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Geotourism Prospect in and around Dubrajpur, Birbhum, West Bengal, India

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ABSTRACT

In this era, it is not a luxury to see new places but a natural urge of the people, making tourism a huge industry. Tourists used to travel and tour for religious, cultural, educational, employment, business, health and adventure purposes. Geomorphologically, the Indian subcontinent is a land of great diversity. It is famous for its grand scenery. Almost all the geomorphic landscapes of the earth are present in this subcontinent. The Himalaya came up with blessings for India and India's grand scenery in the subcontinent. Geotourism is a new form of tourism that is based on geomorphology, geology and also on different geological environments. Geotourism offers a new form of sustainable tourism that is more holistic than previous niche forms of tourism. There are some incredible rocks/rock formations across the Indian Sub-continent which can be the foundation of a geotourism site. The balancing rock forms a startling type, where one or more rocks are balancing on each other. Some of the finest examples are the 'Balancing rock' of Jabalpur, the balancing rock of Mahabalipuram, Tamil Nadu which is distinguished as 'Krishna's Butter Ball', and the balancing rocks of 'Mama-Bhagne Pahar' in Dubrajpur. Among these three amazing spots, the first two is already well known to tourists, however, Mama-Bhagne pahar also offers a famous geomorphosite that has potential from geotourism perspective. However, there are some problems related to anthropogenic interventions that have to overcome to make it a famous geotourism site. Therefore, in the present study, an attempt has been made to formulate geoconservation and geotourism development strategies for the concerned geomorphosite that will protect the site from human activities and promote local tourism in a sustainable way. Moreover, Dubrajpur is located in the approachable vicinity of some popular and famous tourist spots of Birbhum district like Tarapith, Nalhati, Pathar Chapuri, Siuri, Amkhoi, Bolpur, Santiniketan and the very famous Bakreswar.

Keywords*: Geomorphosite, Geodiversity, Geotourism, Mama-Bhagne pahar, Anthropogenic Interventions, Bakreswar, Amkhoi*

1. Introduction

There is immense contrast in geology, structure, tectonism, climate, and elevation along with the long coastal zone in India. This huge diversity in landforms is known as geodiversity. Abiotic richness is also indicated by the geodiversity. During the early 90s', the concept of geodiversity emerged. Sharples (1993) [1] defined geodiversity as "the diversity of Earth features and systems". Some elaboration was given to Sharples's definition. And the definition emerged as "the diversity of Earth's features and systems" [1]. Later, the definition was elaborated and it included ''the range or diversity of geological (bedrock), geomorphological (landform) and soil features, assemblages, systems and processes" [2, 3, 4]. Later Gary (2004) [5] define geodiversity as "the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landform, processes) and soil features including their assemblages, relationships, properties, interpretations and systems". Researchers and developers are trying to define "Geotourism" in different possible ways for the past few years. The term "Geotourism" was first coined by Tourtellot and Sally [6]. It is a new and fast-growing special tourism [7] where high values of geological and geographical landscapes act as the center of attraction. Geotourism nurtures abiotic elements of nature [8] and focuses on the interpretation and preservation of these earthly features by increasing their touristic value. But that is not the case in ecotourism. Ecotourism focuses on the biotic elements i.e., on flora and fauna. And in the year 1995, Thomas Alfred Hose defined it as "The provision of interpretative and service facilities for geosites and geomorphosites and their encompassing topography, together with their associated in-situ and ex-situ artifacts, to constituency-build for their conservation by generating appreciation, learning, and research by and for current and future generations" [9, 10].

The Indian subcontinent is a land of great diversity in terms of geomorphology and is famous for its grand scenery. Almost each and every geomorphic landscape are there in this subcontinent which are comparable to any other such continental landscapes of the world. Starting from the striking glacier valley of Siachen, the frozen ice peaks of Kangchenjunga to the mangrove forest of Sundarbans, the coral chains of Andaman, rocky-sandy desert of Jaisalmer and Thar, dense forest of Bandhabgarh, brakish water lakes of Kerala, flat top mountains of Decan Trap are a few among others are there to give the witness of geodiversity of India. Towering Himalaya formed, out of the Tethys Sea and the adjacent foreland basin, due to the northward drifting of India and collision with Eurasia. The formation of the Himalaya is a blessing for the development of the grand scenery in the Indian subcontinent. Some of the oldest rocks present on the planet Earth is there in the geomorphologically diversified India. Rocks ranging from Archean age to Quaternary age are also there in India. As a result, the Indian landmass gets enough time for landscape evolution due to this long timescale [11].

There are some incredible rocks/rock formations in India. Because of the amazing shape and size of these natural rocks, they have ranked in the list of the World's most amazing rock formations [11]. Some of these rocks/rock formations are turtle-shaped 'Toad Rock' near Nakki Lake of Arbuda Mountain; 'Bugle Rock' is a massive rock in Bangalore; black basalt rock of 'Gilbert Hill' of Andheri, Maharashtra; 'Yana Rocks', located in the Sahyadri mountain range of the Western Ghats; 'Marble Rocks' of Jabalpur; pillar-shaped

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'Pillar Rocks' of Kodaikanal, Tamil Nadu; 'Phantom Rock' of Wayanad, Kerala; 'Hampi's Boulders' or 'Running Rocks' of Hampi; 'Nijagal Betta' near Bangalore; 'Natural Arch' of Tirumala hills of Andhra Pradesh [11]. The Rock art of Bhimbetka and huge rock-cut images of Unakoti hills are a few amazements of India. Because of all these varieties of landforms and landscapes, India become one of the most fascinating places on the planet Earth.

Apart from these above features, there are a few amazing landforms are there in India where one or more rocks are balancing with each other. But they are stable for hundreds of years. These are called 'Balancing Rocks' of India. This types of three famous landforms are there in India. These are the 'Balancing rock' of Jabalpur (Fig. 1), 'Krishna's Butter Ball' – balancing rock at Mahabalipuram, Tamil Nadu (Fig. 2), and the balancing rocks of 'Mama-Bhagne Pahar' in Dubrajpur (Fig. 3). First two are very renowned and very popular to the tourist. Contextually, 'Krishna's Butter Ball' – the balancing rock of Mahabalipuram, Tamil Nadu is a UNESCO World Heritage Site. Jabalpur is also very famous among the tourists. In comparison, '*Mama-Bhagne Pahar'* is not well introduced to the people may be due to lack of publicity and negligence of the authority to some extent.

Fig. 1: Balancing Rocks of Jabalpur, Madhya Pradesh, India.

This stunning rock formation is the extension of the Chota Nagpur Plateau in Dubrajpur, Birbhum. Here, two rocks balanced over each other naturally and are regarded as a tourist spot as many people come to see the very existence of the balancing rock formation. Because of the astonishing balance and bonding of the two rocks, they are known as Mama and Bhagne, and the hill is known as 'Mama-Bhagne Pahar'. The shape of these two rocks is globular. Field investigation indicates the pair of these rocks are of granite rock. Microscopic study of thin sections of these rocks under plain polarized and crossed polarized light corroborates the granitic interpretation (Fig. 4). Apart from these two main balancing rocks, there are numerous fractured boulders in and around them. The rocks here are composed of grey granite with a mineral composition of plagioclase feldspar,

Fig. 2: Balancing rock at Mahabalipuram, Tamil Nadu, distinguished as 'Krishna's Butter Ball'.

Fig. 3: Mama-Bhagne Pahar of Dubrajpur.

K-feldspar, biotite, and apatite (Fig. 4). The famous Shiva Temple or 'Pahareswar' temple is situated at the base of the hill. According to the geologists, volcanic eruption created this rock formation along with the balancing rock during the formation of the Chota Nagpur Plateau [12].

The visitors will have a strange affection with magnificent stretches of rural fields in the entire area. Most of the rocks here in Dubrajpur 'Mama-Bhagne' pahar are spherical in shape. Though the rocks are of different shapes and sizes, they are a creation of nature.

If you look at the size of these three balancing rocks, the size of Mama-Bhagne pahar is much bigger. Even complexity-wise, Mama-Bhagne pahar is more complex compared to the balancing rocks of Mahabalipuram and Jabalpur. But, both Mahabalipuram and Jabalpur are well-established tourist spots due to the policy by the authorities. Moreover, these three areas have been formed due to some

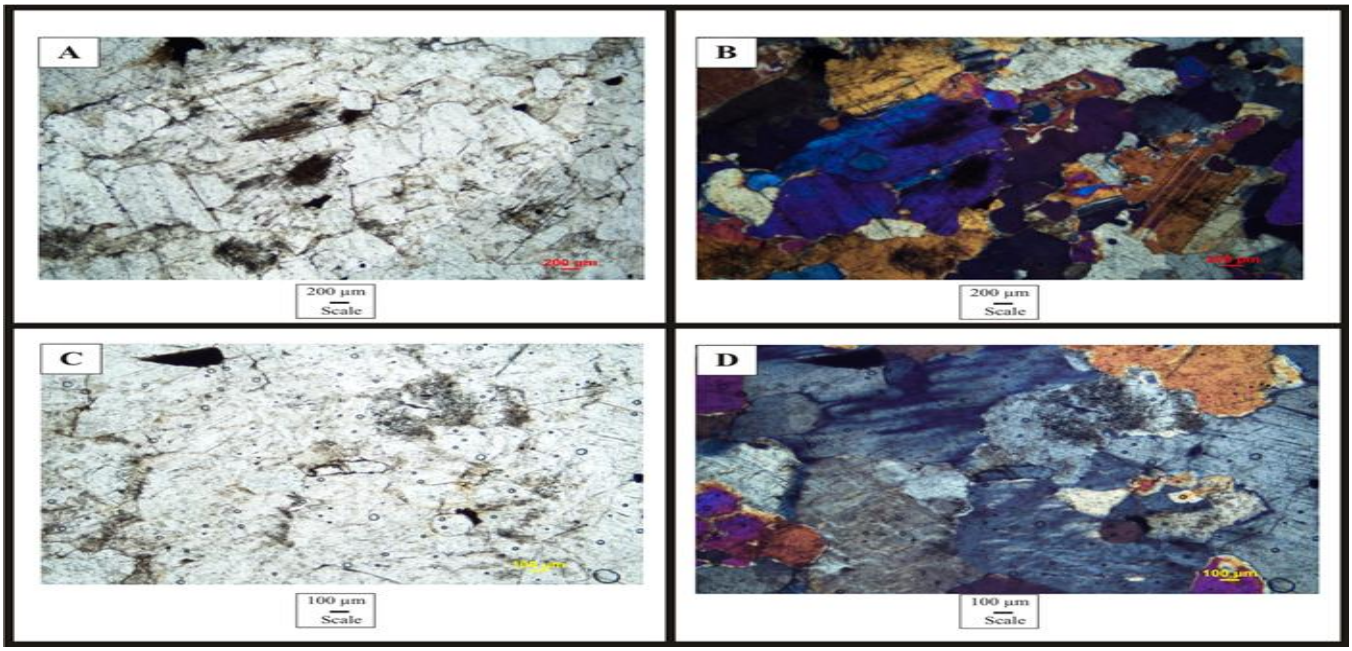


Fig. 4: Photomicrographs of Rock of Mama-Bhagne pahar (A & C: under Plain Polarized Light & B & D: under Crossed Polarized Light)

geological events. Like Mama-Bhagne pahar formed due to volcanic eruption along with Chota Nagpur Plateau. So, due to both geological and geomorphological evolution, Mama-Bhagne pahar has evolved. Thus, tourist spots like Mama-Bhagne pahar can be famous for geotourism if we opt for a sustainable tourism process here in Dubrajpur.

Geosites are part of the geosphere with a specific significance to understand the history of the earth and different human-recognized geological geomorphological features with a scientific, cultural/historical, aesthetic, and/or social/economic value [11]. Lithological sites, stratotypes, geosystems, geological or geomorphological landscapes, caves and grottos, mineral sites, historical mine sites, fossil sites, meteorite impacts, and the geological environment that supports an ecosystem all are part of geosites (Fig. 5).

2. Geology of the Study Area:

The Rajmahal basin is situated to the northeast of the Damodar basin, in Peninsular India (Fig. 6). Trend of the basin is in the north–south oriented. Exposed Gondwana sediments in this area are bounded by the Ganga River in the north, by Rajmahal Traps in the east, metamorphic rocks in the west and laterite and alluvium in the south (Table – 1). At the Western flanks of the Rajmahal Basin, a number of detached outcrops of the Gondwana sediments are exposed laterally [13].

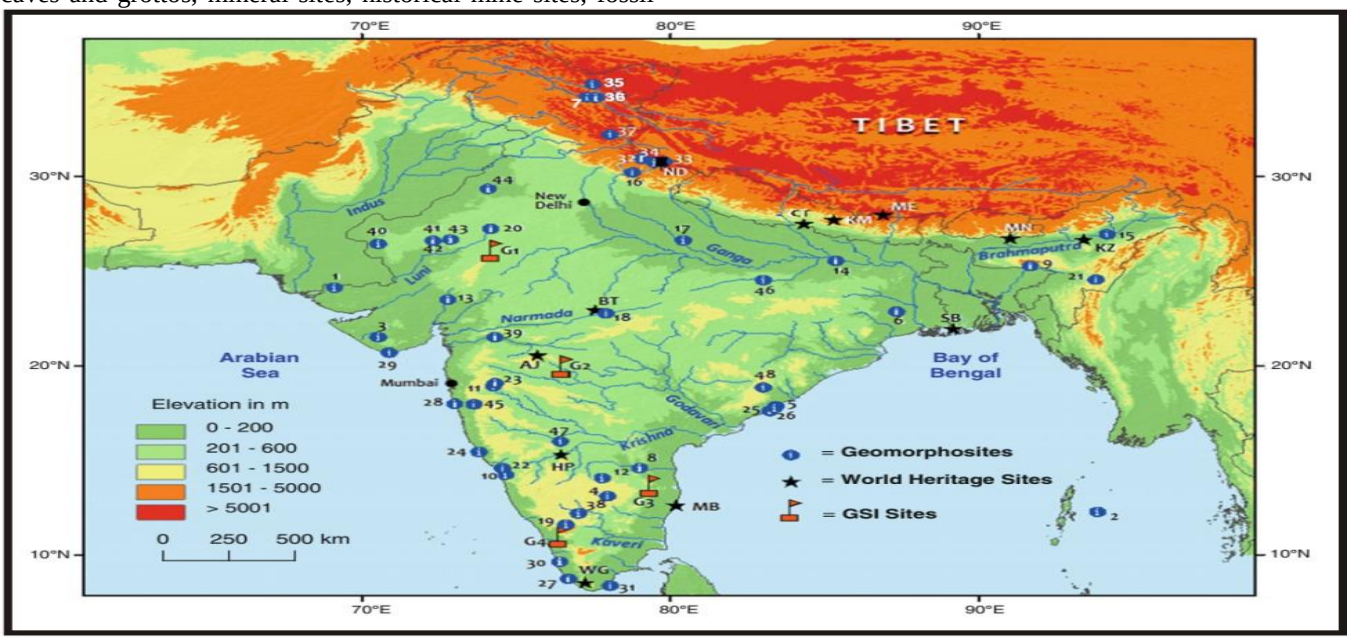
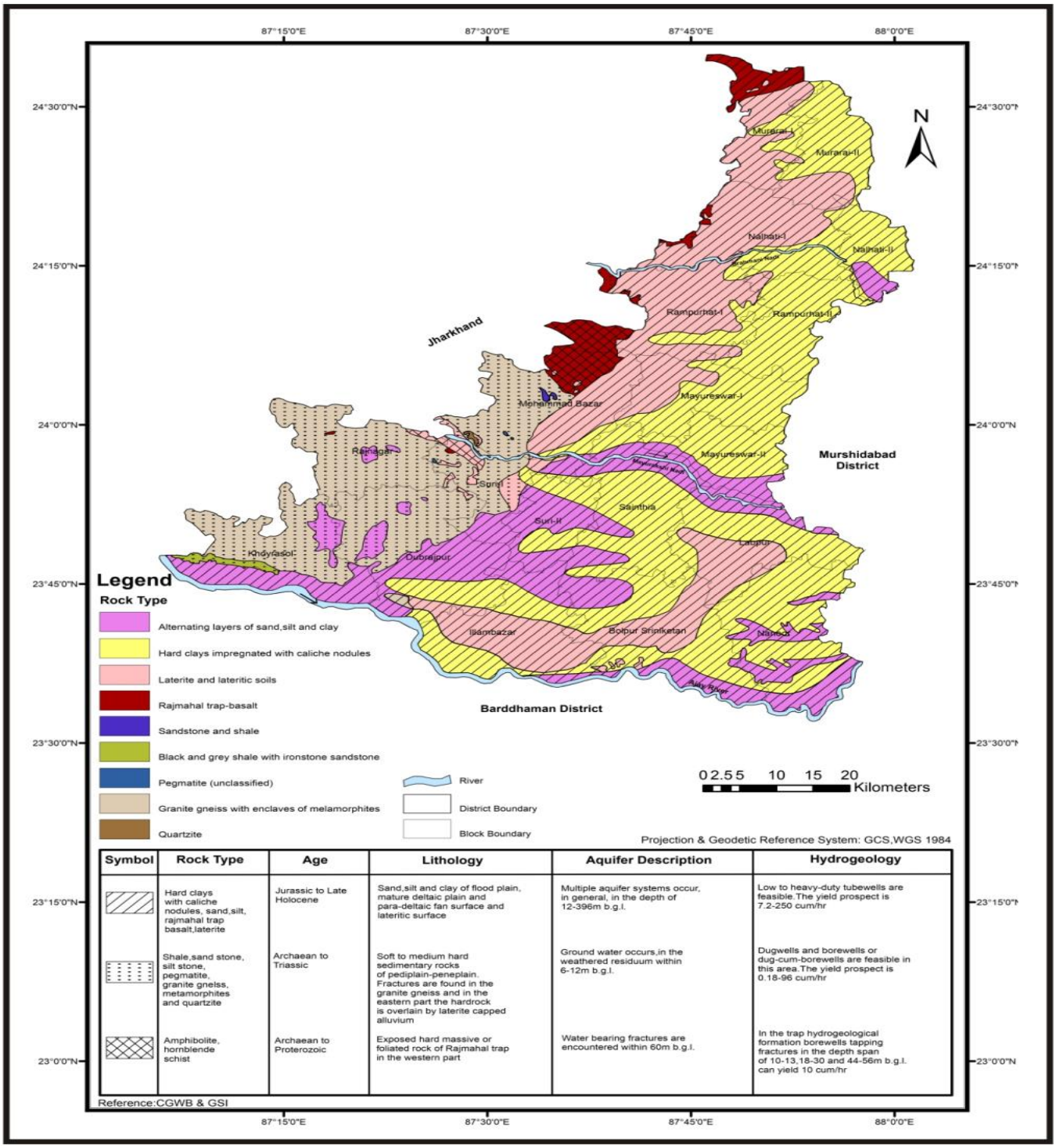


Fig. 5: The potential geomorphosites in India [11]



Symbol	Rock Type	Age	Lithology	Aquifer Description	Hydrogeology
	Hard clays with caliche nodules, sand,silt, rajmahal trap basalt,laterite	Jurassic to Late Holocene	Sand,silt and clay of flood plain, mature deltaic plain and para-deltaic fan surface and lateritic surface	Multiple aquifer systems occur, in general, in the depth of 12-396m b.g.l.	Low to heavy-duty tubewells are feasible.The yield prospect is 7.2-250 cum/hr
	Shale,sand stone, silt stone, pegmatite, granite gneiss, metamorphites and quartzite	Archaean to Triassic	Soft to medium hard sedimentary rocks of pediplain-peneplain. Fractures are found in the granite gneiss and in the eastern part the hardrock is overlain by laterite capped alluvium	Ground water occurs,in the weathered residuum within 6-12m b.g.l.	Dugwells and borewells or dug-cum-borewells are feasible in this area.The yield prospect is 0.18-96 cum/hr
	Amphibolite, hornblende schist	Archaean to Proterozoic	Exposed hard massive or foliated rock of Rajmahal trap in the western part	Water bearing fractures are encountered within 60m b.g.l.	In the trap hydrogeological formation borewells tapping fractures in the depth span of 10-13,18-30 and 44-56m b.g.l. can yield 10 cum/hr

Fig. 6: Generalized Stratigraphic Map of Birbhum District.

Table-1 shows the Gondowana succession as it has developed in the Rajmahal basin [14-16]. Gondwana succession is again divided into Lower Gondwana succession and Upper Gondwana succession. The Lower Gondwana Group consists of the Early Permian Talchir Formation (Asselian–Sakmarian) and the Early Permian Barakar Formation (Artinskian–Kungurian) [17]. Whereas, Dubrajpur and Rajmahal formations together form the Upper Gondwana Group [13]. The Dubrajpur Formation unconformably overlies the Barakar Formation, showing that erosion was active between the two periods of deposition [16].

The centers of tourist appeal across the world are the spectacular scenic beauty or cultural heritage or other forms of the touristic charm of a lot of places. Due to the lack of responsible and conservative nature of travel, many promising tourist places are ruined especially because of environmental

Table – 1: Generalized Stratigraphical Succession of the Rajmahal Basin [14, 15, 16]

Series	Lithostratigraphic Unit	Lithology
Recent	Alluvium	Loose soil, silt, and clay
Upper Tertiary	Alluvium	Coarse- to medium-grained sandstone, gravel, pebble beds
----------Unconformity----------		
Lower Cretaceous	Rajmahal Formation (traps and intertrappean)	Flows of basalt, pitchstone, and intertrappean beds (sandstone, shale, ash)
Lower Triassic to Lower Cretaceous	Dubrajpur Formation	Pebbly and coarse- to medium-grained sandstone, siltstone, clay, grey to pink shale
----------Unconformity----------		
Upper Permian		Coal, shale, sandstone
Lower Permian	Barakar Formation	Coarse- to medium-grained and pebbly sandstone, grey shale, clay and coal
	Talchir Formation	Tillite, fine- to medium-grained sandstone, olive-green shale
----------Unconformity----------		
Precambrian		Basement rocks, amphibolite, quartzite, gneiss and granite

problems [18]. As a result, the tourist place was unable to achieve the sustainable goal of tourism. Again, some areas are vulnerable in spite of their tourism potential. Therefore, prudent drafting and evaluation are required to sustain the immaculate standard of mother earth. If we want to bring cerebral peacefulness and pleasure in humanity, then tranquility and a pristine class of nature will help more than that of a decomposed natural scenery [19]. Fortunately, there are still many pockets in India which are unexplored and own huge tourism potential.

3. Discussion

It is a very futuristic idea to identify the tourism potential of any area. Tourism gives rise to income for the local people, eases the poverty situations, and guides sustainable development as well as socio-economic development for the tourist spots and adjoining areas. The centers of tourist appeal across the world are the spectacular scenic beauty or cultural heritage or other forms of the touristic charm of a lot of places. Many promising tourist places are ruined especially because of environmental problems [18]. As a result, the tourist place was unable to achieve the sustainable goal of tourism. Again, some areas are vulnerable in spite of their tourism potential. Thus, to sustain the immaculate standard of mother earth, prudent drafting and evaluation are required [19]. If we want to bring cerebral peacefulness and pleasure in humanity, then tranquility and a pristine class of nature will help more than that of a decomposed natural scenery [19] [Repetition, change it]. Fortunately, there are still many pockets in India that are unexplored and own huge tourism potential.

Mama-Bhagne pahar is located at Dubrajpur of the district of Birbhum, West Bengal, India (Fig. 7) [20, 21]. It is a hill-like rock formation. From the scientific viewpoint, it is not a hill but an excellent example of tors which are formed by several huge granite rocks (Fig. 8). Among these granite rocks, the famous Mama-Bhagne pahar is balancing one on top of the others (Fig. 3) and thus creating the one of the biggest balancing rock of India and a good geomorphosites. The grey-coloured granites present here in Mama-Bhagne pahar are made up of glassy quartz, plagioclase feldspar, K-feldspar and black biotite (Fig. 4) [22]. Mama-Bhagne pahar is the far-reaching part of Chotanagpur Granite Gneiss Complex (CGGC) [22]. By using Linton's two-stage model, we can explain the formation of Mama-Bhagne pahar [23]. Due to volcanic eruption during the Archean period, intrusion of granite took place in this area. Later, due to warm, humid climates, chemical weathering took place during the Tertiary period resulting in thick regolith with core rock. Finally, the core rock has an upstanding tor result because thick regolith has been removed by erosion.

For the reconstruction of local paleo-geomorphic processes and paleoclimate, Mama-Bhagne pahar has great importance. That is why it has significant scientific value in terms of geology and geomorphology. The area is not more than 1 sq. km and is referred to as "Pahareswar" or "God of the rock" by the local people (Fig. 9). According to the belief of the Santhal tribes, the place belongs to "Bongaburu", God of the tribal people. So, Mama-Bhagne pahar also has cultural or religious value. That is why local people made a temple of Lord Shiva or "Pahareswar" at the base of the 'pahar', known as "Paharreswar Mandir" (Fig. 10). Height of Mama-Bhagne pahar is about 122 m. Balancing rocks on the hill attracts thousands of tourists every year because of its aesthetic view. Mama-Bhagne pahar has a circumference of about 1252.49 m and an area of about 73,665 sq. m. [21]. Hence, such a typical landform can be undoubtedly termed as geomorphosite because of its scientific, cultural, aesthetic, and socio-economic values. Geomorphisite covering $\geq$ 1 sq. km area but $<$ 10 sq. km are considered medium-scale geomorphosites as per Brocx and Semeniuk [24].

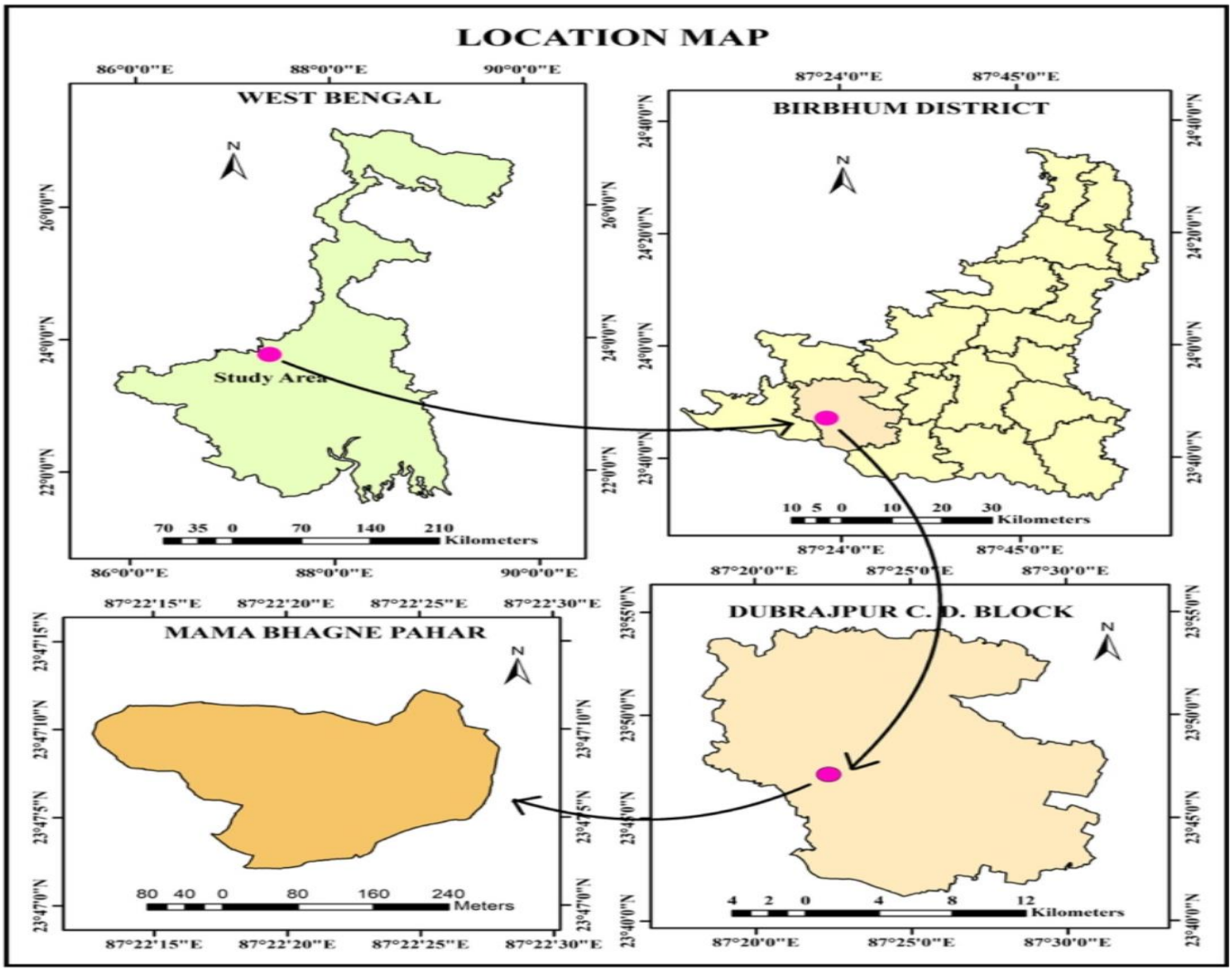


Fig. 7: Location map of the Mama-Bhagne Pahar [20].

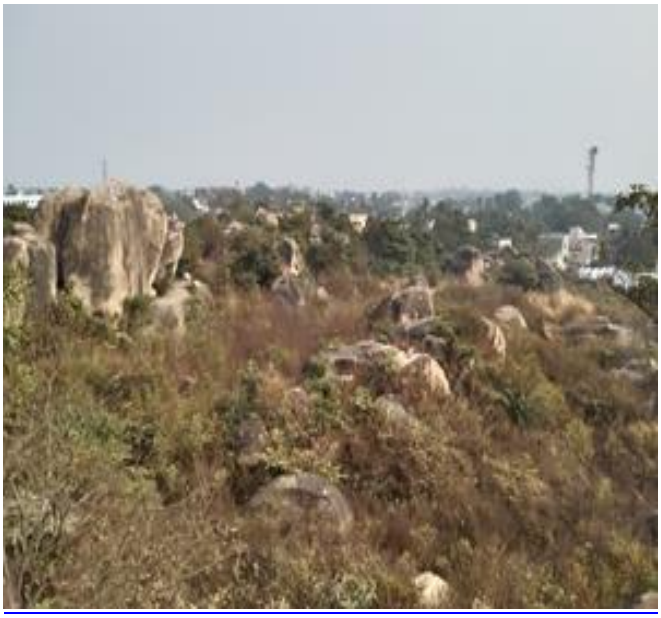


Fig. 8: Mama Bhagne Pahar and its nearby area.

Fig. 9: Lord Shiva inside the Shiva temple

Fig. 10: Lord Shiva temple or "Pahareswr Mandir" at the base of the Mama-Bhagne Pahar.

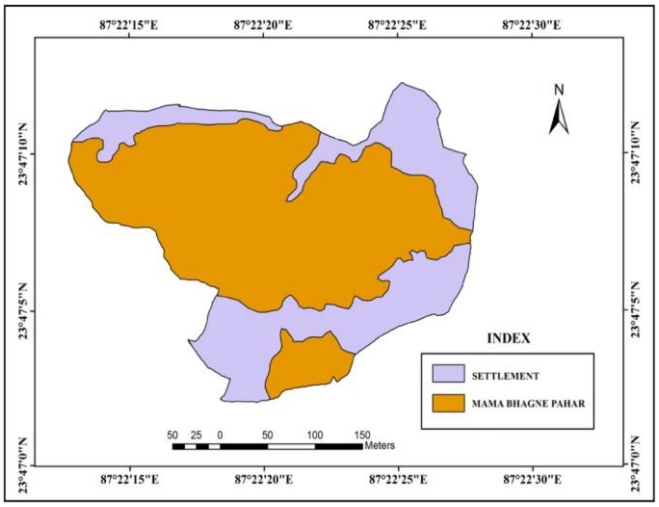


Fig. 11: Human settlements encroached within the area of Mama Bhagne Pahar which is highly vulnerable ([22]).

From the above discussion, we can designate Dubrajpur Mama-Bhagne pahar as an important geomorphosites. But presently the site is heavily decaying due to various anthropogenic interventions. Among these various stressors, the most common is human encroachment and habitation within the periphery of the geomorphosites. People are building their houses within the area of the geomorphosite with the help of immoral politics of the local political leaders (Fig. 11) [22]. Due to a lack of geoeducation and because of their poverty, humanity uses the rocks as an advertising board for various types of commercial statements as well as various rubbish posters on the surface of the rocks (Fig. 12). These advertisements create visual pollution for the tourists. Here and there, tourists are discarding waste all around the geomorphosites and thus polluting the area (Fig. 13). Moreover, the rocks of the Mama-Bhagne pahar are suffering from weathering, a natural phenomenon. While visiting the study area, we witnessed all three types of weathering, namely physical, chemical, and biological weathering. Due to storms and rain, the rocks are coming in contact with different types of chemical agents. As a result, cracks develop in the rocks and after some time, they are broken down (Fig. 14). As the Tropic of Cancer line passes through Panagarh of West Bengal, which is very near Dubrajpur, the temperature fluctuation in summer and winter is very high. Apart from this, the temperature is normally high in Dubrajpur. Thus, physical weathering is very active in Dubrajpur. And Mama-Bhagne is also suffering from these climatic conditions. Moreover, due to lack of care, a huge number of plants grew in and around the geomorphosite. As a consequence, cracks have developed due to the roots of plants in the rocks of the geomorphosite. Hence, both mechanical, chemical and biological wear and tear take place among the rocks of Mama-Bhagne pahar and if one is not cautious, all the large-sized rocks will be converted to smaller rock particles (Fig. 14).

Fig. 12: Advertisement on the rocks of Mama-Bhagne Pahar

Fig. 13: Discarded waste by the tourists.

Fig. 14: Cracks developed within the rocks and they are widening day by day due to weathering, both physical, chemical and biological weathering.

The people of this part of West Bengal are very poor. Cultivation is not good enough in the Dubrajpur block area. Most of the people of this area go outside this area for their income due to unemployment and poverty. To protect the geomorphosites i.e., Mama-Bhagne pahar from human interventions and to promote local tourism sustainably, humanity, along with local bodies, should try to work out geoconservation and geotourism development strategies. Special attention should be given to geoeducation, tourism promotion, socio-economic development of the local people, and legal protection of the site while formulating the strategy of geoconservation as well as geotourism.

These days' the major issue of any tourism hotspots is to achieve sustainability in various developing countries. India is also not an exception since such areas have been interfacing with many categories of environmental problems due to the advent of huge numbers of tourists. As soon as the concept of geotourism emerged in the arena of tourism, it provides favourable openings for sustainable development by achieving quality management of natural settings and ensuring responsible tourism activities.

Dubrajpur is well connected via rail, road or even air. Because Andal airport is only 33 km away from Dubrajpur. Tourists who will visit Dubrajpur Mama-Bhagne pahar can also visit many famous tourist spots like Tarapith, the famous Kali Temple for Hindu pilgrims. It is also famous for the Sadhak Bamahepa and Tarapith is only 70 km. Among the 51 Sati Pitha, one is here in Nalhati of Birbhum which is 85 km away from Dubrajpur. Traditionally, it is believed that the throat or 'Nala' fell here. Subsequently, from this 'Nala', the name of the place is Nalhati. And Maa Nalateswari has a resemblance with Kamakhya, Assam and Kalighat, Kolkata pithas. Santiniketan and Viswa Bharti of Bolpur is 45 km away from Dubrajpur. Tourists who have come to visit Dubrajpur can also visit Bolpur and Santiniketan of Birbhum district. In between Dubrajpur to Bolpur roads, there is a famous Wood Fossil park. The name of the place is Amkhoi and the name of the park is Amkhoi Wood Fossil Park [25]. Tourists can also visit Amkhoi while visiting Dubrajpur and Bolpur. Bakreswar is famous for its hot springs [26]. There are seven 'Kunda' or Hot Springs in Bakreswar which is very near Dubrajpur. It is only 10 km from Dubrajpur Mama-Bhagne pahar to Bakreswar. While moving from Dubrajpur to the district headquarters, Siuri, there is a pilgrimage place called Pathar Chapuri. It is a 'Darga', where both Hindu and Muslim people used to go. So, geotourists who come to visit Mama-Bhagne pahar can visit numerous tourist places which are nearby Dubrajpur (Fig. 15).

4. Conclusion

To judge the Geotourism potential of Mama-Bhagne pahar, Dubrajpur, an attempt has been made in this paper. The findings show what a great moment it was for the area to become a Geotourist destination. But the different level's authorities have to work together focusing on the natural resource management and economic development of the study area. From the earlier discussion, we can conclude that Mama-Bhagne Pahar of Dubrajpur, Birbhum, West Bengal, is an important geomorphosite because of its lofty scientific, aesthetic, cultural and economic values with respect to human perception. But the site is perpetually decaying due to various anthropogenic interventions. Unemployment and poverty of the local people are the catalysts of this continuous deterioration of the geomorphosite. But, if we consider the possibilities of tourism in the concerned site, huge scopes are there. The best way to protect the site from human intervention is geoconservation. To promote tourism in Dubrajpur and to protect the geodiversity of Dubrajpur, we have to cultivate the geotourism most sustainably. The promotion of tourism and the economic advancement of the local people should be the first priority during the formation of the strategy. Encouragement of geoeducations among the local people as well as tourists is the next important step to promote tourism in a sustainable way in Dubrajpur. Among all the geoconservation sites across the world, legal protection is one of the most important strategies. So, we have to take legal protection to protect the geodiversity of Dubrajpur.

It has been observed during field surveys that various anthropogenic interventions are the crucial environmental warnings to Mama Bhagne Pahar The maximum burden in the decaying of the study area is human occupancy. The volume of human occupancy is about one-third of the study area [22]. It is a very subtle issue and the adaptive capabilities of these human-occupied areas are very low compared to the rest of the area. If the government, local bodies as well as local people do not rigidly prohibit such activities, then we shall no longer have our beloved geomorphosite in the near future.

To fruitfully apply all the above-mentioned measures, to conserve the site, we have to extend constructive apprehension about the site among the tourists, local people, and business houses. Then, only we can save a stunning geomorphosite like Dubrajpur Mama-Bhagne pahar.

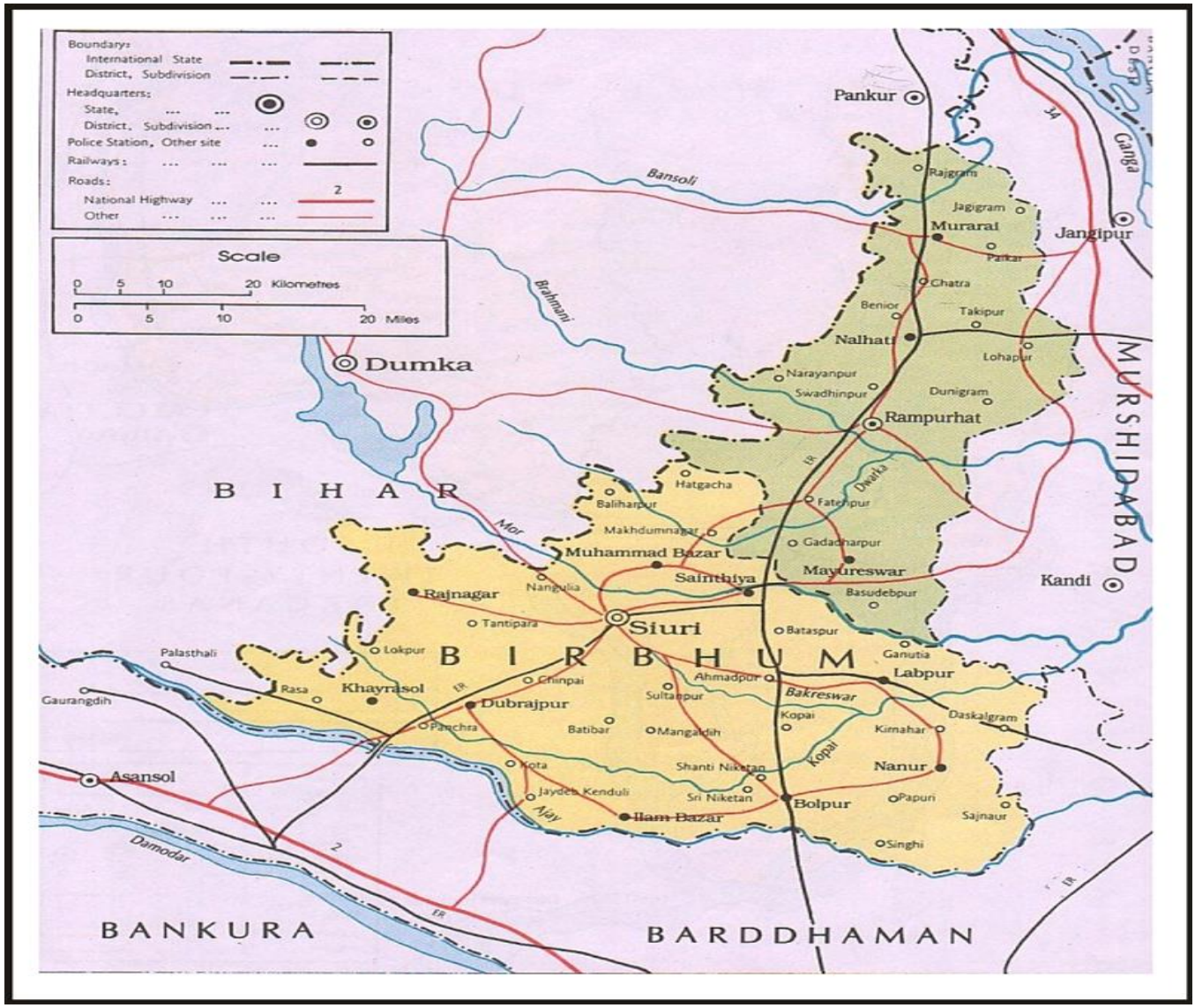


Fig. 15: Various tourist spots near Dubrajpur

Declaration of Competing Interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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