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SWOT Analysis of Geosites for Geotourism Development in Mandya District, Karnataka

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Abstract

Geosites represent locations of significant geomorphological, geological, ecological, and cultural value, forming essential components of geoheritage resources. Mandya District in southern Karnataka hosts an array of distinctive landforms-residual hills, river confluences, waterfalls, wetlands, and lacustrine systems that hold considerable potential for geotourism development. This study presents a comprehensive SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of twenty-seven geosites based exclusively on intensive field visits, direct observation, photographic documentation, and community-level interactions. The analysis reveals strong scenic and geomorphic attributes across all sites, balanced against widespread weaknesses such as inadequate infrastructure, absence of interpretation, lack of institutional coordination, and limited community involvement. Opportunities include eco-rural tourism integration, geo-heritage trails, educational applications, and community-based conservation, while threats arise from unregulated tourism, land encroachment, climate impacts, quarrying, and environmental degradation. The study demonstrates that SWOT analysis is an effective stand-alone tool for evaluating the practical geotourism readiness of geosites and provides a foundation for district-level geotourism planning in Mandya. Findings support developing thematic circuits, strengthening awareness, and promoting sustainable conservation strategies.

Keywords: Geosites, Geoheritage, Geotourism, SWOT Analysis, Field Assessment, Landscape Conservation

1 Introduction

Geosites-landscape features that exhibit scientific, aesthetic, ecological, cultural, or educational significance are widely recognized as fundamental units for conserving geoheritage and promoting geotourism. International scholarship emphasizes that geosites serve not only as repositories of Earth's geological past but also as dynamic spaces for environmental learning, community development, and sustainable tourism [1, 9, 11, 13, 15]. Geotourism, as conceptualized in global literature, highlights the value of interpreting geological heritage for public benefit, tourism diversification, and long-term conservation [4, 5]. The concept of geomorphosites further underscores the importance of landforms as educational and cultural resources that contribute to regional identity and landscape management [2, 12].

In recent years, India has increasingly acknowledged the importance of geoheritage, with initiatives arising from the Geological Survey of India, academic institutions, and regional conservation programmes [14]. Nevertheless, many districts rich in natural geomorphological features remain undocumented, underutilized, and vulnerable to degradation, underscoring the need for structured assessment strategies [10, 16].

Mandya District in Karnataka lies within the southern Deccan Plateau, encompassing an intricate assemblage of granite inselbergs, structural hills, river valleys, waterfalls, wetlands, and cultural landscapes linked to natural features. Despite this geomorphic richness, the region lacks systematic documentation of geosite potential and a coordinated approach for geotourism development. With rising local interest and growing academic engagement in integrated landscape management, assessing the geosites of Mandya becomes both timely and essential [17, 18]. SWOT analysis an evaluative framework identifying Strengths, Weaknesses, Opportunities, and Threats is widely used in tourism planning, destination management, and environmental assessment [3, 7, 8]. It is particularly effective when field-level qualitative information is available, but detailed quantitative or geospatial datasets are limited. The present study applies SWOT analysis solely based on direct field observation across twenty-seven geosites in Mandya District to understand their current conditions, constraints, and development prospects. This approach provides a practical, context-sensitive assessment that can directly support planners, local governments, academic institutions, and geotourism developers in designing sustainable geoheritage strategies.

2 Study Area

Mandya District is located in southern Karnataka, forming part of the Mysore Plateau and lying between the Cauvery River basin and the hilly uplands of the Kalyana Karnataka region. The district features diverse geomorphological characteristics, including granitic domes, residual hills (bettas), inselbergs, pediplains, waterfalls formed along structural discontinuities, river confluences such as Triveni Sangama, and wetlands including lakes, tanks, and irrigation reservoirs. The region's geology predominantly comprises Archean granites and gneisses, with localized metamorphic and sedimentary units forming varied landform assemblages. Rich cultural landscapes such as Melukote, Adichunchanagiri, and Karighatta further enhance the district's geotourism potential. Despite this richness, many of these landscapes remain under-documented and lack formal geoheritage recognition.

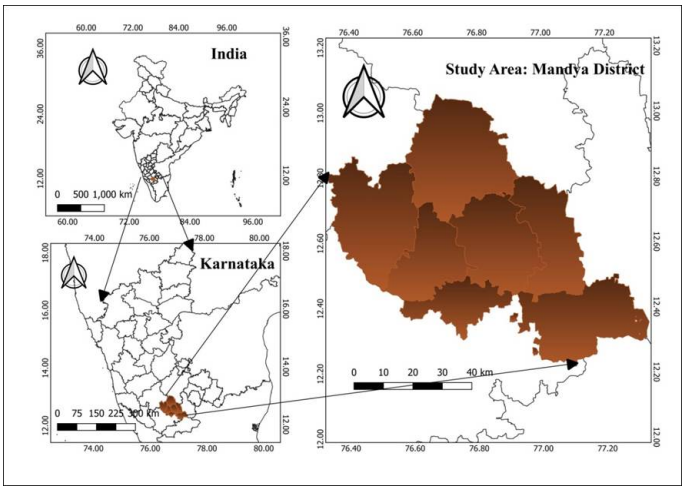

Fig. 1: Study Area-Mandya District

3 Methodology

The present study is based entirely on primary data collected through extensive fieldwork conducted across twenty seven geosites in Mandya District. Each site was visited in person to observe and document its geomorphic characteristics, landscape features, environmental condition, and tourism related attributes. Field assessment involved careful visual interpretation of landforms such as hill profiles, rocky outcrops, drainage features, slopes, and associated geomorphic processes allowing to understand the scientific and aesthetic value of each location directly on the ground. Photographs were systematically taken at every site to capture geomorphological features, environmental setting, accessibility conditions, and any visible signs of degradation or human influence. Informal interactions with local community members provided contextual insights regarding site history, cultural associations, visitor patterns, and local perceptions of tourism potential. GPS based location verification was used to confirm the coordinates and spatial accuracy of each geosite. All observations were recorded using a structured SWOT documentation sheet, enabling the systematic classification of strengths, weaknesses, opportunities, and threats. The assessment was thus grounded exclusively in empirical field evidence and contextual understanding obtained through direct site visits.

Table 1: Taluk-wise Geomorphological Classification, Landform Type, and Local Geology of 27 Geosites in Mandya District

Taluk	Geosite	Geomorphological Classification	Landform Type	Local Geology
Krishnarajapete	Triveni Sangama	Fluvial confluence of three streams	Fluvial confluence	Granitic gneiss terrain with alluvium
	Mandagere Katte Falls	Seasonal knick-point waterfall on hard rock	Waterfall / escarpment	Granite–gneiss with jointed faces
	Hemagiri Katte Falls	Vertical waterfall over resistant granite	Waterfall	Jointed biotite gneiss and granites
	Rayasamudra Betta	Classic granite inselberg on pediplain	Inselberg	Peninsular granite dome
	Aretippuru Betta	Archaeological granite tor hill	Tors / stacked boulders	Granite tor complex with exfoliation
	Kuntibetta	Twin-peaked exfoliated inselberg	Inselberg / exfoliation dome	Archaean pink granite
Pandavapura	Melukote Hills	Structural ridge with stepped slopes	Structural ridge	Quartzites, schist bands, granite
	Tonnuru–Vaddarahalli Betta	Linear granite ridge above lake basin	Ridge / cuesta-like	Granite–gneiss with fractures
	Basavana Kallu Betta	Rounded granite dome	Dome hill	Granite plutonic body
	Kote Betta	Elongated ridge with weathered slopes	Ridge	Gneissic and granitic rocks
	Karighatta	High hill with steep granitic slopes	Inselberg	Granitic gneiss and migmatite
Srirangapatna	Garakahalli Hill	Exposed granite outcrop with sheet joints	Tor / sheet-rock	Hornblende–biotite gneiss
	Haddinakallu Anjaneya Betta	Bouldery inselberg with temple	Bouldery inselberg	Archaean granite
	Mahadevapura Shooting Spot	Broad riverine plain with rocky banks	Floodplain / channel rocks	Granites and alluvium mix
Mandya	Antaravalli Betta	Typical granite inselberg with domes	Inselberg	Grey granites with joints
	Basavana Betta	Isolated granite hill with gentle slopes	Inselberg	Peninsular gneiss
	Dasanakere–Shrirangapura Hill	Low denudational hill	Residual hill	Weathered granite gneiss
	B. Hatna Hill	Isolated rocky rise	Residual hill	Granite–gneiss
	Hunuganahalli Hill	Small erosional hill with exposures	Residual hill	Granitic gneiss
	Sooley Kere	Large wetland basin	Lacustrine basin	Alluvium over granite pediplain
Maddur	Bettadamma Hill	Rugged granite hill	Inselberg	Grey biotite granite
	Kolirayanabetta	Steep granite hill with historical sites	Inselberg	Pink granite, gneissic patches
Malavalli	Kundur Betta	Steep granite trekking hill	Inselberg / tor	Archaean granite
	Belejagali Mole	Backwater wetland landscape	Backwater basin	Alluvium + granitic pediment margins
	Ganasandra Hill	Small granite tors and domes	Tor / residual hill	Peninsular gneiss
Nagamangala	Adichunchanagiri Hill Range	Hill range with rugged outcrops	Hill complex	Hornblende gneiss & granites
	Haddinakallu betta	Rugged granite field	Inselberg field	Archaean granites

4 Results of SWOT Analysis

The SWOT analysis of the twenty-seven geosites in Mandya District provides an integrated understanding of their geomorphic character, field condition, development prospects, and associated vulnerabilities. The evaluation highlights clear spatial patterns across taluks—Krishnarajapete, Pandavapura, Malavalli, Nagamangala, Maddur, Mandya, and Srirangapatna—revealing the strengths and challenges unique to each landscape type. The findings are presented thematically, with multiple examples from the field data.

4.1 Strengths

The geosites of Mandya District possess strong intrinsic qualities that favour geotourism, education, and conservation. Most sites have high scenic and aesthetic value. Hills such as Kuntibetta, Karighatta, Rayasamudra Betta and Tonnuru–Vaddarahalli Betta offer wide panoramic views, dramatic granite massifs and visually striking skylines. Water and wetland based sites like Mandagere Katte Falls, Hemagiri Katte Falls and Sooley Kere add to the visual diversity with seasonal cascades, open water surfaces and lush surroundings.

Geomorphically, the district hosts distinctive landforms: inselbergs (Rayasamudra Betta, Basavana Kallu Betta, Antaravalli Betta), structural ridges (Melukote, Kote Betta), erosional granite forms (Aretippuru Betta, Ganasandra Hill) and fluvial lacustrine systems (Triveni Sangama, Sooley Kere). These features make Mandya a natural geomorphology "field laboratory".

Several sites have clear scientific and educational value. Hemagiri Katte Falls, Garakahalli and Aretippuru Betta are well suited for teaching structural features, weathering, slope processes and multidisciplinary field studies. In addition, cultural - natural linkages at Melukote, Adichunchanagiri, Karighatta and Aretippuru broaden their appeal to heritage and pilgrimage visitors.

Finally, many sites are easily accessible, with good road connectivity to places like Kuntibetta, Melukote, Karighatta, Sooley Kere and Triveni Sangama, supporting their immediate inclusion in geotourism planning.

4.2 Weaknesses

Despite strong natural advantages, several constraints reduce current tourism readiness. A common weakness across all twenty-seven sites is the absence of interpretation and signage. Even geosites with high academic value Rayasamudra Betta, Kundur Betta and Garakahalli lack scientific explanation boards and wayfinding, limiting their use for school and university visits.

Most sites also suffer from poor basic infrastructure. Kundur Betta lacks safe trekking paths and resting places; Kolirayanabetta has steep, difficult approaches and no proper parking; Aretippuru Betta has no water, food or safety arrangements; and Garakahalli has no nearby boarding or lodging. Even popular Kuntibetta does not have adequate toilets, waste bins or official viewpoints.

Community participation and awareness are limited at Basavana Betta, Belejagali Mole, Haddinakallu Anjaneya Betta and several others. Local residents are often unaware of the geoheritage value and do not actively engage in guiding, homestays or conservation, reducing the long-term sustainability of tourism efforts.

In addition, nearly all sites face legal and administrative gaps. There is no formal geoheritage protection for Aretippuru Betta, Ganasandra Hill, Kolirayanabetta and many Nagamangala hills, making them vulnerable to quarrying, land conversion and unplanned development. Seasonal and terrain-related issues such as slippery monsoon slopes at Hemagiri Katte Falls and Kundur Betta, or fluctuating water levels at Belejagali Mole create additional safety and access challenges.

4.3 Opportunities

The SWOT analysis shows strong scope for sustainable, low-impact geotourism development. The geosites naturally group into thematic circuits, such as Fluvial Heritage Circuit, Inselberg Trail, Cultural Geomorphic Circuit and Adventure/Trekking Circuit. These circuits can distribute visitor flows and reduce pressure on individual sites. There is clear scope for eco- and rural tourism integration in villages around Basavana Betta, Belejagali Mole and Sooley Kere through local food, agro-tourism, cultural programmes and community-led guided treks. Sites like Garakahalli, Hemagiri Katte Falls, Aretippuru Betta and Bettadamma Hill can be formally incorporated into university and school curricula for field camps, student projects and environmental interpretation.

Popular sites such as Karighatta and Melukote offer potential for digital interpretation, including temple landscape narratives, mobile apps and virtual tours. At a broader scale, clusters in Pandavapura, Nagamangala and Maddur could underpin proposals for a Mandya Geoheritage Reserve, district-level Geo-Park or, in the long term, UNESCO Global Geopark candidacy.

4.4 Threats

The geosites are exposed to multiple threats that could undermine their long-term sustainability. Pollution and environmental degradation are already visible at Sooley Kere (waste and water pollution), Karighatta (littering by visitors) and Kuntibetta (plastic along trails). Unregulated trekking has caused erosion on paths at several hill sites. Land encroachment and fragmented ownership pose serious risks at Aretippuru Betta, Garakahalli, Kolirayanabetta and Ganasandra Hill, where private plots, agricultural expansion and informal constructions disturb the continuity of the landforms and complicate coordinated management. In granite-rich belts near Nagamangala and Pandavapura, quarrying and mining activities threaten surrounding hillscapes through outcrop removal, dust, noise and visual scarring. Climate variability magnifies these pressures, affecting water levels at Belejagali Mole, seasonal flows at Hemagiri Katte Falls, and trail conditions at Kundur Betta.

Kuntibetta, Pandavapura Taluk, Mandya District

Karighatta, Srirangapatna Taluk, Mandya District

Rayasamudra Betta, Krishnarajpete Taluk, Mandya District

Hemagiri Katte Falls, Krishnarajpete Taluk, Mandya District

Antaravalli Betta, Malavalli Taluk, Mandya District

Sooley Kere, Maddur Taluk Mandya District

Table 2: Consolidated SWOT Evaluation of the 27 Geosites Assessed in Mandya District

Geosite	Strengths	Weaknesses	Opportunities	Threats
Triveni Sangama	Scenic confluence; good access	No signage; low awareness	Eco/rural tourism; education	Pollution; unregulated visits
Mandagere Katte Falls	Scenic waterfall; accessible	Poor facilities; seasonal flow	Heritage trail; rural tourism	Encroachment; degradation
Hemagiri Katte Falls	Scenic; scientific value	No signage; limited facilities	Education; eco-tourism	Climate impacts; crowd pressure
Rayasamudra Betta	Distinct inselberg; scenic	No protection; poor infra	Trails; education; geo-park	Encroachment
Kuntibetta	Popular hill; accessible	No infra; unmanaged trekking	Eco-tourism; trails	Pollution; urban spread
Melukote	Cultural–geomorphic site	No interpretation panels	Cultural geotourism	Quarrying; urbanisation
Tonnuru–Vaddarahalli Betta	Scenic ridges; cultural value	No facilities	Trails; community tourism	Quarrying; erosion
Antaravalli Betta	Inselberg; scenic	Seasonal access	Trekking; education	Land-use change
Basavana Betta	Scenic; clean environment	No signage; low awareness	Eco-tourism; therapy site	Encroachment; pollution
Belejagali Mole	Scenic wetland; boating	No protection; poor infra	Eco-tourism; awareness	Pollution; erosion
Kundur Betta	Scenic; trekking potential	Difficult terrain; no safety	Adventure tourism; education	Trail erosion
Basavana Kallu Betta	Distinct granite hill	No signage; low awareness	Education; rural tourism	Urban expansion
Kote Betta	Scenic; study potential	Poor infra	Trails; community tourism	Pollution
Halathi Betta	Scenic; cultural link	No signage; low awareness	Eco-tourism; interpretation	Encroachment
Dasanakere–Shrirangapura	Scenic; culturally linked	Poor infra; disturbances	Rural/eco-tourism	Urban expansion
Ganasandra Hill	Distinct forms; accessible	No protection; low awareness	Community conservation	Encroachment
Haddinakallu Anjaneya Betta	Scenic; field-study value	No infra; low awareness	Trails; eco-tourism	Lack of coordination
Adichunchanagiri	Cultural–geomorphic	Limited engagement	Cultural geotourism	Encroachment; pollution
Sooley Kere	Scenic wetland	No facilities; low awareness	Eco-tourism; recreation	Pollution; encroachment
Aretippuru Betta	Scenic; historical	Poor infra; fragmented land	Trekking; education	Encroachment; erosion
Bettadamma Hill	Scenic; field-study	Poor infra; low awareness	Eco-tourism; cultural events	Encroachment
Kolirayanabetta	Scenic; historical	No access road; safety issues	Adventure tourism	Quarrying; erosion
B. Hatna	Scenic; accessible	No infra; low awareness	Eco-tourism	Urban expansion
Hunuganahalli	Scenic; accessible	Poor infra	Rural/eco-tourism	Pollution
Mahadevapura Shooting Spot	Scenic; cultural	No infra; private land issues	Heritage trail	Encroachment
Garakahalli	Scenic; scientific value	No protection; poor infra	Education; eco-tourism	Encroachment; neglect
Karighatta	Scenic; cultural significance	Minor infra issues	Eco-tourism; trails	Lack of coordination

Finally, a persistent threat is the lack of institutional coordination. Overlapping mandates of Forest, Tourism, Panchayat and Revenue departments mean that no single agency is responsible for geosite protection. This has resulted in unmanaged visitor activities at Aretippuru Betta, insufficient trail and waste management at Kuntibetta, and absence of unified conservation measures at Garakahalli and other sites.

5 Discussion

The SWOT analysis of the twenty-seven geosites in Mandya District demonstrates that the region possesses a strong natural foundation for geotourism, environmental education, and geoheritage conservation. The overwhelmingly positive strengths indicate that these landscapes are inherently suitable for tourism and scientific interpretation, while the weaknesses, opportunities, and threats highlight the practical considerations necessary for their sustainable development.

The most significant finding is that the natural value of the geosites is exceptionally high, with prominent examples such as Kuntibetta, Karighatta, Rayasamudra Betta, Antaravalli Betta, Hemagiri Katte Falls, and Sooley Kere

showcasing striking landform diversity inselbergs, structural ridges, waterfalls, wetlands, and panoramic hilltops. These characteristics reveal that Mandya District is naturally positioned as a geomorphologically rich landscape capable of supporting education-based tourism, outdoor recreation, and heritage interpretation.

However, the analysis clearly indicates that the challenges facing these sites are largely management-related rather than natural. Almost every geosite lacks interpretation boards, scientific signage, waste bins, visitor amenities, or safety infrastructure. Sites such as Kundur Betta, Aretippuru Betta, Kolirayanabetta, and Garakahalli illustrate this gap most strongly, despite their high scenic and scientific potential. The absence of formal legal protection further exposes several landscapes particularly those in Nagamangala and Pandavapura to quarrying, encroachment, and unregulated construction. These weaknesses represent critical barriers to formal geotourism development and highlight the need for coordinated planning.

The opportunities identified in the analysis underscore the significant potential for sustainable and community-linked geotourism. The natural clustering of sites enables the development of thematic circuits such as the Fluvial Heritage Circuit, Inselberg Trail, Cultural–Geomorphic Circuit, and Trekking Circuit. These circuits would not only diversify tourism offerings but also evenly distribute visitor pressure across the district. Additionally, the close proximity of many geosites to rural settlements such as those around Basavana Betta, Belejagali Mole, and Sooley Kere creates strong possibilities for community-based ecotourism, homestays, local guiding, traditional food tourism, and handicraft markets, allowing geotourism to support rural livelihoods.

Educational applications are another key opportunity, as several geosites offer ideal settings for field studies, research, and environmental interpretation. Sites like Aretippuru Betta, Hemagiri Katte Falls, Garakahalli, and Bettadamma Hill could be integrated into university-level field camps, school excursions, and training programmes in geomorphology and environmental science. Digital interpretation including AR/VR tools, mobile apps, and virtual field tours can further enhance accessibility and visitor engagement without disturbing the natural environment.

On the other hand, the threats identified particularly pollution, trail erosion, quarrying, land encroachment, and climate variability pose serious risks to the long-term integrity of the geosites. For example, Kuntibetta and Karighatta are already affected by littering and unmanaged trekking, while Aretippuru Betta, Ganasandra Hill, and Kolirayanabetta face encroachment and land fragmentation. Quarrying activities near Nagamangala and Pandavapura threaten the visual and structural integrity of nearby hills. These threats highlight the urgent need for protective regulations, environmental monitoring, and community awareness.

A key insight emerging from this evaluation is the lack of institutional coordination, which is the single most consistent governance challenge across the district. The overlapping roles of the Tourism Department, Forest Department, Revenue Department, and Gram Panchayats have resulted in a vacuum in which no agency takes full responsibility for geosite conservation. This has led to inconsistent management, unregulated visitor movement, and the absence of long-term planning. Establishing a district-level geoheritage committee or nodal cell could provide the required coordination.

6 Recommendations

- **Develop Basic Visitor Infrastructure at Priority Sites**

Install essential amenities such as safe trekking paths, viewing platforms, toilets, drinking water points, resting shelters, and waste bins at high-potential sites like Kuntibetta, Kundur Betta, Aretippuru Betta, Kolirayanabetta, and Garakahalli to improve safety and enhance visitor experience.

- **Introduce Interpretation and Signage for Educational Enhancement**

Establish scientific interpretation boards, directional signage, and geoheritage information panels at key sites (e.g., Rayasamudra Betta, Hemagiri Katte Falls, Sooley Kere, Melukote) to support school and university fieldwork and to increase public awareness of geoscientific values.

- **Implement Community-Based Geotourism Models**

Engage local communities around sites such as Basavana Betta, Belejagali Mole, and Sooley Kere through training in guiding, homestay development, cultural tourism, and eco-friendly service provision, thereby creating local employment and promoting grassroots stewardship.

- **Strengthen Legal Protection and Institutional Coordination**

Designate vulnerable landscapes including Aretippuru Betta, Ganasandra Hill, Kolirayanabetta, and Nagamangala hill clusters as geoheritage conservation areas. Establish a district-level geoheritage coordination committee to streamline management across Tourism, Forest, Revenue, and Panchayat departments.

- **Promote Thematic Geotourism Circuits across the District**

Implement structured circuits such as the Fluvial Heritage Circuit, Inselberg Trail, Cultural–Geomorphic Circuit, and Adventure/Trekking Circuit. These circuits will distribute visitor pressure, diversify tourism opportunities, and support integrated regional planning.

- **Adopt Sustainable Environmental Management Measures**

Introduce regular cleaning drives, enforce anti-littering practices, regulate trekking routes, monitor quarrying activities, and implement ecosystem restoration measures in sensitive areas such as Sooley Kere, Karighatta, and Hemagiri Katte Falls to protect natural integrity.

7 Conclusion

The present study provides a comprehensive SWOT-based assessment of twenty-seven geosites in Mandya District, offering valuable insights into their geomorphic significance, current condition, and potential for sustainable geotourism development. The findings demonstrate that the district possesses exceptional natural strengths, including diverse landforms, high scenic value, strong educational potential, and rich cultural associations. These intrinsic qualities position Mandya as a naturally endowed geoheritage landscape capable of supporting both scientific learning and nature-based tourism. However, the assessment also highlights critical weaknesses—such as inadequate infrastructure, absence of interpretation, limited community engagement, and lack of legal protection—which currently restrict the effective utilization of these sites. Despite these challenges, the opportunities identified are substantial. The geosites can be integrated into thematic circuits, rural tourism models, educational programmes, and digital interpretation systems, collectively contributing to regional development and community livelihoods. At the same time, the threats of pollution, quarrying, encroachment, and institutional gaps underscore the urgent need for conservation-oriented planning and coordinated management.

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