

Inventory of geotouristic routes along the southern hills of the Kathmandu Valley

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Abstract: An inventory map of geotouristic sites was prepared on the scale of 1 : 25 000 along the Chandragiri-Chitlang Range, southwestern part of the Kathmandu Valley of central Nepal. From the ridges and peaks of the Chandragiri-Chitlang range, visitors can witness breathtaking views of the surrounding hills, modern buildings, and ancient temples of the Kathmandu Valley from a distance. The objective of the study was to explore the geotouristic sites around the Kathmandu Valley. For this purpose, all the available information related to geology, environment, geography, culture, religion, and other touristic components was reviewed thoroughly, and extensive fieldwork was carried out with the purpose of geological mapping and data collection. The Chandragiri-Chitlang range is a renowned place and open book not only for geologists but also for the nature lover, climbers, trekkers, photographers, videographers, cultural tourists, biologists, and ayurvedic and it has a great prospect for tourism due to its geomorphological variation, unique geological features, beautiful natural scene, unique trekking trails, culture, biodiversity, adventurous way, heritage, and historical sites. Major geotouristic sites, which attract tourists throughout the year in this range are the lush green Chandragiri Hill, Chandragiri Temple with children's playground and exciting recreational equipment, snowfall, on the winter season, Chitlang Homestay, Chobhar Hill, Taudaha natural pond, Pharping Hill, Champadevi Temple, Gupteshwor cave, Chobhar cave, Thankot, and Matatirtha Temple, etc. Geologically, the study area comprises the lower four geological units of the Phulchoki Group of the Kathmandu Complex from older to younger sequences i.e. the Tistung Formation, the Sopyang Formation, the Chandragiri Limestone, and the Chitlang Formation along with alluvial fan deposits and Kathmandu Lake sediments. The basin of Kathmandu is filled with the lacustrine-fluvial deposits of ancient lakes followed by river deposits. The Chandragiri Thrust, Chitlang Syncline, Kirtipur Anticline are the major regional-scale geological structures within the study area. Unique old-fashioned foottrail attracts tourists and increased the charm of traveling in this place. The homestays in Chitlang village, joyful of culture and environment, provide a tranquil retreat away from the bustling crowds of Kathmandu. Preparation of a tourist guidebook and planning and development from the perspective of a geotouristic approach is recommended after this research. Reconstruction and establishment of trekking foot trails and tourist information centers based on currently available natural and human resources without investing high costs can be carried out for sustainable tourism development in this range.

Keywords: geosites, geotourism, Chandragiri hills, Kathmandu Valley

Introduction

Geotourism is a major field in the tourism sector regarding geological points of view such as geoheritage, geosites, geomorphology, and history of the earth (Joyce,

2006; Dowling, 2011; Reynard & Brilha, 2018). Geotourism is another way of understanding, learning, or getting an idea or knowledge on geology in an entertaining way along with experience with it. Geotourism helps to understand the earth, conserve and protect the geosites, develop the local

community, and increase national GDP. For the sake of enhancing the geotourism sector and encouraging people in this field, the information from geological processes that can be deduced from outcrops and landscapes should be managed properly without destroying the environment (Drumm & Moore, 2005). Likewise, the essential components such as facilities for food, accommodation, nutrition, entertainment, recreation, peace, and security are basic prerequisites for the development of ecotourism and geotourism in any area (Bulatović, 2017; Nepal, 2002).

The Nepal Himalaya is the open book to getting geological information and has a great prospect for geotourism due to its geomorphological variation, geological features, beautiful natural scenery, and unique trekking foot trails. Biodiversity, heritage, historical sites, culture, adventurous way, and good nature of human beings. There is no other destination like Nepal Himalaya to see the wide range of geography, nature, culture, etc. and also these are encouraging investors to grab opportunities and gain good benefits (Gautam, 2011; Bhote, 2018).

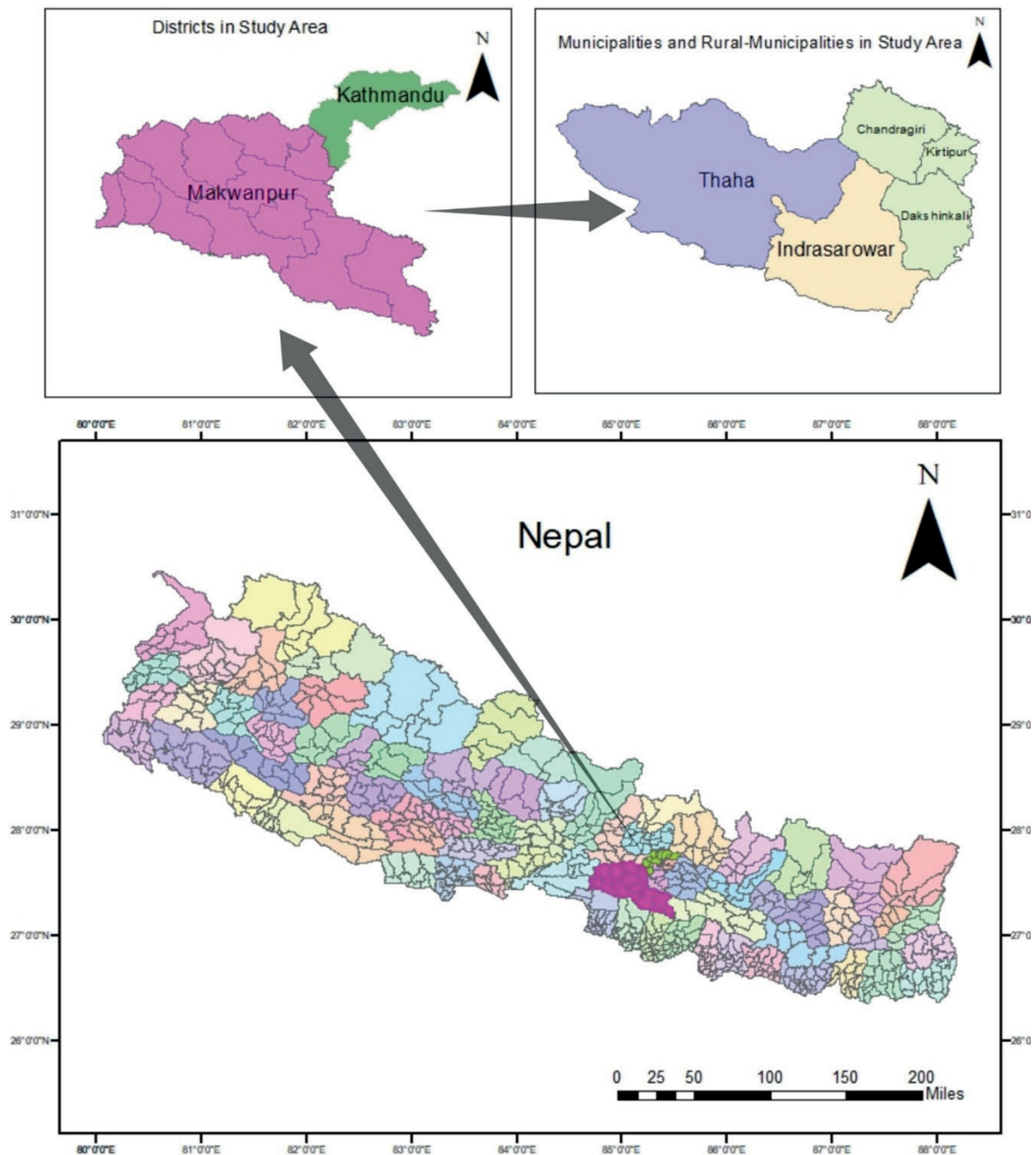


Fig. 1. Location map of the study area

The Himalayas extend across five countries: Nepal (about 800 km), India, Bhutan, China and Pakistan stretching over 2400 km between the Namche Barwa Syntaxis and the Nanga Parbat Syntaxis in Tibet and India respectively. The Himalayas, the highest and youngest mountain range is said to be the most active and fragile belt and its ongoing orogeny is the result of a collision between two tectonic plates i.e., Indian and Eurasian. Geologically, the Nepal Himalaya is divided into five major tectonic units/zones from south to north these units are the Terai/Indo-Gangetic plain, the Sub-Himalaya (Churia Hills or Siwaliks), the Lesser Himalaya, the Higher Himalaya, and the Inner Himalaya (Tethyan Himalaya). These tectonic units are separated by large-scale intra-continental thrusts and faults such as the Himalayan Frontal Thrust (HFT), the Main Boundary Thrust (MBT), the Main Central Thrust (MCT), the South Tibetan Detachment Fault System (STDFS) and the Indus Suture Zone (Indus–Yarlung–Tsangpo Suture Zone) (Gansser, 1964).

The Central Nepal is differentiated into the Nawakot Complex representing the Lesser Himalayan metasedimentary rock sequence and the overlying Kathmandu Complex (Stöcklin & Bhattarai, 1977; Stöcklin, 1980) belonging to the Higher Himalayan Crystallines and the Tethyan Himalayan Sequence. These two Complexes differ basically in their lithostratigraphic characteristics and are separated from each other by the MT, which is the southern continuation of the Main Central Thrust (Stöcklin & Bhattarai, 1982).

The study area mainly represents a part of the Kathmandu Complex which is further divided into the Bhimphedi Group and the succeeding Phulchoki Group. It is believed that the Kathmandu Nappe is a large folded thrust sheet of the Higher Himalayan Crystallines. The Phulchoki Group contains Paleozoic fossils in the Chandragiri hills (Stöcklin, 1980).

The Chandragiri-Chitlang range area lies on the Phulchauki Group of central Nepal between 27°35'00"N to 27°43'30" N latitudes and 85°09'30"E to 85°19'00"E longitudes. The southwestern hills of the Kathmandu Valley are the major attraction points for geotourism. The study area includes portions of Kathmandu, Makwanpur, and Dhading Districts (Fig. 1), respectively extending from Balkhu to Chitlang in the east-west, and from Naubise to Pharping in the north-south direction. It comprises topographic maps entitled Kathmandu (2785 06A) and Thankot (2785 05B) – which cover the majority of the area along with Tikabhairav (2785 06C) and Bhimphedi (2785 05D) provided by the Department of Survey, Government of Nepal.

The study area is mainly connected by the Prithivi Highway, which is linked with many local rough roads, foot trails, and muddy rural trails along which many geological traverses were made. The study area consists of many industrial minerals, decorative stones, dimension stones, and some metallic minerals (Acharya & Paudyal, 2019b). Geotourism in Chandragiri-Chitlang range has to be based on available natural and human resources, and what could be made available

in the near future with reliable costs. If the geological records once destroyed will be lost forever and cannot be restored artificially, it is our prime responsibility to transfer the knowledge and geo-heritage to future generations.

Objectives

The present study aimed to identify the geotouristic sites along the Chandragiri-Chitlang range. Within this framework, the specific objectives are listed below:

- to locate and examine overall geotouristic sites within Chandragiri-Chitlang range, southwest of the Kathmandu Valley;
- to evaluate the geomorphological, geological, and topographical characteristics of routes from geotourism perspectives;
- to know tourist flow within the study area.

Methodology

The extensive literature review and filed data were revised on initial phase of the research, which was followed by field work. The study is based on primary data collected through extensive field observation that includes in-depth geological and geomorphological study and systematic photographs. The major geotouristic attraction of the Chandragiri-Chitlang range was studied systematically and the final report was written by compiling all the researched data.

Results

Topography and drainage

The study area consists of hilly terrain, colluvium deposits as well as flat alluvial terraces. Physiographically, the study area belongs to the part of the Mahabharat Range of central Nepal representing a strongly dissected range of topographic variations with moderate to very steep slopes, ridges, spurs, saddles, and valleys. The altitude of the research area ranges from 1259 m (lowest) at the Chalnakhel and 2561 m (highest) at the Bhaleshwar Dada. The research area is mainly covered by forest, colluvium, and also agricultural land. The overall drainage pattern shows dendritic. The Bagmati Nadi drains into the eastern part of the study area flowing from north to south direction. The Bagmati Nadi govern by a centripetal drainage system (Fig. 2).

Climate and vegetation

Tropical and sub-tropical climate is dominated throughout the study area. The climate of study area is somewhat mild similar to that of Kathmandu (sub-tropical). The temperature ranges from 0°C to 30°C and the average annual rainfall ranges from about 1400 mm to 2500 mm.

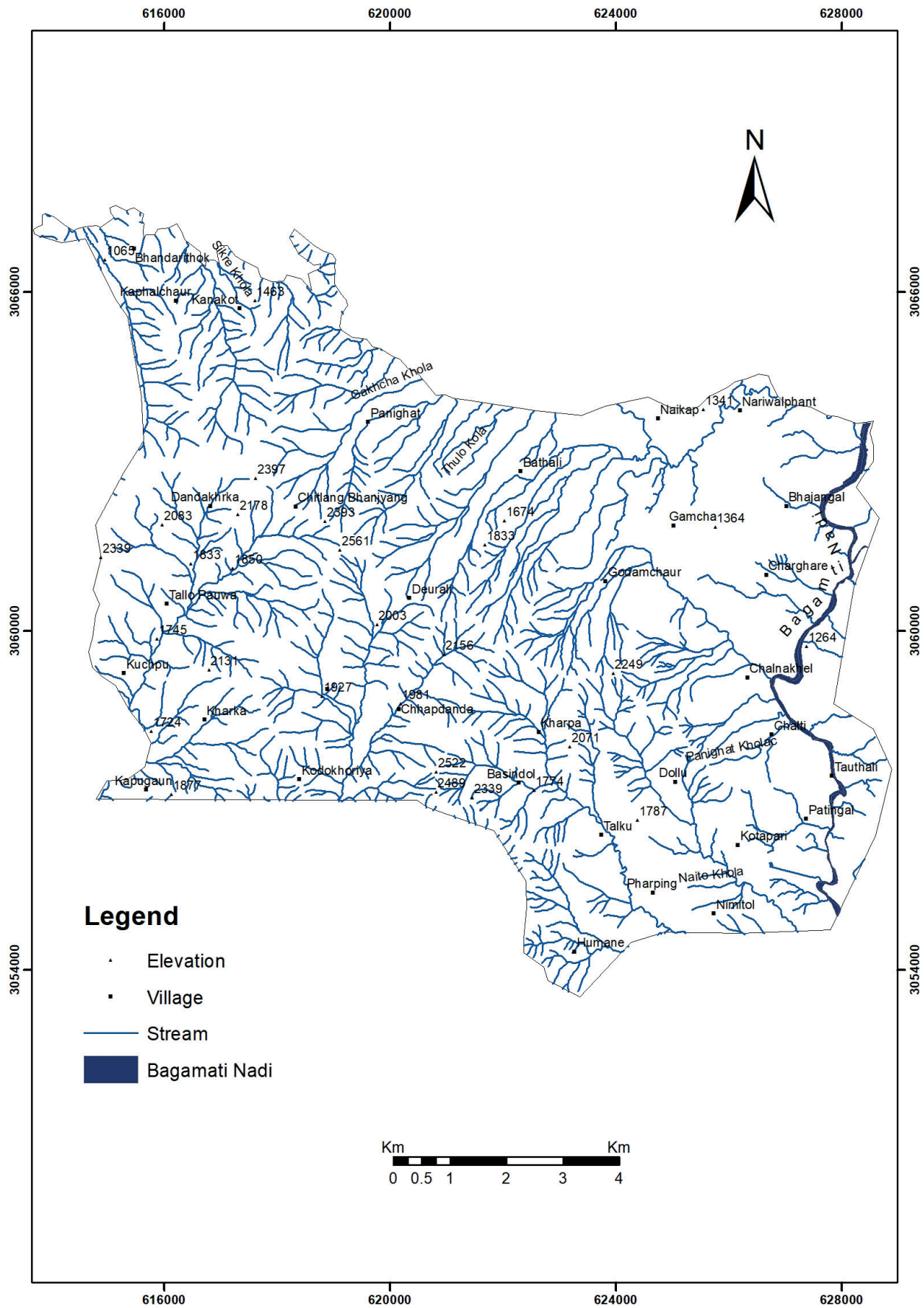


Fig. 2. Drainage map of the study area

Most of the hilly land is covered by biennial and perennial trees, a dense forest of immature trees, shrubs, and bushes. The frequently and remarkably notices vegetation in the study area are *Rhododendron arboretum* (Guras) (Fig. 3A), *Juglans regia* (Okhar), *Myrica esculenta* (Kaphal), *Loyanis sp.* (Angeri), *Alnus nepaulensis* (Utish), *Pinus wallichiana* (Gobre Salla), *Berberis aristata* (Chutro), *Schima wallichii* (Chilaune), *Corylus ferox* (Katush), *Drepanostachyum intermedium* (Nigalo), *Quercus robur* (oak), *Dryopteris* (Ferns), *Orchidaceae* (Orchids), etc. The faunas like mongoose, monkey, jackal, squirrel, kalij, maina, parrot, dove, sparrow, owls, eagles, crow, leech, etc. are found in the study area. Buffalo, cow, ox, sheep, and goat are the most common domestic animals within the study area.

Land-use and culture

Most of the land in the study area is covered by dense forest and colluvium deposits. The plain land is used for agricultural purposes. Ethnic groups like the Tamang, Magar, Gurung, Chhetri, Brahman, Newar, Kami, and Damai, etc. live in the study area. Villager farewell guest stayed on the Chitlang Homestay with a special garland placed around the guest's neck made out of the Sayapatri flower (Fig. 3B).

Socio-economic condition

Agriculture, business, and job in schools, colleges, and government offices are the main occupation of the people in the research area. Potato, beans, maize, wheat, millet, apple, barley, mustard, rice, and vegetables like cauliflower are the main cash crops. The forest is the main source of timber, fuel wood for the villagers. The financial status of some local people is moderate and some people live under the poverty line.

Why Chandragiri-Chitlang range?

The Chandragiri-Chitlang range has attractive natural areas with extensions of unique geology, landscape, and geomorphology (Fig. 3C). Similarly, *Rhododendron* forests, religious places, picnic spots, snowfall, ecology, environment, climate, and varieties of birds and animals attract people more (Fig. 3D–F). Most of the study area is covered with a lush green blanket of forest and the hilltop offers breathtaking views of the peaks along the Kathmandu Valley (Fig. 3G–I). However, the study area is nearby the Kathmandu Valley, the site even falls within the rugged, steep hills topography along with the dense forest. There are various ways to travel the Chandragiri-Chitlang range (Figs. 4 and 5).



Fig. 3. Attractive features within the study area: A – national flower of Nepal along Baneshwor Dada; B – farewell of guest on a traditional way at the Chitlang homestay; C – Gupteshwor cave near Simpani Chakhel; D – man worshipping at the Champadevi Temple; E – unique foot-trail downhill from the Champadevi Temple; F – International tourist heading towards the Baneshwor Dada from Saukhel; G – Taudaha seen uphill from the Sallaghari; H – cable car facility to reach the Chandragiri Temple; I – well facilitate resort under construction near to the Chandragiri Temple

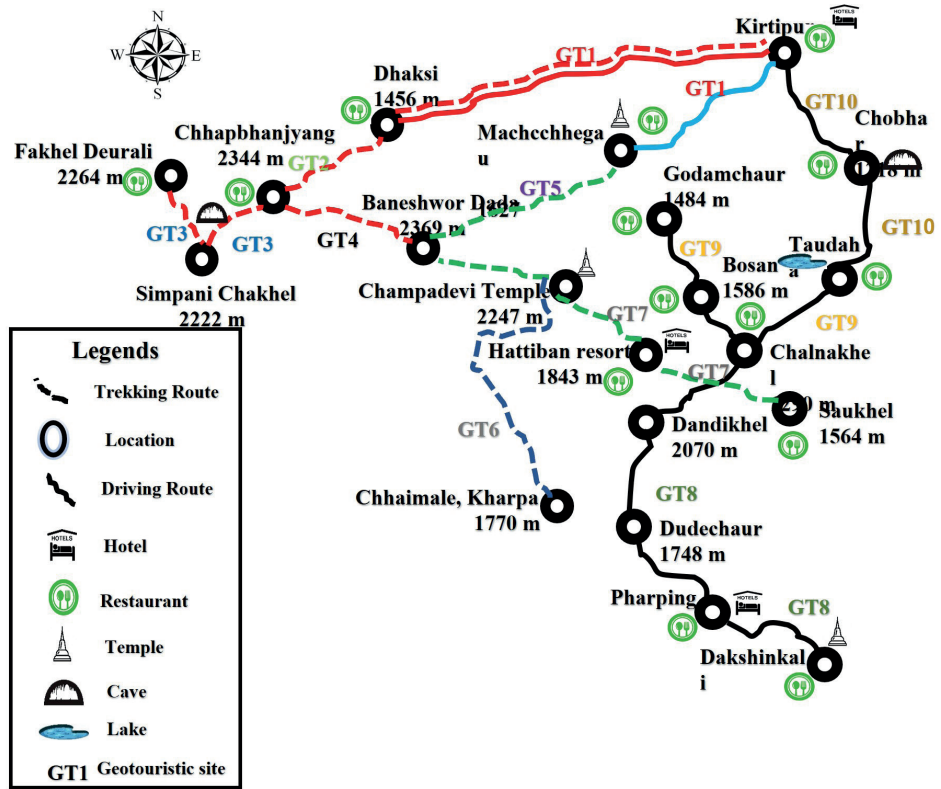


Fig. 4. Route along the Chandragiri-Chitlang range (Eastern side)

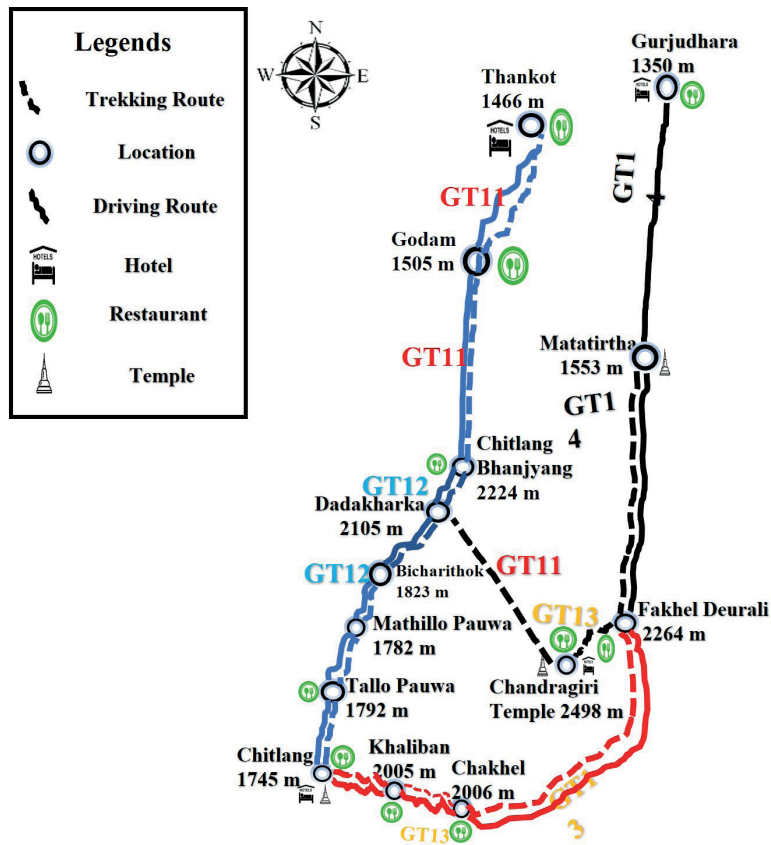


Fig. 5. Route map along the Chandragiri-Chitlang range (Western side)

The study area is the best place to gain geological knowledge as the area covers low-grade metamorphic rocks succession by the Lesser Himalaya sequence in the Kathmandu Complex of the Phulchauki Group in Central Nepal (Fig. 6). The lower four formations of the Phulchauki Group i.e.,

Tistung Formation, Sopyang Formation, Chandragiri Limestone and Chitlang Formation from older to younger respectively, lacustrine sediments, alluvial fans (Quaternary deposits) and Kathmandu Valley sediment can be observed in the study area (Figs. 7 and 8).

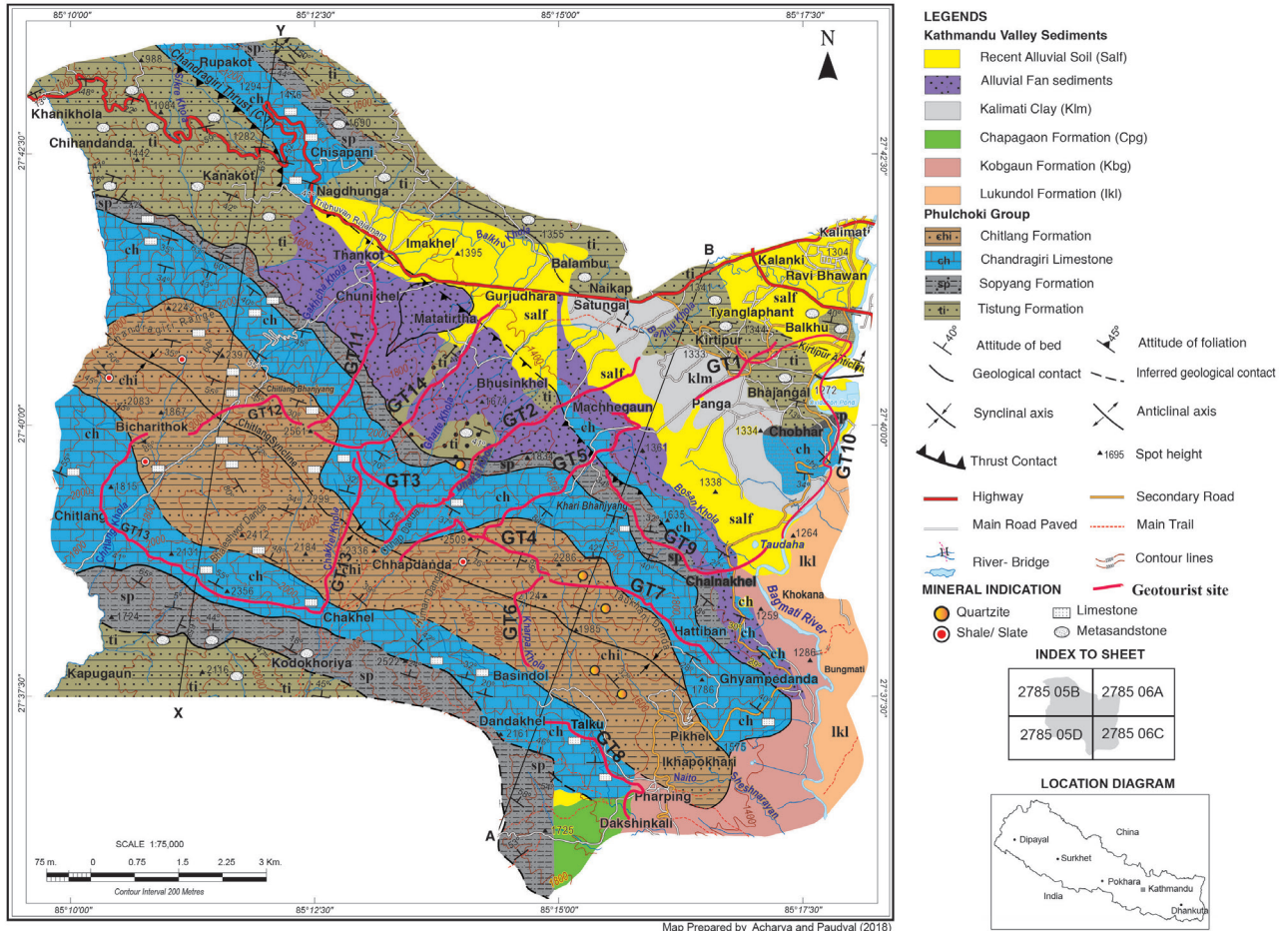


Fig. 6. Geological map of the Chandragiri-Chitlang range showing major geotouristic routes (after Acharya & Paudyal, 2019a)

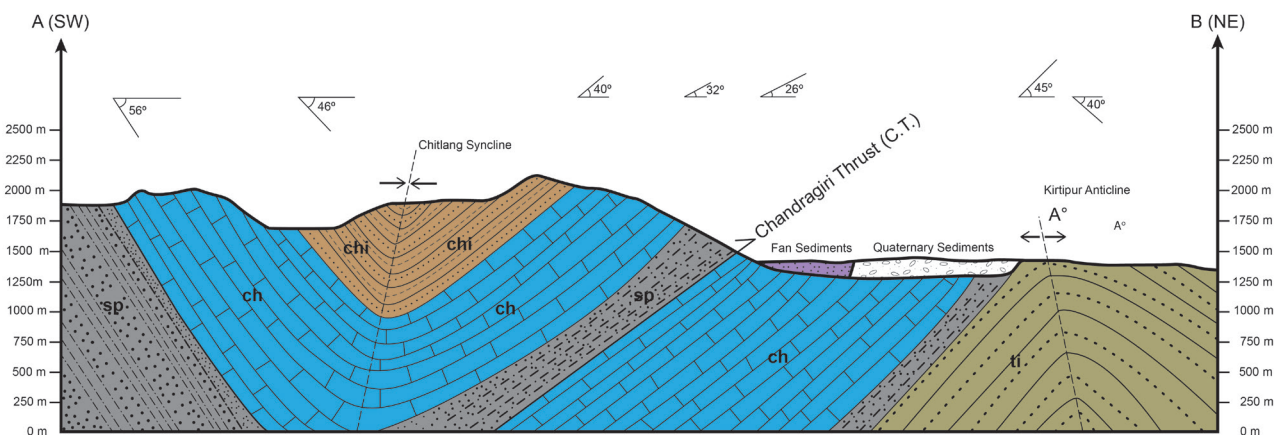


Fig. 7. Geological cross-section along Fakhel (SW) to Naikap (NE) (after Acharya & Paudyal, 2019a)

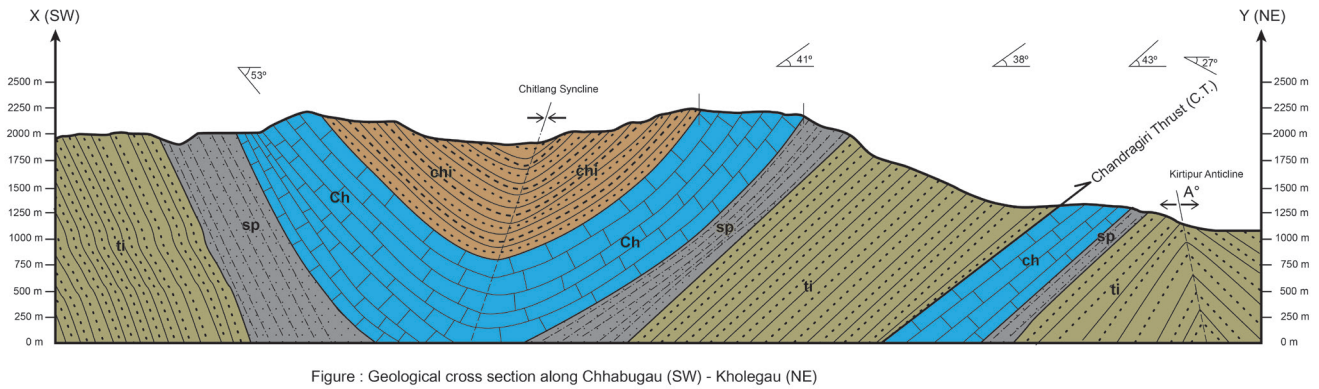


Figure : Geological cross section along Chhabugau (SW) - Kholegau (NE)

Fig. 8. Geological cross-section along Chhabugau (SW) to Kholegau (NE) (after Acharya & Paudyal, 2019a)

The Tistung Formation is the lowermost and oldest formation in the study area. The unit is well distributed at Badbhanjyang-Kafalchaur-Kanakot-harithok-Khanikhola-Kodokhoriya-Khodpu-Chhabugau-Dhaksi-Matatirtha-Kirtipur-Balkhu-Tinthana-Chobharsection of the study area. The lower part of the succession consists of intercalation of brown to grey, thick-bedded metasandstone and dark grey, thinly-bedded highly metamorphosed phyllite (Fig. 9a). The middle part of the Tistung Formation consists of grey, laminated, medium- to fine-grained, metasandstone with sub-ordinates of dark grey, thinly bedded, both argillaceous and arenaceous phyllite and some metasiltstones are faintly calcareous. The upper part of the Tistung Formation consists of grey, fine-grained, thick-bedded metasandstone subordinates with dark grey to ash grey argillaceous, thinly-bedded phyllite (Fig. 9B, C).

Sopyang Formation is a transitional zone between the fine rocks of the Tistung Formation and the thick Chandragiri Limestone. The succession is well distributed around the Sikre Khola, Kholegaun, Godam, Dhaksi Khola, Kharaka, Khaliban, Chobhar, Thapagaun, Bosan, Basbari, Phakel Bhanjyang, Humane, Sanimal, Dandakhel. The lower part of the Sopyang Formation consists of interbanding of grey, psammatic, coarse-grained, and dark grey, pelitic fine-grained metasandstone (Fig. 9D). The middle part of this succession comprised compositional variation between fine- and coarse-grained laminated metasandstone (Fig. 9E, F). The upper part of this succession consists of intercalation between greyish blue pelitic phyllite and grey psammatic metasandstone.

The succession of the Chandragiri Formation is well exposed around the Sisnekhola, Nagdhunga, Chisapani, Jhakriban, Koiralathok, Sano-Nayagau, Chakhel, Basindol Chalnakhel, the Chitlang Khola, Chobhar, Khahare, Kharibhanjyang, Ghyampedada, Talku Dudechaur, Lamagau, and Basbari. The lower part of the succession consists of argillaceous-arenaceous partings, yellowish brown weathered, and thin- to medium-bedded limestone. The middle part of the succession consists of grey, bluish grey, medium- to thick-bedded limestone, dolomitic limestone with leachate, and thin partings of argillaceous phyllite. The

caves and vugs are fairly common in various parts (Fig. 9G, H). The upper part of the succession comprised partings of dark grey to light grey phyllite subordinated with white quartzite (about 150 m) band and greyish leachate on limestone (Fig. 9I). Caverns are formed in some parts.

The Chitlang Formation mainly consists of white quartzite, some beds of argillaceous limestone, dark bluish-grey slate, and dolomitic limestone. The succession is well distributed around the Chitlang Bhanjyang, Chitlang, Dadakharka, Bhandarkharka, Mathilopauwa, Chakhel Khola, Baneshwor Dada, Kharpa, Champadevi, Chandragiri Range, Talku Dudechaur, Taukhani Dada, Sheshnarayan, Dollu, Sundol Khola, Satikhel, and Pikhel. The lower part of this formation consists of violet, grey slate, white, muddy quartzite, grey, fine to coarse-grained metasandstone, thick to massive, fine to medium-grained limestone, dark grey well-laminated shale, and phyllite in some parts (Fig. 10A, B). The middle part of the succession is comprised of ash grey, thickly-bedded dolomitic limestone, whitish grey quartzite, and dark grey, thickly-bedded limestone with calcite precipitation. Similarly, the upper part of the succession is comprised of intercalation between yellowish grey shale and dark grey limestone in which wave marks are observed with subordinates of dolomite. White, thickly-bedded quartzite and variegated colored shale, and grey slate were common (Fig. 10C).

Similarly, the study area exhibits several large-scale (mega), mesoscale as well as small-scale geological structures. The primary structure such as ripple marks, and cross-bedding preserved in the rocks shows that there is a normal stratigraphic sequence in the study area (Fig. 10D-F). Well develop foliation; large scale as well as small-scale folds, crenulation cleavage is frequently present in different parts of the study area (Fig. 10G, H). Metallic minerals i.e., pyrite, and non-metallic minerals such as slate, limestone, quartzite, and metasandstone are common in the study area. The study area will be a suitable place for level school-level students to teach the history of the earth, rocks in a natural environment, and their natural relationship to one another (Fig. 10I).

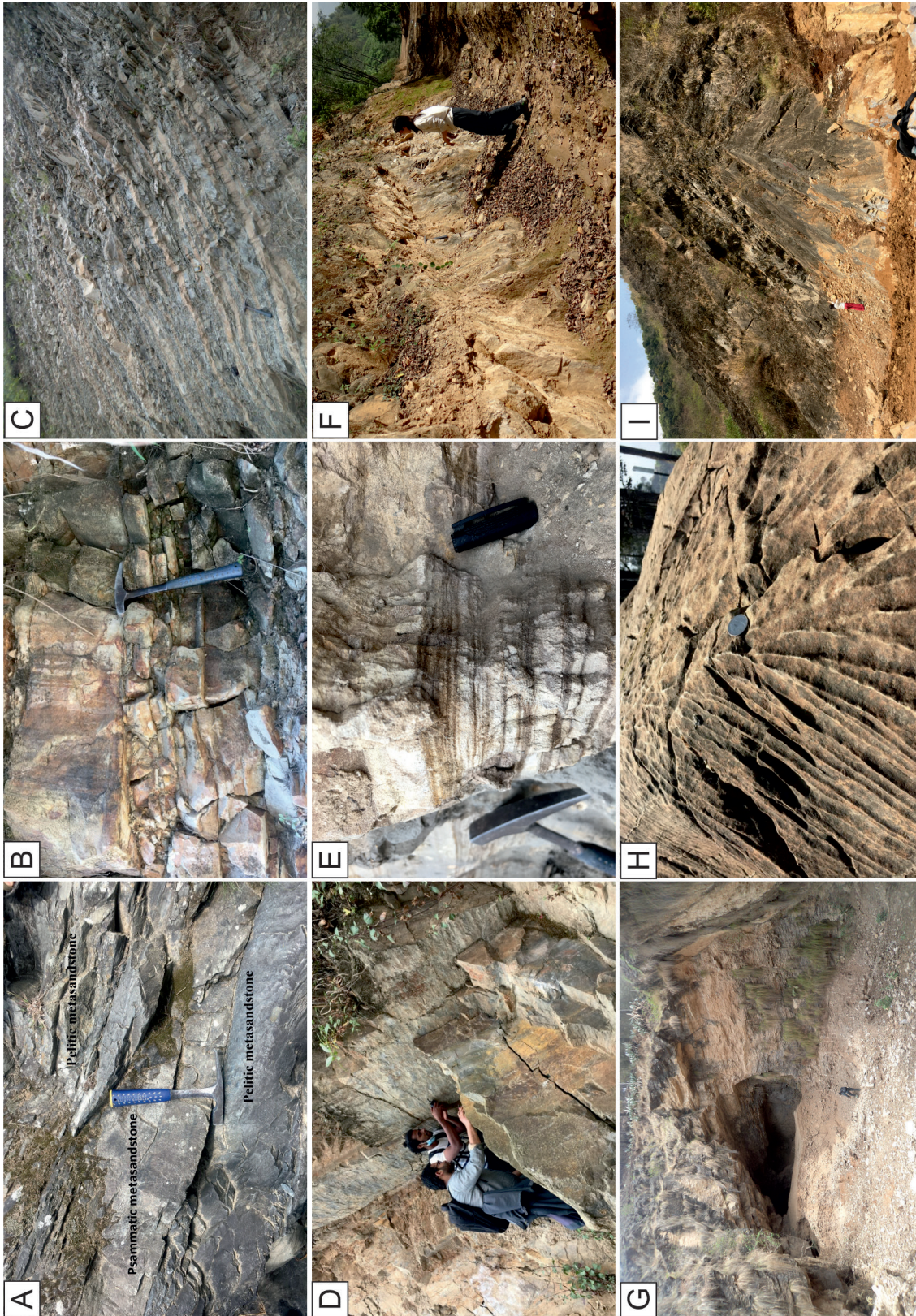


Fig. 9. Representative outcrop showing geological features: A – intercalation between pelitic phyllite and psammatic metasandstone on the Tistung Formation at Balkhu Khola; B – intercalation between thick-bedded, laminated metasandstone and partings of phyllite of the Tistung Formation at Chobhar; C – interbedding of thick-bedded metasandstone and thin-bedded phyllite of the Tistung Formation around Kanakot; D – thickly-bedded psammatic phyllite on the Sopyang Formation uphill from Matatirtha; E – interbanding between yellowish brown and dark brown metasandstone of the Sopyang Formation near to Sikre Khola; F – transitional contact between the Sopyang Formation and the Chandragiri Limestone uphill from Godam; G – cavern of leachate limestone with alteration of phyllite on the Chandragiri Limestone at Kathmandu to Dakshinkali road; H – elephant skin-type weathered limestone of the Chandragiri Limestone at Chobhar; I – outcrop showing massive Limestone bed of Chandragiri Limestone about 1.5 km uphill from Godam, Thankot

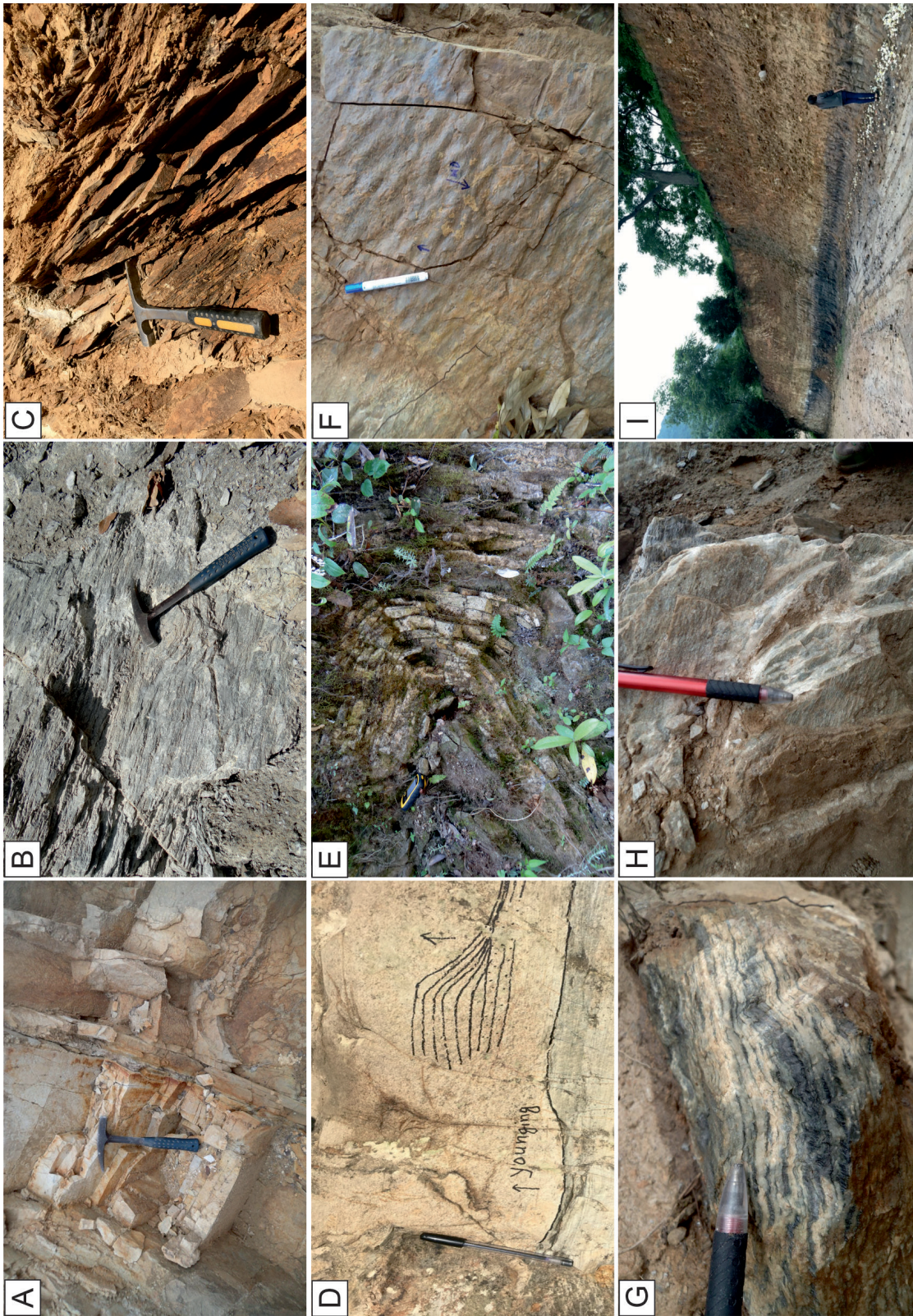


Fig. 10. Outcrop showing various geological structures: A – interbedding of white quartzite and laminated shale of the Chitlang Formation near Chitlang Bhanjyang; B – wavemark present on dark grey limestone of the Chitlang Formation near Chitlang Bhanjyang; C – slate of the Chitlang Formation around Chitlang Bhanjyang; D – cross lamina on the metasandstone bed of the Tistung Formation at Balkhu Khola; E – Folded phyllite of the Chitlang Formation near to Chandragiri Range; F – current ripple mark observed on limestone of the Chandragiri Formation about 1.5 km uphill from Godam, Thankot; G – crenulation fold present on limestone of the Chandragiri Limestone near to Deurali; H – stretching lineation developed on argillaceous limestone of the Chandragiri Limestone around Chandragiri hill near to Deurali; I – outcrop showing the excellent Alluvial Fan sediments (Quaternary deposits) from both calm and rapid environment near Chalnakhel on the way to Dakshinkali

Kirtipur–Dhaksi–Machchhegaun section (GT1)

Kirtipur, Balkhu, Dhaksi and Machchhegaun lie on north-eastern side of the Chandragiri-Chitlang range. This section is more fascinated region of the study area because of available several means of transportation from Kathmandu city, good hospitals, education, restaurant, housing, colony, and lodging facility. But, the area is facing more pollution problem day by day due to the increase in population. People hike on Bosan Hill and enjoy the scene seen from the Whitehouse Hotel which is located at the top of the hill. Balkhu (E628229, N3063359, 1295 m) belongs to the Tistung Formation which consists of the intercalation of grey, well-laminated metasandstone, and psammatic phyllite. The axis of the Kirtipur Anticline extends from the Balkhu, northeast and ends near Basundol at the southwestern part. The beds around Balkhu Khola, Balkhu, and Naikap show the north dipping beds whereas the beds near Kirtipur, Bishnudevi Mandir (Tinthana) show south dipping which justifies the Kirtipur Anticline. The Dhaksi area (E623252, N3061861, 1456 m) lies on the Tistung Formation where the metasandstone bed is observed. The beautiful view of the Kathmandu Valley can be seen from the Dhaksi area. Similarly, the Machchhegaun area (E623370, N3060291, 1627 m) lies within the Chandragiri Limestone where a dolomite bed with SW dipping can be observed. The Hindu temple, regional view of the Kathmandu Valley, beautiful hills, and forest are the main attraction points of this area.

Dhaksi–Chhapbhanjyang section (GT2)

The Chhapbhanjyang (E621222, N3060467, 2344 m) lies within a dense forest area about 2 hr. uphill from Dhaksi. Hiking within this section is adventurous and amazingly enjoyable. The Chhapbhanjyang area belongs to the Chitlang Formation which consists mainly of white quartzite and some beds of argillaceous limestone. There is a foot trail to reach up to Chhapbhanjyang where only one hotel is located. This section will be a more attractive place for biologists, ayurvedician, mountaineers, and photographers. During the rainy season, there is the dominance of leeches all over the area. Biodiversity, fresh air, beautiful forest, and quartzite bed can be observed in this region where most of the Nepalese youth and some international tourists visit the place. Beautiful views of the Kathmandu Valley, the beauty of nature, and the surrounding landscape can be observed near the top of the Bhanjyang.

Chhapbhanjyang–Simpani Chakhel–Fakhel Deurali section (GT3)

The Simpani Chakhel (E620579, N3059898, 2222 m) is about 45 min. downhill from the Chhapbhanjyang (E621222,

N3060467, 2344 m). The Fakhel Deurali (E620135, N3060832, 2264 m) is again about 45 minutes uphill from the Simpani Chakhel. The Simpani Chakhel and Fakhel Deurali belong to the Chandragiri Limestone Formation. The famous Gupteshwori cave is situated near the Simpani Chakhel where white brownish-white, ash-grey limestone is found. The intercalation of ash grey, thinly-layered phyllite, and white pink-to-white dolomitic limestone with frequent calcite veins is observed along the Fakhel Deurali.

Chhapbhanjyang–Baneshwor Dada–Champadevi Temple (GT4)

The Champadevi Temple (E623423, N3059127, 2247 m) is about 45 min. NE downhill from the Baneshwor Dada (E622209, N3059628, 2369 m). Through the Chhapbhanjyang, the Baneshwor Dada is about 35 min. NE. Around the Champadevi and Baneshwor Dada, there is greyish-white calcite precipitation, grey weathered metasandstone, and white, yellowish brown, coarse-grained quartzite and dolomitic limestone are observed. The landscape view, geomorphology, cool dense forest, typical foot trail, and religious temple i.e. the Champadevi Temple are the attraction of this section. This section is an open book for the ayurvedic, botanist, zoologist, geologist, mountaineer, photographer, tourist, and many internal and international tourists hiking in this area. Though there is some tourist guide map along the way, this guide map has lack information and is not enough for new tourist. The quartzite bed is frequently observed but almost all exposure is covered by residual soil in most of the area. A dense forest with biodiversity, a peaceful environment, and a religious temple i.e. the Champadevi Temple is the most attractive point of this area.

Baneshwor Dada–Machchhegau (GT5)

Through the Baneshwor Dada, it takes of about 1 hr 15 min time to reach Machchhegau. The Baneshwor Dada belongs to the Chitlang Formation. While moving downhill towards Machchhegau, the Chandragiri Limestone is observed. The massive whitish-grey quartzite is observed along the Baneshwor Dada. While along the Machchhegaun section, the dolomite and dolomitic limestone is observed belonging to the Chandragiri Limestone. The beautiful dense forest with a slippery foot trail attracts tourists. The tourist can get knowledge of rocks, geomorphology, plants, animals, herbal medicine, etc.

Chhapbhanjyang–Simpani Chakhel–Fakhel Deurali section (GT3)

The Chhaimale, Kharpa is about 2 hr. downhill from the Champadevi Temple. The Chhaimale, Kharpa area belongs

to the Chandragiri Limestone while moving uphill towards the Champadevi Temple, the Chandragiri Limestone is followed by the younger Chitlang Formation. The metasandstone, quartzite bed, and some dolomitic limestones are observed. The steep foot trail, biodiversity, and beautiful dense forest in this area attracts tourist.

Champadevi Temple–Hattiban Resort–Saukhel (GT7)

The Saukhel at the Bhanjyang petrol pump (E626080, N3056328, 1564 m) is about 2 hr. downhill from the Champadevi Temple. There is a dense pine forest on the way to Hattiban resort (E625526, N3057713, 1843 m). Around the Saukhel, metasandstone some quartz vein is observed. While moving uphill towards Hattiban resort from Saukhel greyish limestone with calcite crystal belonging to the Chandragiri Limestone is observed having an attitude of bed $105^\circ/15^\circ$ (NE)/ 42° . Moving uphill towards the Champadevi Temple, a younger succession of the Chitlang Formation having brownish yellow to white colored coarse-grained thick-bedded quartzite bed and intercalation of grey fine-grained highly compact metasandstone is observed. Only an hour's drive from Kathmandu Valley, the peaceful Hattiban resort is famous in this study area where lovely landscape with a great view of Kathmandu Valley, high mountains, pine forest, lush green gardens, independent cottages, sunshine, and good hospitality makes tourist feel more relax.

Dandikhel–Dudechaur–Pharping–Dakshinkali (GT8)

Dandikhel (E622780, N3056108, 2070 m) and Talku Dudechaur (E623585, N3055805, 1748 m) belong to the Chandragiri Limestone where light grey to grey limestone is observed. The Pharping, well known for pear fruit, and Dakshinkali Temple, a famous religious place are covered with the Kathmandu Valley sediments. The Kobgaun Formation along Pharping area comprised of light grey, laminated, fine to silty sand and poorly graded gravel (sub-rounded to rounded) gravel. The Chapagaun Formation along the Dakshinkali area comprised of silty sand, rounded gravel, and boulder beds.

Taudaha–Chalnakhel–Bosan–Godamchaur (GT9)

Taudaha comes from a combination of Newari words *Ta* = snake, and *Daha* = lake. Taudaha Lake with a tree in the middle of the large water pool, a variety of fish, and migratory birds is the perfect place to have a peaceful time. Taudaha, Chalnakhel (E626207, N3059203, 1290 m), and Bosan (E624997, N3059154, 1586 m) villages belong to the

Chandragiri Limestone. The Chandragiri Thrust (C.T) passes through the Godamchaur (E624282, N3060758, 1484 m). Large alluvial fans and repetition of stratigraphy are the evidence of the Chandragiri Thrust (C.T). This thrust has brought the older rocks of the Sopyang Formation over the younger Chandragiri Limestone.

Kirtipur–Chobhar–Taudaha (GT10)

Taudaha is about 30 min. ride from Kirtipur. The rock beds around the Balkhu Khola, Balkhu, Naikap show the north dipping whereas the beds near Kirtipur, Bishnudevi Temple (Tinhana) show south-dipping, hence the Kirtipur Anticline is observed in this area. The well-known Barahi cave is located on the Chobhar (E627880, N3060793, 1281 m) where Chobhar Gorge is situated near the cave. The Elephant-skin type weathering on limestone is observed in Chobhar. At the northeastern part of the study area at Chobhar, the three successions i.e., the Tistung Formation, the Sopyang Formation, and the Chandragiri Limestone are observed. The study area is dominated by grey, thick- to massively bedded limestone with intercalation of thinly bedded phyllite and thickly bedded metasandstone.

Thankot–Godam–Cable car–Chandragiri Temple (GT11)

Thankot is 1 hr. ride from Kathmandu Valley where Tribhuvan Park well known for picnic spot is located. The cable car station is located in Godam which consists of alluvial fan sediments. The 2.5 km, 9-minute cable car ride is the shortest means to reach Chandragiri Hills' top station with a low entry fee. Cable car ensures a safe and pleasant journey with an up-close view of the untainted wilderness, lush green Chandragiri range forest, geomorphological landscape, and beautiful Kathmandu Valley. The religious temple, shops with a variety of reasonably-priced clothing brands, cultural merchandise, and toy store are perfect mementos for visitors to the Chandragiri Temple (E619102, N3061572, 2498 m). A more fascinating hotel, the "Hotel Chandragiri Hill" is located in this area and provides good hospitality, healthy, hygienic, delicious food, and clean night stay room at an affordable price.

Chandragiri Temple–Chitlang Bhanjyang–Dadakharka–Bicharithok–Mathillo Pauwa–Tallo Pauwa–Chitlang (GT12)

A 1 hr. hike downhill from the Chandragiri Temple (E619102, N3061572, 2498 m) to the Chitlang village (E616172, N3060187, 1745 m) experiencing a designated

trail is for those who like to take their time to soak in the vistas of the wilderness. The Chandragiri Temple also known as Bhaleshwor Mahadev Temple is a famous religious Hindu Temple in Nepal (Fig. 11A). There is a children's playground with exciting recreational equipment like climbing ropes, swings, slides, seesaws, a jungle gym, and riding on a pony around the hilltop near the Chandragiri Temple (Fig. 11B). The area belongs to the Chitlang Formation which consists mainly of white quartzite, argillaceous limestone, dark bluish-grey slate, and dolomitic limestone. At the Chitlang Bhanjyang (E617890, N3062317, 2224 m), dark bluish grey limestone with wave marks and on the way to Mathillopauwa (E616512, N3060825, 1782 m) and Tallopauwa (E616205, N3060569, 1792 m) from Chitlang Bhanjyang, thickly-bedded white quartzite and thinly bedded, variegated shale was observed. Violet limestone is observed around Bicharithok (E616215, N3061254, 1823 m). Downhill from the Chandragiri Temple towards Chitlang Bhanjyang, interbedding of well-laminated shale and quartz vein oblique to the quartzite beds is common (Fig. 11C). Tourists visit Chandragiri Hill and enjoy the snowfall during the winter season (Fig. 11D).

Chitlang is an adventurous three-hour walk from Thankot (Fig. 11E). Some pickup vehicles leave for Chitlang in the morning from the Godam and go via the Chandragiri pass which takes an hour to reach. Similarly, bus leaves the Chitlang in the afternoon to reach Kathmandu. The main benefits of homestays at the Chitlang village are additional income for the average family and the conservation of the local environment and culture. Many positive comments can be seen in the visitors' books kept at each lodge of the Chitlang (Fig. 11F).

Chitlang–Khaliban–Chakhel–Fakhel Deurali (GT13)

Chitlang is the nearest point for refreshment being out of crowd from Kathmandu with Newar settlement. Chitlang Valley is a fertile valley from where huge amount of rice fields and vegetables supplies to Kathmandu. Early morning, having breakfast the trekkers, and riders shall then move ahead to catch Khaliban-Chakhel-Fakhel Deurali route. A 30 min off-road ride and a 3 hr. walk from the Chitlang to the Fakhel Deurali (E620135, N3060832, 2264 m), Makwanpur District. Visitors can gather at different spots to share experiences and refreshments; the trip will be filled with greenery and rough roads gradually. Since the trip is not to be made pressure filled up, riders or trekkers will have lunch either at Khaliban (E616767, N3057801, 2005 m) or at Chakhel (E619416, N3060624, 2006 m). Having enough rest, riders/trekkers can have a short walk around the village and towards the Fakhel Deurali to spend time relaxing, and sightseeing in stunning sceneries. The Fakhel Deurali and Chakhel village belongs to the Chandragiri Limestone

where calcareous metasandstone is frequently common. Calcite crystal on pinkish-white limestone of the Chandragiri Limestone is observed on the way to Khaliban from Chitlang (Fig. 11G). Near the Chakhel from the Deurali, intercalation of ash grey, thinly-layered phyllite, and pinkish-white dolomitic limestone with frequent calcite veins are observed. Near Khaliban, ash-grey laminated shale subordinates with brown weathered metasandstone are found which belongs to the Sopyang Formation.

Chandragiri Temple–Fakhel Deurali–Matatirtha–Gurjudhara (GT14)

It takes about 30 min. to reach the Fakhel Deurali from the Chandragiri Temple by walking via foot trail. Visitors can enjoy riding, cycling (Fig. 11H), trekking, or hiking to reach Matatirtha (E6211707, N 3061278, 1793 m) and Gurjudhara. The visitors will get the opportunity for sightseeing the beautiful dense forest, Kathmandu Valley, biodiversity, and geological features. The Fakhel Deurali-Matatirtha road is a historic route from where the late king Prithivi Narayan Sah noticed Kathmandu Valley for the first time. In this section, visitors can observe the Chandragiri limestone, Sopyang Formation, Tistung Formation, and alluvial fan deposits on the Kathmandu Valley sediments while moving downwards. Geotourist can learn about transitional contact between the Tistung Formation and the Sopyang Formation near the Matatirtha. Massive-thick, huge outcrops of limestone on the Chandragiri Limestone can be seen as cement grade (Fig. 11I). Visitors may get dehydrated and hungry as there are no hotels on this route so visitors may manage their own takeaway while traveling on this section.

Logistics for traveling to the study area

Upon arriving at the Tribhuvan International Airport (Kathmandu) and at other airports in Nepal like Pokhara, Bharatpur, etc. visitors have various transportation options to reach their destination in the study area. Visitors can hire a taxi, pre-book transportation services, or choose from local buses and private vehicles available outside the airport. Visitors can travel from India to the Nepal-India border at crossings like Sunauli-Bhairahawa or Kakarbhitta. For bus travel from China, the Zhangmu/Kodari border crossing, the Friendship Bridge is commonly used and they can continue their journey by bus or other transportation modes to reach Kathmandu and the study area. Visitors should remember to check local conditions, permits, visa requirements, and border regulations beforehand. In the study area, local buses connect Kathmandu with destinations like Godam, Chitlang, Taudaha, and Pharping, offering flexibility for exploration. These affordable buses are ideal for shorter distances within the area.



Fig. 11. Various activities performed within the study area: A – people on the Chandragiri Temple to worship the god; B – kids enjoying on the Chandragiri Temple; C – quartz vein near Chitlang Bhanjyang; D – news published on the national newspaper about snowfall on the Chandragiri hill; E – geomorphological view of the Chitlang valley and Chasndragiri Range; F – homestay facility on the Chitlang valley for tourist; G – calcite crystal on limestone near the Khaliban; H – domestic tourist enjoying cycling on the Chandragiri hill; I – local people are making limestone aggregates for construction purposes from uphill of the Matatirtha

Chandragiri and Thankot are popular trekking starting points with stunning Himalayan views accessible by road from Kathmandu. Chitlang provides an easily reachable and charming rural experience, while Pharping, known for its monasteries and pilgrimage sites, serves as a spiritual starting point for treks and hikes. Thankot is a town located near Kathmandu and serves as a starting point for treks in the Chandragiri to Chitlang range. There are several hotels and guesthouses available in Thankot for accommodation. Chandragiri itself is a popular starting point for treks in the region and has a cable car station that can take you to the hilltop, where visitors can begin their trek. There are few hotels available on Chandragiri Hill for overnight stays. There are guesthouses, resorts, and homestays in Chitlang for accommodation where they can stay before or after their trek. It is advisable to make necessary arrangements and book accommodations in advance, especially during peak trekking seasons.

Conclusions

The Chandragiri-Chitlang section consists of several attractive geotouristic sites. One has ample opportunity to learn geological, geographical, biological, historical, religious, and cultural diversity. A traveler can walk from the Kathmandu Valley an elevation of about 1250 m to the highest peak of the hill up to 2561 m crossing several ridges, spurs, and streams. Furthermore, one can see the good outcrops of the Quaternary Valley sediments with a thick succession of lacustrine soil horizons in the lower elevation to a well-bedded succession of low-grade metamorphic and sedimentary rocks

in the upper elevations. The type of rock varies from carbonate to siliciclastic in nature. Sedimentary structures, as well as deformed bedding features, are found in the rocks. The rocks have developed several local scale folds, faults, brittle shear zones, and lineation. A regional scale fault named the Chandragiri Fault can be observed in this route. This fault is considered as the active fault of the region. Several colluvial fans and debris cones are developed at the base of the hills due to this fault. Several levels of river terraces can be viewed from the height looking down to the valley. Additionally, the landscape view of the Rhododendron (national flower of Nepal) Forest, a cold climatic adaptation of plants, a peaceful environment, and biodiversity are the other accessories for tourists and researchers. The old-fashioned traveling routes along the mixed-type forest-covered region have added more beauty to the region. Therefore, the region can be developed as a good destination for geotourism. Due to the lack of proper tourist guide maps, tourist information centers, good hotels, proper trek routes, foot trails with safety measures, resting parks, and water facilities, it is difficult to attract tourists, researchers, and visitors in the present condition. However, in the future, the presently studied section have a very good future to promote geotourism.

Recommendations

The geological heritage of the region should immediately protect to develop the region as a good site for geotourism. Facilities like view towers, botanical gardens, rock gardens, geoparks, picnic spots, etc. should be developed to promote the geotourism trade soon.

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