpose of this intricately carved five-storied pyramidal shaped monument of sandstone with 953 small windows was to allow women from royal families to observe the processions (especially world fame *Gangaur* festival) passing through the road below. Among the five floors, the top three floors have the width of a single room while the first and second floors have patios in front of them. The front elevation is like a honeycomb with small portholes. Each porthole has miniature windows and carved sandstone grills, finials and domes with decorated *Jharokhas*. Intricate lattice work make it a beautiful historical and culturally magnificent edifice.

9. *Jantar Mantar* (Fig. 31)

Jantar Mantar, the largest stone astronomical observatory in the world is situated just near the city palace in Jaipur. It was built by *Sawai Jai Singh* in the year 1734. Covering about 18,700 sq. m area, *Jantar Mantar* is an old patronage of Jaipur with the brand of UNESCO World Heritage site. It is still in operational condition and built remarkably by sandstone and marble. Bronze tablets, bricks and mortar were employed to make its instruments. The monumental instruments are operating in three main classical celestial coordinate systems: the horizon-zenith local system, the equatorial system, and the ecliptic system. Each instrument carries an astronomical scale, marked on the inner marble lining. The observatory consists of nineteen instruments for measuring time, predicting eclipses, tracking the location of major stars, ascertaining the declinations of planets and determining the celestial altitudes and related ephemerides. Because of these significances, it is a popular educational site and tourist attraction in the world as it showcases India's scientific prowess at a time when even in the US this type of outdoor laboratory did not exist (Sharma, 2016).

Fig. 30. *Hawa Mahal.*

Fig. 31. *Jantar Mantar.*

E. UNIQUE CULTURAL TYPE GEOHERITAGE

1. Albert Hall (Fig. 32)

Albert Hall Museum (named after King Edward VII) is one of the oldest museums in India. It was opened publically in 1887 and later on designated as the state museum of Rajasthan. It has a rich collection of various kinds of antique items such as paintings, carpets; ivory, stone, metal sculptures and colourful crystal works representing old time art, culture and traditions. It is surrounded by a lush green *Ram Nivas* Garden stuffed with appealing fountains and dazzling serene pools. Besides this park, the Geopark area has many other lush green gardens which add beauty and tranquillity to Jaipur. These include *Sisodia* Garden, *Vidyadhar* Garden, Central Park garden, Science park, *Shaheed Bhagat Singh* park, *Jhalana* park, *Jai Niwas* garden and *Zawahar* circle garden. *Zawahar* circle garden is considered as the largest circular park and circle in Asia having a beautiful Rajasthan *Patrika* (news paper) gate. It is a magnificent civil structure

with park and *chata Chauk* (food corners) for local people and is a famous tourist place of Jaipur.

2. *Amrapali* Museum (Fig. 33)

The recently opened *Amrapali* Museum is a unique museum of this type in the world. It is situated about 2 km from Albert hall museum. It exhibits a great collection of jewellery in different forms and designs in precious metals (gold, silver, platinum and pearl). It is considered to be a treasure of jewellery of old to modern designs. Nearly 4,000 artefacts, painstakingly collected from across the Indian subcontinent are showcased here.

Fig. 32. Albert Hall Museum.

Fig. 33. *Amrapali* Museum.

3. *Govind Dev* Temple (Fig. 34)

Govind Dev Temple is located in the city palace campus in heart of Jaipur. The largest temple in the world of that time was constructed by red sandstone by *Man Singh* in 1590. The temple is 117 feet in length with a width of 105 feet. Additionally, 135 acres of land is reserved for cowshed (*Gaushala*) for cows to live and feed. The Temple has become religiously famous because when Emperor *Aurangzeb* tried to destroy the shrine at *Vrindavan,* it is said that the idol was picked up from there and relocated to this temple to save the unique idol of Krishna. Locals believe that the statue of the deity here looks exactly like that of Krishna when he descended on Earth.

Fig. 34. *Govind Dev* Temple.

CURRENT STATUS IN TERMS OF PROTECTION AND MANAGEMENT

Most of the geoheritage sites of Jaipur Geopark except a few hydro-geological types are well-conserved and have educational values that can be utilized as geotourism sites as an additional element for the promotion of tourism in the region. Additionally, the scenic landform, historical and cultural values of these geosites, these are popular nationally and internationally as some of these are with UNESCO branding. Usually, UG, PG and research students of many Universities conduct their educational tour every year to these sites. Necessary infrastructural facilities are available at almost all geosites/ geomorphosites and can be utilized for geotourism by training new entrepreneurs and guides or those already working there. Importantly, all these geosites are easily accessible through tar roads situated on the suggested route map (Fig. 3). However, few geosites of hydrogeological geoheritage types need conservation as suggested by Mathur et al., (2020) for Indian geosites. For promotional activities, many videos of tourist places of Jaipur are already available but these need some modification to include geotourism values of sites. Because of these specialities and aspects, potential Jaipur Geopark satisfies the requirements of UNESCO (GGN, 2004). Jaipur significantly having four types of geoheritage undoubtedly of national and international values, are the strength of the proposed Geopark. Most of the geosites are unique and representative of educational, aesthetic, historical, cultural and geotourism values. Majority of geosites are well managed by local Govt., private stakeholders, trusts and individuals and are in good condition. Additionally, a legal body with the inclusion of local Govt., administration, stakeholders, academicians and experts on geoheritage should be setup to achieve the goal of Jaipur Geopark in future.

CURRENT OR POTENTIAL THREATS AND REMEDIAL MEASURES FOR GEOCONSERVATION

Few geosites especially geological features at various hills and Baories of *Govindpura* area of Jaipur Geopark, are poorly managed and are under serious natural and anthropological threat. To save these geosites, protected status can help in mitigating negative natural (erosion, weathering, and siltation) and anthropogenic (mining of rocks, unplanned urbanization and infrastructural development activities) influence damages, as suggested by Mathur et al., (2020). Among hydrogeological sites (few *Baories*) which are not covered under *Jal Swavlamban* Scheme of the state government, require urgent maintenance and conservation. As a whole, the geosites under the Geopark management system can be a better option for their conservation and utilization in the future for the socio-economic development of the region.

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