 DOI: https://doi.org/10.7494/geotour.2024.3-4(78-79).71

Exploring the potential of geotourism along the trek route of the Pokhara Ghandruk section of Gandaki Province, Nepal

Sanjeeb Pandey*, **Kabi Raj Paudyal**

Central Department of Geology, Tribhuvan University, Kirtipur, Kathmandu, Nepal
pandeysanjeeb1127@gmail.com; paudyalkabi1976@gmail.com

* Corresponding Author

Article history:
Received: 29 September 2024
Accepted: 2 March 2025
Available online: July 2025

Abstract: *Geoconservation enhances tourist knowledge of a site's geology, going beyond surface appreciation. Geotourism emphasizes geology and landscape, contributing to geodiversity conservation through various activities. While the Pokhara Ghandruk area in Gandaki Province is renowned for tourism, it remains unexplored from a geotourism perspective. The study focuses on identifying key geoconservation and geotourism sites for national economic development by systematic geological survey with map preparation highlighting distinctive geological, geomorphic, cultural, heritage and site-seeing features of each site. The region boasts several significant sites, such as Pokhara Valley known for its caves, lakes, and the Seti River gorge. Pokhara canyoning provides thrilling water geoadventures on quartzite cliffs. Naudanda offers breathtaking views of Pokhara Valley and the Annapurna range. Poon Hill and Khumai Danda serve as stunning vantage points for observing snow-capped mountains. The Mardi and Annapurna trek routes, along with Ghandruk Landruk Lwang Dhampus, offers geologically significant sites, including unique rock outcrops due to its passage through the Mahabharat Thrust and the Main Central Thrust (MCT) and exhibit potentiality for rock climbing centers, hot springs, and geocultural parks capitalizing on Gurung hospitality and rich traditions to boost tourism and preserve geoheritage. The study recommends the establishment of geotrails and a geopark within this region.*

Keywords: *geoconservation, geotourism, Poon Hill, Pokhara, Ghandruk*

Introduction

Geotourism focuses on sustainable travel to appreciate and conserve natural and cultural heritage, while geoconservation aims to protect and manage geological sites for future generations and raise awareness about their significance. Geotourism and geoconservation promote sustainable tourism by highlighting a destination's unique geography and culture while minimizing negative environmental and social impacts. It also offers educational experiences, benefits local communities, and safeguards natural and cultural resources for future generations (Drumm & Moore, 2005). It helps to prioritizes authentic, high-quality travel and encourages ethical and responsible tourist behavior and finally help to promote the economic standard of the whole country.

Geoconservation involves creating interpretive and service facilities that allow tourists to gain a deeper understanding of a site's geology and geomorphology, going beyond just appreciating its beauty. Geotourism, on the other hand, focuses on tourism centered on geology and landscapes. The Nepal Himalaya serves as a treasure trove of geological knowledge, offering immense potential for geotourism thanks to its diverse geomorphology, geological landmarks, breathtaking natural beauty, and unique trekking paths (Reynard & Brilha, 2018). It's a region rich in biodiversity, cultural heritage, historical sites, adventure, and the warmth of its people. There's no place quite like the Nepal Himalaya for experiencing a vast array of geography, nature, and culture. This unique blend not only attracts tourists but also presents lucrative opportunities for investors to reap significant

 eISSN 2353-3641 | ISSN 1731-0830

benefits (Gautam, 2011; Bhote, 2018; Acharya & Paudyal, 2023). It plays a crucial role in conserving geodiversity and geoheritage by offering independent visits to geological features, geotrails, viewpoints, guided tours, geoactivities, and supporting visitor centers at geosites.

The Himalayas, formed approximately 55 million years ago by the collision of the Indian and Eurasian continents, exhibit distinct features indicating it as a young fold mountains which has been further evident by the features such as deep gorges formed by the upliftment of the mountains and erosion by older rivers, U-turn river courses resulting from the tectonic uplift and morphological changes induced by folding, parallel mountain ranges reflecting differential uplift and structural adaptation of river segments, and steep gradients leading to frequent landslides due to the fragile nature of the rock formations and continuous stress from plate movements (Stöcklin, 1980). The landscape's susceptibility to landslides is compounded by factors such as high seismic activity and heavy rainfall, making the Himalayas a region prone to geological hazards.

The Himalaya is a prominent orogenic belt formed by the collision of the Indian and Asia Plates, recognized for its youth and height (Dewey & Bird, 1970). The formation process involves northward convergence and crustal fracture (Valdiya, 1998). Le Fort (1975) identifies four east-trending geological belts: Sub-Himalaya (Siwalik), Lower Himalaya (non-fossiliferous low-grade metamorphic rocks), Higher Himalaya (crystalline complex), and Tibetan-Tethys Himalaya (marine, fossiliferous strata). Yin (2006) further divides it into North and South Himalaya. Stratigraphically, the Himalayan formation includes Neogene Siwalik Group, Proterozoic units of Lesser Himalaya, Ordovician-Proterozoic unit of Greater Himalayan Crystalline Complex, and Tethyan Himalayan Sequence, providing insights into geological history and formation.

Stöcklin & Bhattarai (1977) conducted a study on the geology of the Lesser Himalaya and the Lesser Himalaya Crystallines in central Nepal, using stratigraphy, geological structures, and metamorphism as their basis. They observed that the Nawakot Complex is composed of low-grade metasedimentary rocks and is further divided into the Lower Nawakot Group and the Upper Nawakot Group, with an unconformity between them. The Nawakot Complex includes pelitic, psammatic, and calcareous meta-sedimentary rocks that exceed the chlorite-sericite grade.

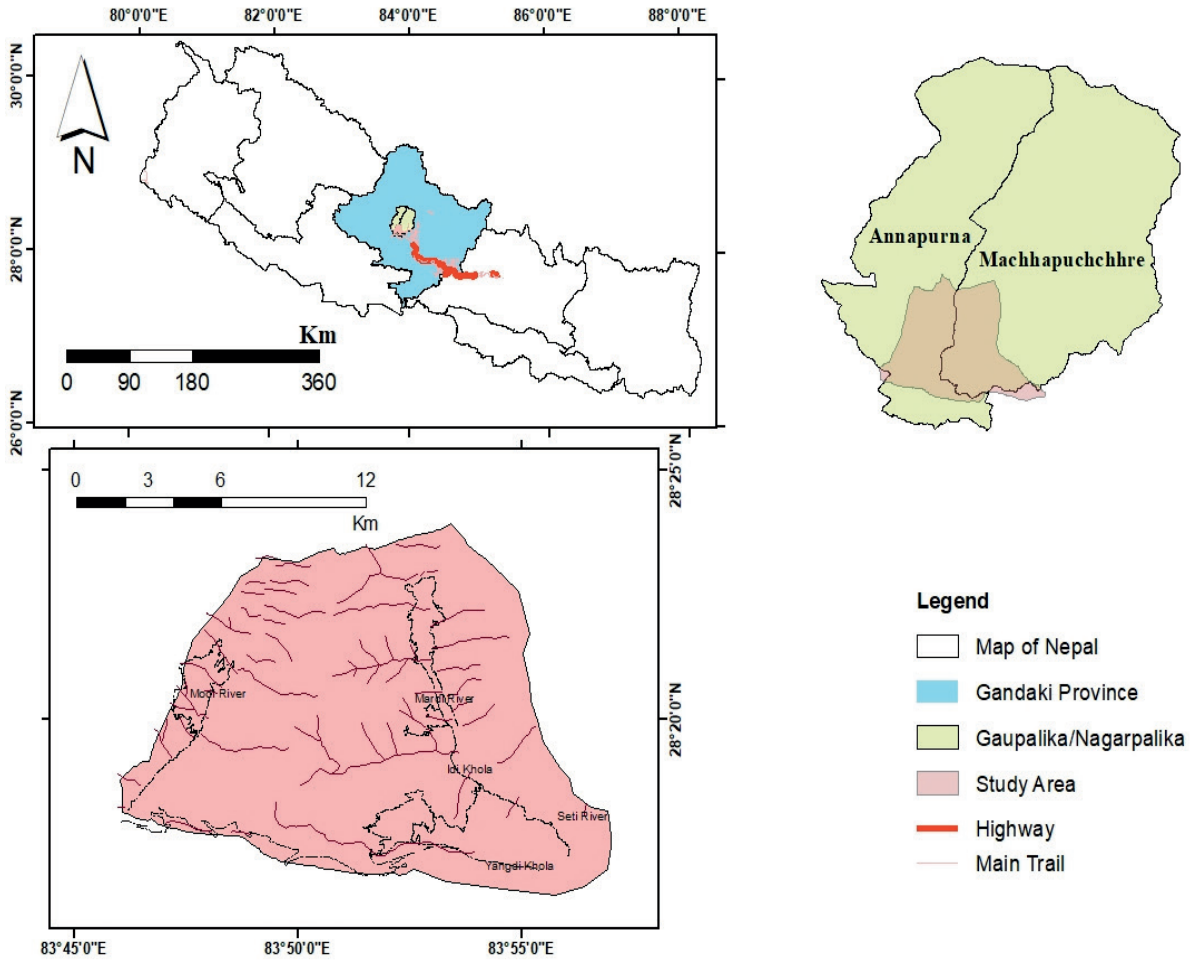

Fig. 1. Political map of Nepal showing the location of the study area

Meanwhile, the Lesser Himalayan Crystallines, also known as the Bhimphedi Group, contain high-grade metasedimentary rocks that exhibit normal metamorphism. The Mahabharat Thrust (MT) has been placed between the Nawakot Group and the Bhimphedi Group.

The Lesser Himalaya in the Pokhara region, western Nepal comprises low-grade metamorphic rock of the Nawakot Group in the south and highly deformed rocks of the Main Central Thrust Zone in the north (Paudel & Arita, 1998). The Lesser Himalaya Zone of the western part comprises several folds and thrusts at local to regional levels as this zone of the Himalaya is also known as the fold and thrust belt of the Himalaya (e.g., the Phalebas Thrust, the Lumle Thrust, the Kushma Reverse Fault, and the Main Central Thrust (MCT) are some major thrusts of the Lesser Himalaya in the Pokhara region of western Nepal (Paudel & Arita, 1998).

The recent geological study of Thapa *et al.* (2023), has identified seven lithostratigraphic units (Gyarjati, Begnas, Siswa, Ghachok, Phewa, Pokhara with its two members Pokhara A and B, and Rupakot Formation) and two geomorphic units (Gravel veneer and recent deposit). The Pokhara Formation, the most widespread, lies over the Ghachok Formation and indicates significant geological events, including large-scale debris flows and lake formations. Contradiction to the earlier findings, the Gyarjati Formation, identified as the oldest based on the geomorphic position, elevation and degree of lithification of the material. From this study some variation in clast composition and texture has been reported in different formations.

The Pokhara Ghandruk section, located in western Nepal's Gandaki Province, is famous for its stunning landscapes, rich culture, and trekking paths in the Annapurna Mountain range. Despite being a top tourist destination in Nepal, unfortunately, the geology and geotouristic potential of this area have not been well studied. In order to fulfill this gap present study aims conduct detailed geological surveys with preparation of the comprehensive geological as well as geotouristic maps with documentation of geotrails, geoconservation sites, geoadventure opportunities, and geocultural and geoheritage sites. The ultimate goal is to provide the insight to convert these locations into top geotourism destinations. Additionally, the research aims to identify significant geological and geomorphic features, as well as notable sightseeing spots present within the area. This study seeks to promote both geoconservation and geotourism, enhancing the tourist experience while preserving the region's natural and cultural heritage.

The present study area falls within the Kaski district of the Gandaki Province. Geographically, the coordinates of the study area lie between 28° 17' 30" N, 83° 45' E and 28° 27' 30" N, 83° 50' E (Fig. 1). Access to the study area can be achieved through multiple routes. One option is via the Prithvi highway, while another is by air travel from Kathmandu to Pokhara, followed by road transportation. The majority of the study area can be reached through a blacktopped motorway along the Mardi River and the Modi River, with the remaining portion accessible by foot trails.

Methods

The initial phase of the research involved a thorough revision of extensive literature. Subsequently, fieldwork was conducted based on primary data acquired through comprehensive field observations, including in-depth geological and geomorphological investigations and systematic photography. In this geological study, a series of traverses were conducted to meticulously examine the lithostratigraphy, geological structures, metamorphism, and mineral resources of the region in order to prepare the detail geological map of the local scale. The primary focus was on systematically studying the major geotouristic attractions (i.e. geotrails, hot spring, geoconservation site, geoadventures site) of the Pokhara Ghandruk range. The area being unexplored yet initially the existing topographic and the google maps were explored further followed by the gathering and studying of the published and the unpublished article related to the cultural heritage and traditions of the local communities.

A comprehensive collection of social and cultural data, as well as information on local resources, was conducted. Required information were gathered through a variety of methods, including questionnaires, visits to local museums, review of existing articles and news reports pertinent to the area, and interactions with local community representatives such as ward members. Valuable insights were also gathered from foreign trekkers, adding a diverse perspective to the study.

Results

Geoenvironmental factor

The study area in Pokhara, Nepal, features a humid subtropical climate with moderate temperatures due to its elevation. Summers range from 25°C to 35°C, while winters hover around −2°C to 15°C, with significant precipitation during the monsoon season. The region boasts diverse vegetation, transitioning from lush subtropical forests to temperate forests and including notable rhododendron blooms.

The topography is rugged, influenced by tectonics, with elevations ranging from 1,046 m to 2,642 m. Several rivers, such as Mardi, Seti, and Modi, exhibit a dendritic drainage pattern. The area is predominantly forested, with residential settlements, tourism infrastructure, and terrace farming in some parts (Fig. 2). Popular tourist destinations, like Lumle and Ghandruk, offer stunning views of the Himalayan peaks, attracting visitors from around the world.

Fig. 2. Terrace and the forest covered area observed from the Dhampus Hill of the study area

General geology of the Nepal Himalaya

The Himalaya is the 2,400 km long highest as well as the youngest mountain range on the earth formed between Indo-Eurasian convergent boundaries. Of which Nepal Himalaya is the central 800 km stretch between the Mahakali River (west) and the Mechi River (east). Like the entire 24,000 km long Himalayan range, the Nepal Himalaya is also divided into five major tectonic units as Indo-Gangatic Plain (in Nepal: the Terai Zone), the Sub-Himalayan Zone, the Lesser Himalayan Zone, the Higher Himalayan Zone and the Tethys Himalayan Zone from south to north, respectively. These zones extend approximately parallel to each other throughout the country. Each zone is characterized by its own lithology, tectonics, structures and geological history.

The Lesser Himalaya is the one of the major tectonic divisions of the Himalaya bounded between the Sub-Himalaya and Higher Himalaya by the means of the thrust-fault, i.e. Main Boundary Thrust (MBT) in south and Main Central Thrust (MCT) in north. The total width ranges from 60 to 80 km. This zone comprises of the un-fossiliferous sedimentary and metasedimentary rocks such as shale, sandstone, slate, phyllite, schist, quartzite, limestone, dolomite ranging from Pre-Cambrian to Oligocene (Hashimoto *et al.*, 1973; Stöcklin & Bhattarai 1977; Sakai 1983). The geology of this zone is complicated due to folding, faulting and thrusting. Tectonically, the entire Lesser Himalaya consist of two sequences of rocks: allocthonous and autochthonous-paraauthochthonous units; with various nappes, Klippe and tectonic windows.

Geology of the Pokhara-Ghandruk Section

This geological study focuses on a specific area characterized by complex and diverse geological formations. Three major geological units are identified, excluding Quaternary deposits (Fig. 3A), the Higher Himalaya, the Bhimphedi Group, and the Nawakot Group. Each unit has unique characteristics in terms of Lithostratigraphy, metamorphic conditions, and deformational features.

The southern part of the area features low-grade metasedimentary rocks of the Nawakot Group, particularly prominent in the Pokhara Valley Hill. This group is separated from the Bhimphedi Group by the Mahabharat Thrust (MT) and is characterized by a gentle dip. The Nawakot Group includes formations like the Kuncha formation, Fagfog Quartzite (Fig. 3B), and Dandagaun Phyllite. A notable feature is the inverse metamorphism observed in these formations, particularly in the footwall of the MT. In the northern part of the study area, high-grade metamorphic rocks from the Higher Himalaya dominate, including paragneiss and orthogneiss (Fig. 3C, D) which overlie on the gentle dipping thrust known as the Main Central Thrust (MCT) from the Bhimphedi Group crystalline rock mass. The Bhimphedi Group consists of crystalline rocks like garnet schist, quartzite, and marbles, showing significant deformation. Its boundaries are defined by the MCT to the north and the MT to the south.

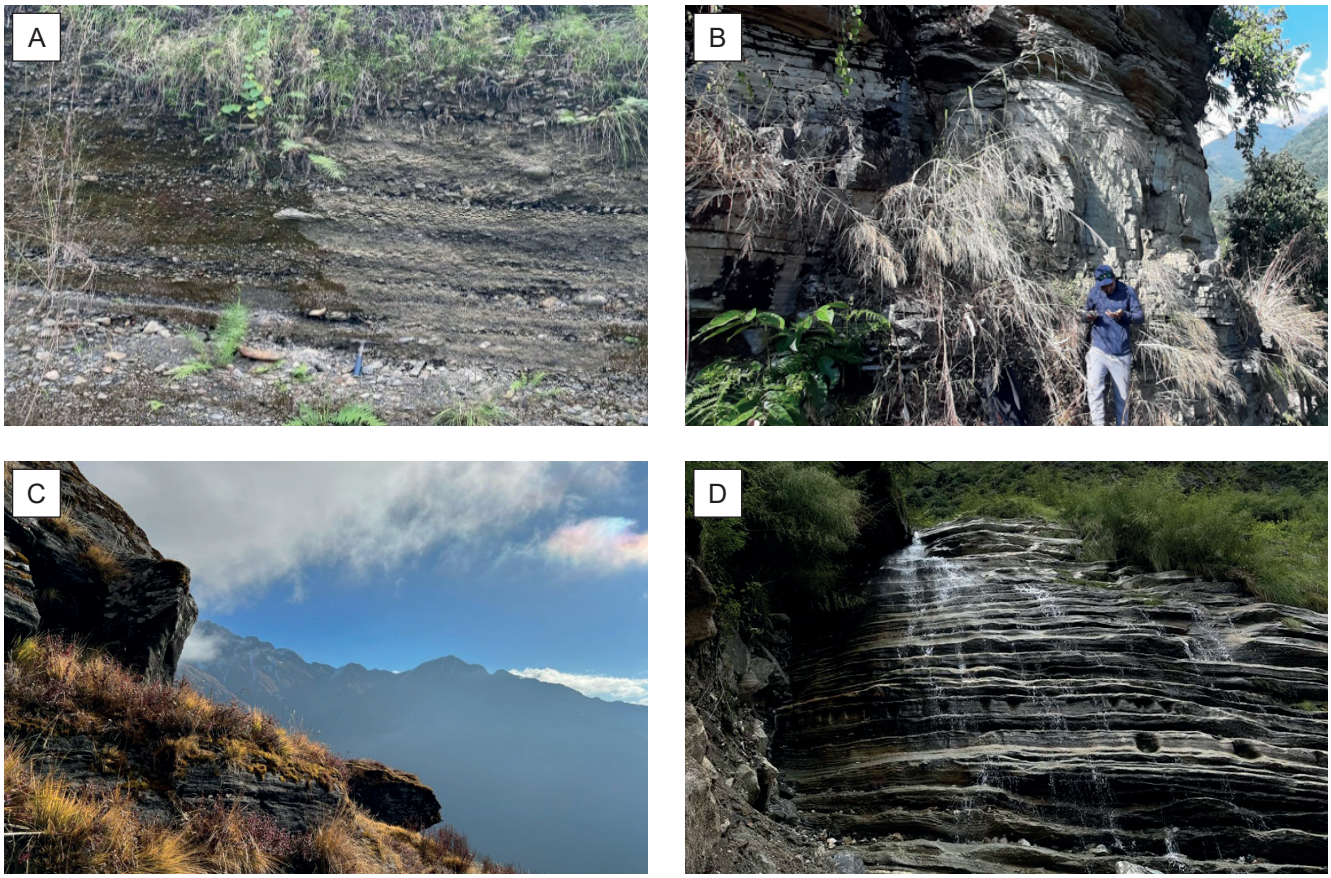

Fig. 3. Pokhara Valley sediment observed nearby Ghachowk area (A), quartzite of the Nawakot Group observed nearby the Lumre Village (B), paragneiss observed nearby the high camp area of the Mardi trek route (C) and gneiss observed nearby Deurali on the way to Annapurna Base Camp (D)

Pokhara Valley

The Pokhara being the second largest city in Nepal has been nestled in the southern foothills of the majestic Annapurna and Machhapuchhre Himalayas, situated in an intramontane basin. This beautiful valley is not only a gateway to the iconic Annapurna range, which includes three of the world's ten highest peaks Dhaulagiri, Annapurna I, and Manaslu but also a place of profound natural beauty and geological wonder. Within a radius of 15 to 35 miles from the valley, these towering peaks create a breathtaking backdrop.

Pokhara is characterized by its rich geological history, evident in the glacio-fluvial sediments that date from the Upper Pleistocene to the Holocene epochs. Adding to its geological intrigue are the karst features scattered across the valley, including fascinating caves and sinkholes such as Bat Cave, Mahendra Cave, and Gupteshwor Mahadev Cave (Fig. 4A). Mahendra Cave, located in Pokhara-16, Batulechaur, Kaski district, is a large limestone cave near the Kali Khola, known for its stalagmites and stalactites, attracting thousands of tourists annually. Discovered in the 1950s by shepherds and originally called 'Adhero Bhawan' (Dark Habitat), it was renamed after King Mahendra Bir Bikram Shah Dev. Nearby, the Bat Cave (Chameri Gufa) in Kaski District is a limestone cave famous for housing Horseshoe bats and is a popular tourist spot. Additionally, Gupteshwor Mahadev Cave in Pokhara-17, Chhorepatan, opposite Davis Fall, features limestone and calcareous metasandstone formations with water from Davis Fall flowing through it, making it another major attraction in Pokhara. The Pokhara Valley, geologically rich and diverse, features the Kuncha Formation as its foundational rock layer beneath quaternary deposits. The surrounding foothills are marked by a dominant lithology of calcareous metasandstone, psammatic schist, and calcareous quartzite, showcasing the valley's varied geological makeup.

Complementing its stunning natural landscape, Pokhara boasts an array of tranquil lakes – Phewa Lake (Fig. 4B), Begnas Lake, Rupa Lake, Dipang Lake, and Khaste Lake – each contributing to the serene beauty of the region. Pokhara is renowned for its stunning lakes, each offering unique attractions and natural beauty. Phewa Lake, the second-largest in Nepal, features serene waters, boating, fishing, and views of the Annapurna and Machhapuchhre ranges, with the Tal Barahi Temple on an island. Begnas Lake, the third-largest, is tranquil and less crowded, ideal for relaxation and nature appreciation.

Fig. 4. Some geotouristic site in the Pokhara Valley: A – outcrop of calcareous metasandstone observed at the Gupteshwor Cave; B – Phewa Lake; C – breathtaking view of the Machhapuchhre observed from the Bindhyabasini temple; D – Lord Shiva statue on the Pumdikot Hill

Nearby Rupa Lake is smaller and perfect for bird watching and fishing. Dipang Lake offers a secluded spot for nature lovers, and Khaste Lake is known for its pristine beauty and variety of bird species, making it perfect for picnicking and leisurely walks. Pokhara is home to several significant monasteries and temples, enriching the city's cultural and spiritual heritage. Notable sites include the World Peace Pagoda, a hilltop stupa with panoramic views; Matepani Gumba and Jangchub Choeling Monastery, both offering serene environments and insights into Tibetan Buddhism. Key temples include Tal Barahi, on an island in Phewa Lake; Bindhyabasini (Fig. 4C); offering stunning Himalayan views; Gupteshwor Mahadev Cave Temple, featuring a natural Shiva lingam (Fig. 4D); and Bhadrakali, nestled in a peaceful forest near Matepani Gumba.

Naudanda Hills

Naudanda, a charming town nestled in the northern hills of the Pokhara Valley, beckons with its breathtaking landscapes on the way to Sarangkot, the world's 5th-ranked paragliding spot. This picturesque haven is celebrated for its awe-inspiring views of the Annapurna range, offering excellent bird-watching opportunities and panoramic vistas that unveil the beauty of the entire Pokhara Valley (Fig. 5A). Delving into the rich tapestry of Naudanda hilltop region, careful study and observation pave the way for captivating guided tours, presenting a captivating geopark experience. This unique offering holds the promise to attract geotourists, fostering not only the economic growth of Naudanda but contributing significantly to the prosperity of the entire nation. Geologically this area lies within the Kuncha Formation of the Nawakot Group of the Lesser Himalaya Zone (Stöcklin & Bhattarai, 1977).

Naudanda has gained renown as a haven for bird enthusiasts, offering the chance to witness the captivating spiny babbler and majestic Black Eagle in their natural habitat (Fig. 5B). This scenic locale is also home to a diverse array of avian wonders, including vibrant sunbirds, melodious Laughingthrushes, graceful upland pipits, warblers, and the enigmatic presence of owls. The rich tapestry of birdlife in Naudanda adds to the allure of this picturesque town, making it a paradise for those seeking to immerse themselves in the beauty of the feathered inhabitants gracing its skies.

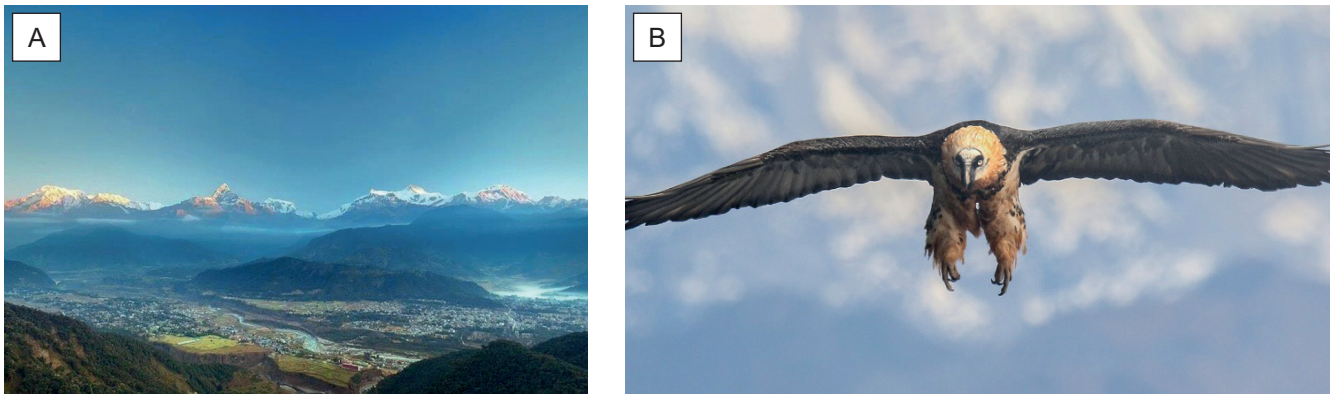

Fig. 5. Panoramic view of the Pokhara Valley (A) and the species of the eagle observe from the Naudanda Hills (B)

Pokhara canyoning

Pokhara canyoning is an exciting adventure for thrill-seekers, offering a refreshing break and a chance to rejuvenate amidst invigorating waters (Fig. 6A). Located in the Lumrek section on the Fagfog Quartzite (Fig. 6B) of the Lesser Himalaya, this thrilling activity has the potential to become a promising geoadventure destination. Accessible through Ghalel Village, approximately 22 km northeast of Pokhara city, it provides a simple yet exhilarating escape into the heart of nature's wonders. Pokhara canyoning not only provides an exciting escape but also holds the potential to evolve into a captivating haven for those yearning to explore the rocky terrain beauty of the Fagfog Quartzite (Stöcklin & Bhattarai, 1977) in the breathtaking landscape of the Lesser Himalaya. The formation of this waterfall might be due to the intra-formational thrust within the Fagfog Quartzite (Stöcklin & Bhattarai, 1977), known as the Pau Khola Thrust (present study).

Waterfall rappelling or canyoning in Nepal is an exhilarating, lesser-known adventure for thrill-seekers, particularly in Pokhara. This activity involves descending gorges using abseiling and rope techniques, providing a profound mind and body experience in some of the Himalayas' most remote areas. Expert guides lead participants through thick jungles, across rivers, and remote pathways, making it a rejuvenating escape from daily life. Pokhara canyoning, established in 2014 at the Khudi Waterfall in Ghalel Village, 22 km northeast of Pokhara city, offers an unmatched adventure with descents of 45 m or 75 m, blending raw nature with extreme sport.

Fig. 6. Geoadventure location observed at the Lumrek Valley (Pokhara canyoning) (A) and Fagfog Quartzite observed nearby Pokhara canyoning nearby the Lumrek Village (B)

Annapurna Base Camp and Mardi Himal trek

The beginning of the unique journey from Pokhara to Annapurna Base Camp and Mardi Himal, revealing the distinct charm of Nepal's Annapurna region. The trek encompasses geological significant sites, traversing the Mahabharat Thrust (MT) and the Main Central Thrust (MCT), unveiling unique rock outcrops along the way of the Lesser Himalayan Zone to the Higher Himalayan Crystalline on its pathway. As an impact of the Main Central Thrust (MCT), Hot-spring can be evident on the way to the Annapurna Base camp in the Jhinu area called as Jhinu Hot Spring (Fig. 7A). This hot spring has been nestled on the riverbanks of the Modi Khola, flowing from the majestic Annapurna Himalayan ranges and been surrounded by lush, beautiful trees, this serene spot offers hot, soothing waters to relax body while eyes can feast on the panoramic views of the tranquil river. Geologically, these hot springs appear to originate from the subsurface thrust known as the MCT. Savor the breathtaking panorama of Mardi Himal and Machhapuchhre Himal (Fig. 7B) from the enchanting high camp on the Mardi Himal trek route (Fig. 8).

In the traverse route, multiple captivating waterfalls, hot springs, and towering cliffs, presenting opportunities for rock climbing centers and serene hot spring ponds. The trek is about the natural beauty and remarkable destinations (Annapurna Base Camp, Fig. 7C) as well as for an immersion into the warm hospitality and captivating culture of the Gurung community (Fig. 7D). The Gurung, a prominent ethnic group in Nepal's Annapurna region, are renowned for their bravery, solidarity, and rich cultural heritage. Their vibrant customs include festivals like Ghatu Naach and Tamu Lhosar, rhythmic music with instruments like the tungna and madal, and a cuisine featuring fresh, locally grown foods and traditional dishes like chicken curry and Sisnu. Expert farmers, the Gurung thrive on the challenging Himalayan slopes, maintaining their agricultural traditions. Known for their warm hospitality, they welcome trekkers with open arms, offering a genuine taste of their cultural and culinary traditions. To further enrich the experience and celebrate the region's cultural and geological heritage, there's potential for creating a geocultural park or museum. This promising endeavor aims to enhance tourism, highlight the geological wonders, and showcase the rich cultural beauty that makes this trek truly special.

Fig. 7. Some captivating site along the Annapurna Base Camp and the Mardi Himal Trek Route: A – Jhinu Hot Spring present on the way to the Annapurna Base Camp; B – captivating view of the Machhapuchhre observed from the High Camp of the Mardi Himal Trek Route; C – destination of the Annapurna Base Camp; D – Gurung hospitailty captured during the study along this route

Fig. 8. Trek route to the Annapurna Base Camp and the Mardi Himal from the capital city of the Nepal (not in scale)

Ghandruk, Landruk and Dhampus section

Ghandruk, Landruk and Dhampus, three charming villages nestled in the northwest part of the Gandaki Province, grace the lap of the Lesser Himalayan meta-crystalline rock. Coincidentally, all three villages share the same geological formation, belonging to the Lesser Himalayan Zone known as the Kuncha Formation (Stöcklin & Bhattarai, 1977). This formation along this route can be divided into three parts: lower, middle, and upper. The lower part is dominated by metasandstone with some greywacke and metabasite. The middle part has roughly equal amounts of metasandstone and phyllite while the uppermost part comprises of the Ulleri gneiss rock body with host body of the psammatic phyllite. This section is renowned for Gurung hospitality and their alluring culture (Fig. 9), these sites have become popular among both local and international tourists. To elevate tourism, consider establishing a geoconservation (museum) or geoheritage park in this captivating area. Additionally, enhancing the experience with view stations can showcase the spectacular Annapurna Mountain vistas, providing a perfect vantage point for witnessing majestic sunrises and sunsets.

Fig. 9. Cultural program and the old museum present on the Ghandruk Village of the study area

Poon Hill

Poon Hill, positioned as a scenic hill station boasting breathtaking views of the Annapurna Massif and the Dhaulagiri Mountain range (Fig. 10A), presents significant potential for the preparation a geological hiking trail (trails that are specifically designed to showcase the geological features of an area), similar to the Annapurna Mardi trek route.

The trek route to Poon Hill traverses through the Lesser Himalayan rocks. The main rock formations of the Nawakot Group (Stöcklin & Bhattarai, 1977) along the trail. It consists of various formations including Kuncha Formation (metasandstone and phyllite with Ulleri Gneiss on top), Fagfog Quartzite (milky white quartzite), Dandagaon Phyllite (dark grey phyllite with schist in upper section), while the northern section comprises of the rock formation of the Bhimphedi Group (Stöcklin & Bhattarai, 1977) comprising the Raduwa Formation (garnetiferous schist with marble), and Kalitar Formation (biotite schist and micaceous quartzite).

The destination offers a remarkable opportunity for establishing a geopark (designated area that fosters protection, education, and sustainable development of a particular geological heritage) with binoculars, can act as a prime spot to witness stunning sunrises (Fig. 10B) with staring at the snow-capped peaks of Annapurna (8,091 m), Dhaulagiri (8,127 m), Annapurna South (7,219 m), Machhapuchre (6,993 meters), Hinchuli, Annapurna III, Dhampus Peak, and Dhaulagiri II.

Khumai Danda

Perched atop Khumai Danda (Fig. 11), where breathtaking panoramas unfold with views of Mt. Machhapuchhre (6,993 m a.s.l.), Annapurna (8,091 m a.s.l.), and Mardi (5,587 m a.s.l.), the locale presents an exceptional opportunity for crafting a geocultural park (designated area that combines geological heritage with cultural heritage and sustainable development). Unveiling pristine and untouched trails, the region invites geotrekking adventures, offering the chance to witness stunning sunrises and sunsets from the elevated vantage point of Korchan (3,700 m a.s.l.).

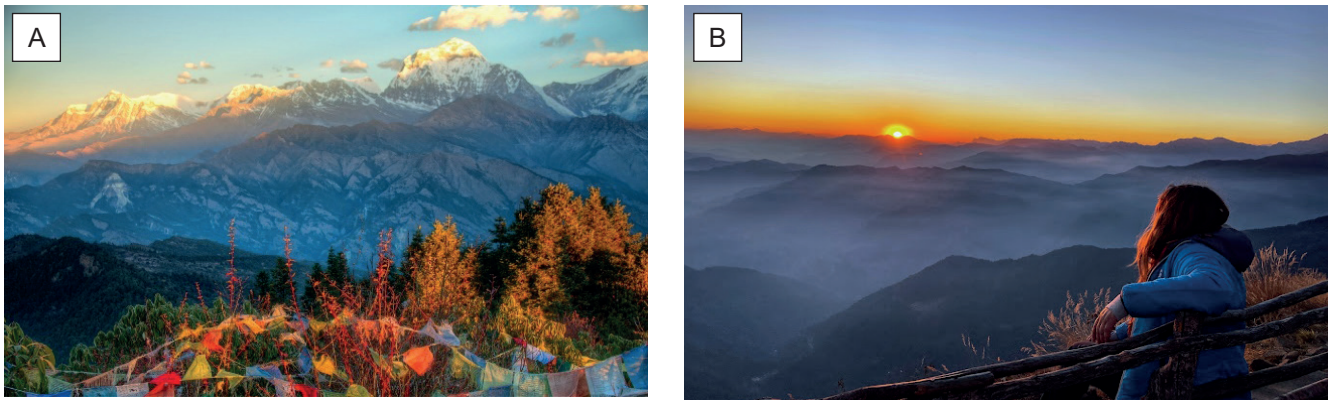

Fig. 10. Some geotouristic features observed from the Poon Hill area: A – mountain range observed from the Poon Hill view point; B – sunrise evident from the Poon Hill


Fig. 11. Eye pleasing view of the Mt. Machhapuchhre observed from the Khumai Danda of the study area

Engage in the warmth of local hospitality and immerse yourself in the distinctive culture of the community. This wonderful setting is the perfect canvas for establishing a geocultural park and creating captivating geotrails, elevating the overall visitor experience. This initiative can showcase the natural and cultural heritage of the region with exploration and appreciation of its unique geological and cultural facets. The route to the destination passes through the passage of the Kuncha Formation (Stöcklin & Bhattarai, 1977) rock body and mostly comprises of the metasandstone and the psammatic phyllite.

Conclusions

In conclusion, the Annapurna region of Nepal presents a treasure trove of opportunities for visitors seeking a deeper appreciation for both nature and culture. Trekkers traversing existing routes like the Annapurna Base Camp trek or the Ghandruk Landruk Dhampus route can be transformed into explorers navigating captivating geotrails. These trails, designed to highlight the region's unique geological and cultural tapestry, would offer an unparalleled perspective on the Himalayas. The establishment of geocultural parks or museums along these routes would further enrich the visitor experience by providing dedicated spaces to learn about the region's fascinating history and the intricate link between its geology and cultural practices.

Travel beyond established trails, the enchanting regions of Ghandruk Area, Naudanda Hills, Khumai Danda, and Poon Hill hold immense potential for the development of geoconservation sites and view towers. These designated areas would serve as focal points for exploration and education, inviting visitors to delve deeper into the distinct geological and cultural facets of each location. Imagine soaking in the panoramic vistas from a view tower atop Poon Hill, or participating in educational programs at a geoconservation Site in the Naudanda Hills that explores the traditional ways of life shaped by the region's unique geology.

Finally, Pokhara Valley beckons as a land where geoheritage and geoadventure seamlessly blend. Pokhara canyoning, for example, offers a thrilling opportunity to rappel and explore the heart of the Fagfog Quartzite, providing a unique adrenaline-pumping experience while fostering a deeper appreciation for the valley's geological marvels.

By implementing these initiatives, Nepal can position itself at the forefront of geotourism. These developments can enhance the tourism industry as well as serve to celebrate the rich natural, cultural, and geological heritage that defines the extraordinary destinations within the Annapurna region. Sustainable tourism practices would be central to this approach, ensuring the region's unique character is preserved for generations to come.

Recommendation

To create a flourishing geotourism destination in the Annapurna region, the immediate prioritization for protection of its geological heritage is the most. This crucial first step safeguards the foundation of geotourism – the fascinating rocks and landforms themselves. Once the foundation is secure, strategical investment can be recommended to design visitor facilities. Some site-specific recommendation such as developing well-positioned view towers offering breathtaking panoramas, planning the meticulously crafted geotrails that weave through the region's geological wonders as well as constructing the captivating rock gardens showcasing the diverse rock types in an accessible and educational setting can be made. Establish engaging geopark that serve as hubs for learning about the region's geological history and its connection to local culture.

This approach of safeguarding the geological treasures and creating immersive experiences for visitors – fosters

a sustainable tourism industry. Tourists are drawn in by the beauty and educational value of the geofacilities, while the protected geological heritage ensures these wonders are preserved for future generations. This virtuous cycle celebrates the unique geology of the Annapurna region, fostering both conservation efforts and a thriving geotourism sector.

References

Acharya M. & Paudyal K.R., 2023. Inventory of geotouristic routes along the southern hills of the Kathmandu Valley. *Geotourism/Geoturystyka*, 3–4(66–67): 47–61. https://doi.org/10.7494/geotour.2021.3-4(66-67).47.

Bhote G.R., 2018. Perceptions of tourism stakeholders towards tourism industry in Nepal. *Journal of Business and Social Sciences Research*, 1(1): 129–143. https://doi.org/10.3126/jbssr.v1i1.20953.

Dewey J.F. & Bird J.M., 1970. Mountain belts and the new global tectonics. *Journal of Geophysical Research*, 75(14): 2625–2647. https://doi.org/10.1029/jb075i014p02625.

Drumm A. & Moore A., 2005. *Ecotourism Development: A Manual for Conservation Planners and Managers. Volume I: An Introduction to Ecotourism Planning* (2nd ed.). The Nature Conservancy, Arlington, VA. https://www.researchgate.net/publication/277786951_Ecotourism_Development_-_A_Manual_for_Conservation_Planners_and_Managers_Volume_I_-An_Introduction_to_Ecotourism_Planning.

Gautam B.P., 2011. Tourism and economic growth in Nepal. *NRB Economic Review*, 23(2): 18–30. https://doi.org/10.3126/nrber.v23i2.52743.

Hashimoto S., Ohta Y. & Akiba C., 1973. *Geology of Nepal Himalayas*. Saikon, Tokyo.

Le Fort P., 1975. Himalayas: the collided range. Present knowledge of the continental arc. *American Journal of Science*, 275(1): 1–44.

Paudel L.P. & Arita K., 1998. Geology, structure and metamorphism of the Lesser Himalayan metasedimentary sequence in Pokhara region, western Nepal. *Journal of Nepal Geological Society*, 18: 97–112. https://doi.org/10.3126/jngs.v18i0.32202.

Reynard E. & Brilha J., 2018. *Geoheritage: Assessment, Protection, and Management*. Elsevier, Amsterdam. https://doi.org/10.1016/C2015-0-04543-9.

Sakai H., 1983. Geology of the Tansen Group of the Lesser Himalaya in Nepal. *Memoirs of the Faculty of Science, Kyushu University (Japan). Series D, Geology*, 25(1): 27–74. https://doi.org/10.5109/1546083.

Stöcklin J., 1980. Geology of Nepal and its regional frame. *Journal of Geology Society of London*, 137(1): 1–34. https://doi.org/10.1144/gsjgs.137.1.0001.

Stöcklin J. & Bhattarai K., 1977. *Geology of the Kathmandu area and central Mahabharat range, Nepal Himalaya*. Report of Department of Mines and Geology/UNDP [unpublished].

Thapa D., Paudyal K.R., Sah R.B., Dhungana U. & Chetri R.K., 2023. A revised Quaternary stratigraphy in and around Pokhara valley, Gandaki province, Nepal. *Himalayan Geology*, 44(2): 89–103.

Upreti B.N. & Le Fort P., 1999. *Lesser Himalayan crystalline nappes of Nepal: Problem of their origin*. In: Macfarlane A., Quade J. & Sorkhabi R. (eds), *Himalaya and Tibet: Mountain roots to mountain tops*, Special Paper, 328, Geological Society of America, Boulder, CO, 225–238. https://doi.org/10.1130/0-8137-2328-0.225.

Valdiya K.S., 1980. The two intracrustal boundary thrusts of the Himalaya. *Tectonophysics*, 66(4): 323–348. https://doi.org/10.1016/0040-1951(80)90248-6.

Yin A., 2006. Cenozoic tectonic evolution of the Himalayan orogen as constrained by along-strike variation of structural geometry, exhumation history, and foreland sedimentation. *Earth-Science Reviews*, 76(1–2): 1–131. https://doi.org/10.1016/j.earscirev.2005.05.004.