Universidade do Minho
Escola de Ciências

Liu Zhongya

Analysis of Asian Models of Geotourism and Geoeducation in Geoparks and Their Potential Applicability in Europe: The Example of Terras de Cavaleiros Geopark (Portugal)

junho de 2025

Analysis of Asian Models of Geotourism and Geoeducation in Geoparks and Their Potential Applicability in Europe: The Example of Terras de Cavaleiros Geopark (Portugal)

Liu Zhongya

UMinho | 2025

Universidade do Minho
Escola de Ciências

Liu Zhongya

Analysis of Asian Models of Geotourism and Geoeducation in Geoparks and Their Potential Applicability in Europe: The Example of Terras de Cavaleiros Geopark (Portugal)

Dissertação de Mestrado
Mestrado em Geociências
Área de Especialização em Património Geológico e Geoconservação

Trabalho efetuado sob a orientação do
Professor Doutor Diamantino Manuel Insua Pereira

junho de 2025

ACKNOWLEDGMENTS

I would like to express my deepest gratitude to my supervisor, Professor Diamantino Manuel Insua Pereira, for his patient guidance, critical insights, and continuous encouragement throughout this research. His support was essential to the completion of this thesis.

I am also sincerely thankful to Professors Paulo Jorge Silva Pereira and José Bernardo Rodrigues Brilha from the University of Minho, whose courses and mentorship greatly broadened my understanding of geoheritage and geotourism.

I am indebted to the staff of the three UNESCO Global Geoparks where I conducted fieldwork: Danxiashan UGGP (China), Itoigawa UGGP (Japan), and Terras de Cavaleiros UGGP (Portugal). Special thanks to Chen Fang and Yu Dongliang from Danxiashan, Theodore Brown from Itoigawa, and João Alves from Terras de Cavaleiros, for their generous support in organizing, coordinating, and guiding my internship activities.

My heartfelt thanks go to my wife, Dai Dai, who has accompanied me through the entire two years of the PANGEA master's program. Her unwavering emotional and practical support has been a source of strength throughout this journey.

Lastly, I would like to thank all the fellow students and faculty members of the PANGEA program, whose collaboration and friendship have made this academic experience truly memorable.

STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

ABSTRACT

Analysis of Asian Models of Geotourism and Geoeducation in Geoparks and Their Potential Applicability in Europe: The Example of Terras de Cavaleiros Geopark (Portugal)

Over the past two decades, geopark and geotourism research has shifted from geodiversity-focused studies to applied investigations into site management, community participation, and educational integration. Among emerging priorities, the link between geotourism and geoeducation has gained momentum, driven by demand for learning-based travel and the limitations of conventional interpretive tools. While China, Japan, and Europe have each developed unique integration models, systematic cross-regional comparisons remain limited. This study addresses this gap by analyzing how education and tourism are combined in selected geoparks across Asia and Europe, aiming to identify transferable strategies for enhancing this synergy, particularly in Europe.

A mixed-methods approach combined bibliometric analysis with fieldwork in three UNESCO Global Geoparks: Danxiashan (China), Itoigawa (Japan), and Terras de Cavaleiros (Portugal). Literature mapping revealed regional research trends, while interviews, site visits, and participation in educational programs offered practical insights into implementation models.

The findings identify three models: China's policy-driven and commercially oriented system, with standardized study tours and modular curricula; Japan’s community-based approach, highlighting storytelling and integration with cultural and disaster education; and Europe’s research-focused model, which emphasizes geoheritage inventory and conservation. These differences reveal both transferable practices and region-specific constraints.

This study offers theoretical and practical insights into education-tourism integration. It proposes a gradual development strategy for European geoparks focused on narrative interpretation and modular tools. A storytelling-based panel system, developed in Portugal, shows how improved communication design can enhance public engagement without major investment. Limitations include the focus on three cases; future research should expand comparative analyses and assess the long-term impact of narrative-based education strategies.

Keywords: geotourism, geoeducation, cross-regional comparison, case study, narrative interpretation, science communication.

RESUMO

Análise dos modelos asiáticos de geoturismo e geoeducação em geoparques e o potencial de aplicação na Europa: o exemplo do Geopark Terras de Cavaleiros (Portugal)

Ao longo das últimas duas décadas, a investigação sobre geoparques e geoturismo evoluiu de estudos centrados na geodiversidade para análises aplicadas à gestão dos sítios, participação das comunidades e integração educativa. A ligação entre geoturismo e geoeducação tem ganho destaque, impulsionada pela procura por viagens com foco educativo e pelas limitações das ferramentas interpretativas tradicionais. Embora a China, o Japão e a Europa tenham desenvolvido modelos de integração distintos, ainda são escassas as comparações sistemáticas entre regiões. Este estudo aborda essa lacuna, analisando como educação e turismo são combinados em geoparques da Ásia e Europa, visando identificar estratégias transferíveis para potenciar essa sinergia, especialmente na Europa. Foi adotada uma metodologia mista, combinando análise bibliométrica e trabalho de campo em três Geoparques Mundiais da UNESCO: Danxiashan (China), Itoigawa (Japão) e Terras de Cavaleiros (Portugal). O mapeamento da literatura revelou tendências regionais, enquanto entrevistas, visitas e participação em programas educativos forneceram perceções práticas sobre os modelos implementados. Os resultados identificam três modelos: o chinês, orientado por políticas públicas e com enfoque comercial, com visitas de estudo padronizadas e currículos modulares; o japonês, baseado na comunidade, que valoriza a narração de histórias e a integração com educação cultural e sobre desastres; e o europeu, centrado na investigação e conservação do património geológico. Essas diferenças revelam práticas adaptáveis e limitações contextuais. O estudo oferece contributos teóricos e práticos à integração educação-turismo, propondo uma estratégia gradual para os geoparques europeus, centrada na interpretação narrativa e em ferramentas modulares. Um sistema de painéis narrativos, desenvolvido em Portugal, demonstra como a melhoria da comunicação pode reforçar o envolvimento do público sem grandes investimentos. As limitações incluem o foco em apenas três casos; investigações futuras deverão expandir as análises comparativas e avaliar o impacto a longo prazo das estratégias educativas baseadas em narrativa.

Palavras-chave: Geoturismo, Geoeducação, Comparação inter-regional, Estudo de caso, Interpretação narrativa, Comunicação científica.

Content

Chapter 1 Introduction

Since the launch of UNESCO's Man and the Biosphere Programme (MAB) and World Heritage Convention, the importance of geoheritage has gained international recognition. In response, initiatives such as the Global Geosites Project and UNESCO Geoparks Programme emerged in the 1990s (Brilha, 2018). The concept of geoparks rapidly expanded: the European Geoparks Network (EGN) was established in 2000, followed by China's national geoparks in 2001, and the formal recognition of UNESCO Global Geoparks (UGGp) in 2015. As of 2024, there are 213 UGGps across 48 countries (www.unesco.org/en/iggp/geoparks), tasked with geoheritage protection, education, and sustainable development.

Geopark-related research has evolved over the past 25 years in two distinct stages (Herrera-Franco et al., 2021). The early stage (2002–2009) focused on defining geodiversity and developing methods for inventorying geosites (Brilha, 2016; Gray, 2004). Since 2010, the field has diversified significantly, with growing interest in community engagement, geoeducation, geotourism, and sustainability (ARIMA, 2016; Dowling, 2014; Henriques & Brilha, 2017).

Geotourism is widely regarded as a key driver for geopark development, offering both economic value and opportunities for sustainable rural development (Newsome & Dowling, 2018). Research on geotourism has also undergone a shift - from early definitional debates to increasingly applied, practice-oriented studies. While initial discussions sometimes confused geotourism with "geographical" tourism, a clearer consensus has formed since Dowling's widely cited definition (Dowling, 2014): Geotourism is defined as tourism which focuses on an area's geology and landscape as the basis of fostering sustainable tourism development. it begins with an understanding of the Abiotic (non-living) environment, to build greater awareness of the Biotic (living) environment of plants and animals as well as the cultural environment of people, past and present.

Since 2011, geotourism research has grown rapidly in scale and scope. Studies now address site management, interpretive techniques, community participation, educational integration, and tourist perceptions(Duarte et al., 2020; Ólafsdóttir & Tverijonaite, 2018). Recent work has also emphasized

translation strategies, geotrail design, thematic tourism (e.g., dinosaur sites), and communication tools such as official websites and interpretive panels (Li et al., 2022; Shah et al., 2022; Stolz & Megerle, 2022).

Among these themes, the connection between geotourism and education has gained particular attention. On one hand, demand for learning-based travel is rising among geopark visitors (Fernández Álvarez, 2020); on the other, traditional educational tools like interpretive panels are often insufficient (Prendivoj, 2018), highlighting the need for more engaging educational models.

Notably, distinct regional approaches have emerged. In China, geotourism-education integration has taken the form of "study tour" or " popular science tourism " widely viewed as a new development model (Zhu et al., 2024). And geoparks are increasingly becoming important destinations for China's popular science tourism, bringing increasing tourism revenue to Chinese geoparks (Xu et al., 2023). In Japan, geoeducation is embedded within the broader ecotourism framework and linked to rural revitalization (Jimura, 2023). In Europe, geopark education focuses on student groups through museum visits and field trips, but funding and sustainability remain challenges (Catana & Brilha, 2022).

This study conducts a comparative analysis of geoeducational models in Asian (China, Japan) and European geoparks, focusing on successful cases that integrate education with geotourism. It addresses two key gaps: (1) the lack of systematic comparison between commercial (Asian) and public-service (European) approaches, and (2) the need for strategic recommendations for implementing such models in Europe.

Chapter 2 Research Method and Materials

This research adopts a mixed-methods approach combining bibliometric analysis with in-depth fieldwork conducted in three UGGPs: Itoigawa (Japan), Danxiashan (China), and Terras de Cavaleiros (Portugal). These field investigations provide first-hand data that complement the literature analysis and enhance the empirical grounding of the comparative study.

In Itoigawa UGGP, the author conducted a two-week internship from August 15 to 30, 2024. Activities included site visits to various geosites and museums, informal interviews with park staff and visitors, and participation in a two-day geoeducation program organized by a company.

In Danxiashan UGGP, a seven-day field study was carried out from September 30 to October 6, 2024, involving site visits, museum analysis, and participation as a teaching assistant in two structured study tour programs (2.5 and 3 days respectively). Interviews with both staff and tourists were conducted.

In Terras de Cavaleiros UGGP, a one-month internship was conducted from May 1 to 31, 2025. During this period, the author participated in two school-based field trips (covering kindergarten and middle school groups), visited key geosites and the local museum, conducted multiple staff interviews, and designed a new interpretation panel system to improve science communication within the geopark.

The following sections outline the two core methodological components: (1) literature-based comparative analysis of geotourism research across regions, and (2) case study-based field analysis of geopark practices.

2.1 Literature-Based Comparative Analysis

To explore regional differences in geopark-related research, this study adopts a combined approach of bibliometric and network analysis. The workflow includes literature retrieval, keyword normalization, co-occurrence network construction, and visual comparison across China, Japan, and Europe.

2.1.1 Data Collection and Preprocessing

Relevant articles were collected from databases including Web of Science, CNKI, and J-STAGE, using keywords such as “Geotourism” and its regional equivalents. The dataset included articles with titles, keywords, and publication years.

2.1.2 Keyword Normalization and Classification

To enable cross-regional comparability, all original keywords were standardized into a two-level classification system.

Major Categories (16 in total) represent core research domains such as Geopark Management, Geoeducation, Geotourism, Community Development, Research Methodology, and Technology.

For clarity, a “_P” suffix is added only to major categories that also appear in the dataset as subcategories, in order to distinguish between hierarchical levels. For example, Geoheritage and Geotourism are used both as major themes and as subcategory keywords, so they are labeled as Geoheritage_P and Geotourism_P when referring to their role as major categories. Other categories like Technology or Community Development do not carry this suffix, as they appear only at the major level.

Subcategories indicate more specific research topics (e.g., Volcanic Tourism, Guide Training, Community Involvement) and are grouped under the corresponding major categories.

A keyword mapping table was developed to normalize all terms prior to the co-occurrence analysis (see Supplementary File 1).

2.1.3 Co-occurrence Network Construction

Keyword co-occurrence networks were built based on article titles. Subcategories co-occurring in the same article were recorded as undirected edges, and their frequencies were counted to construct weighted edge and node tables. To minimize bias from unequal publication volumes, only the top 100 most frequent subcategories per region were included.

2.1.4 Visualization and Tools

Network visualizations were produced in Gephi using a consistent layout and styling scheme to

ensure clarity and comparability across regions.

2.1.5 Cross-Regional Comparison Strategy

Each region was analyzed independently. First, major categories were used to identify macro-level research focuses. Second, subcategory co-occurrence networks were compared using both visual inspection and quantitative metrics (e.g. frequency, degree, clustering coefficient, modularity) to reveal structural differences and thematic priorities.

2.2 Case Study-Based Comparative Analysis

Building on the fieldwork conducted in the three selected geoparks, this section develops a case-based comparative analysis to examine how geotourism and geoeducation are integrated in practice. The comparison draws on empirical observations and interviews and is structured around six analytical dimensions:

Policy and Governance： Examines state-led versus community-driven governance models.

Education and Tourism program: Assesses how school systems, museums, and community programs collaborate to provide layered geoeducation and geotourism programs.

Community Involvement: Analyzes local stakeholder engagement in geotourism activities.

Guide Services and Storytelling: Assesses tour guide systems, training, and narrative strategies.

Information Accessibility: Evaluates the availability and friendliness of tourism-related information for domestic and international visitors.

Sustainability and Funding structure: Compares funding sources, ticketing models, and revenue structures.

This mixed-method, multi-scalar approach enables a nuanced understanding of how different regions operationalize geotourism–education integration, and informs future strategies for sustainable development in geoparks.

2.3 Case Study Areas

2.3.1 Danxiashan UNESCO Global Geopark

Danxiashan UGGP, located in Renhua County, Shaoguan City, Guangdong Province (Figure 2-1), is the type locality of Danxia landforms. Although the park spans a large area, development has primarily focused on the Danxiashan Scenic Area.

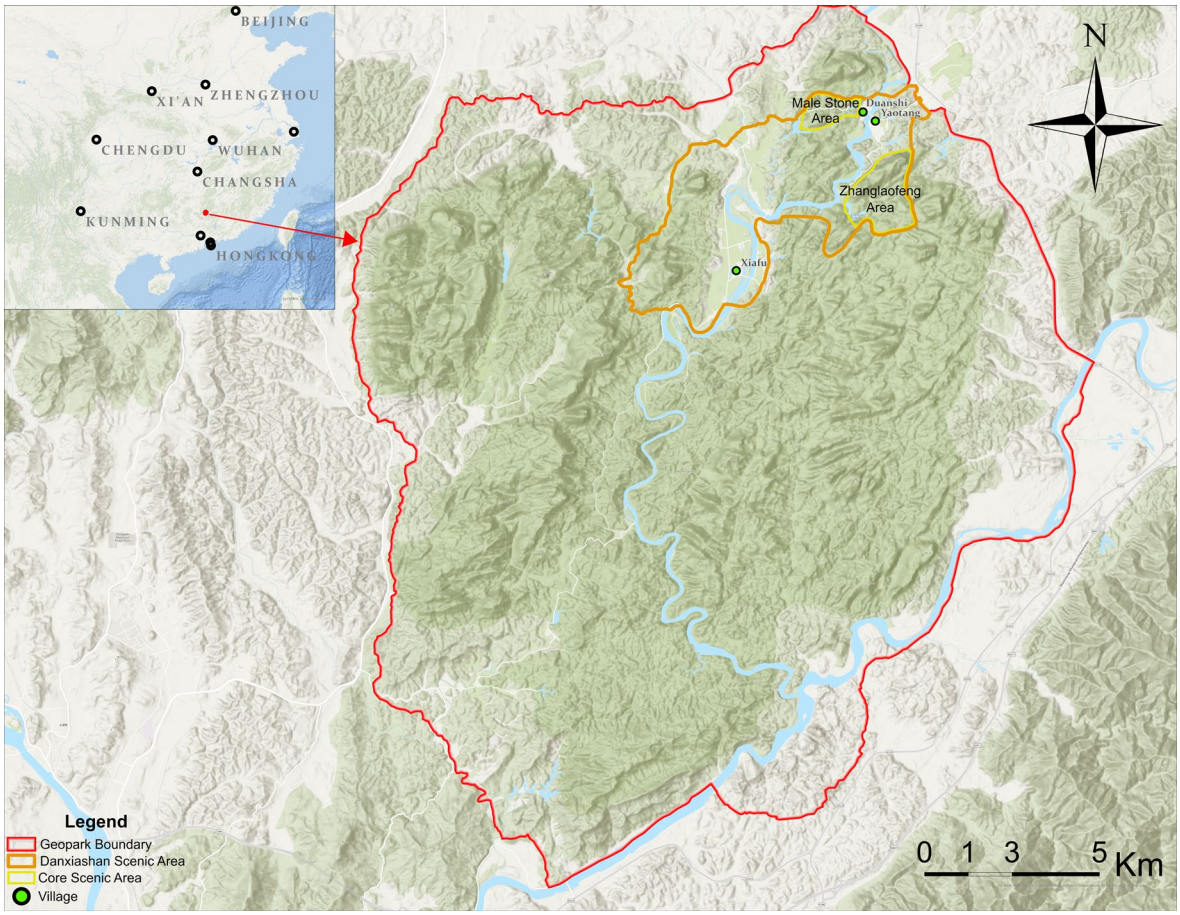


Figure 2-1. Location and Boundary of Danxiashan UGGP

The red line indicates the boundary of the UGGP, while the orange line marks the well-developed Danxiashan Scenic Area. The yellow outline highlights the two core scenic areas: the Zhanglaofeng Area and the Male Stone Area. The green dots represent villages - among them, Yaotang and Duanshi are located just outside the core scenic zones, while Xiafu is situated farther away. These villages will be discussed further in the following sections.

Prior to its designation as a geopark, Danxiashan was already a national scenic site. The core zone, centered around Zhanglao Peak, contains numerous temple relics embedded in sandstone caves,

shaped by long-term weathering and historically used for religious practices. The park also presents unique geoforms with symbolic shapes, enhancing its visual identity and tourism appeal(CHEN et al., 2022).

Danxiashan exemplifies a common development model among Chinese geoparks: selecting representative core areas within the larger park boundary for concentrated infrastructure investment and tourism operations, primarily supported through entrance fees. This “intensive core zone development” approach is widely adopted across geoparks in China.

2.3.2 Itoigawa UNESCO Global Geopark

Itoigawa UGGP is located in Niigata Prefecture in central Honshu, Japan. Its administrative boundary coincides with that of Itoigawa City (Figure 2-2). It is one of the first Japanese members admitted to the Global Geoparks Network. The park is characterized by typical mountainous landscapes and abundant geoheritage, reflecting both significant geological and cultural value.

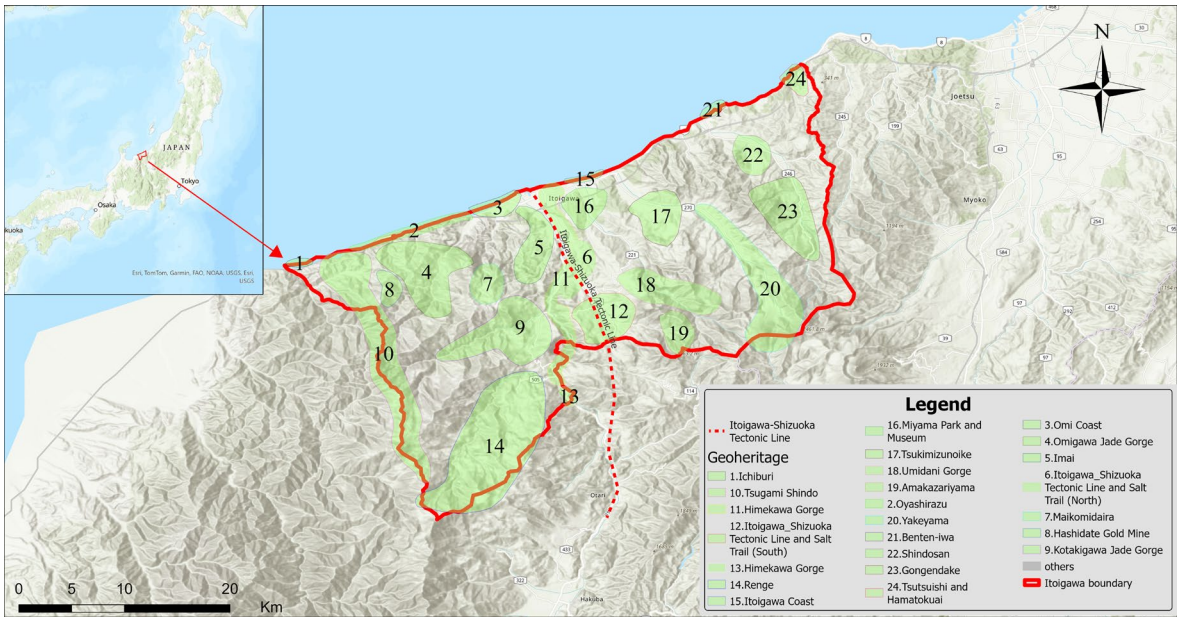


Figure 2-2. Location and Geosites Distribution of Itoigawa UGGP

At the core of the park's geology is the Itoigawa–Shizuoka Tectonic Line (ISTL), a plate boundary of global geological significance. This fault line separates the Eurasian Plate from the North American Plate and serves as an important geological boundary within the Japanese archipelago. Beyond its geological role, the ISTL is also regarded as a dividing line between eastern and western Japan in

terms of geography and culture (Takenouchi et al., 2018).

Currently, the Itoigawa UGGP designates 24 geosites, covering a wide range of geological features including folds, faults, volcanic remnants, and coastal landforms dating from the Paleozoic to the Cenozoic era. These sites represent a high degree of geodiversity.

Among them, the most iconic is the jade cultural heritage. Itoigawa is the only region in Japan that produces gem-quality jadeite. Its formation is controlled by deep tectonic activity along the ISTL. Archaeological evidence shows that as early as the Jōmon period (approximately 7,000 years ago), jade was already being mined and processed locally, forming one of the world's earliest jade cultures.

2.3.3 Terras de Cavaleiros UNESCO Global Geopark

Terras de Cavaleiros UGGP (TCG) is located in the municipality of Macedo de Cavaleiros in northern Portugal (Figure 2-3), with its administrative boundary fully aligned with the municipal limits. The park officially joined the UNESCO Global Geoparks Network in 2014.

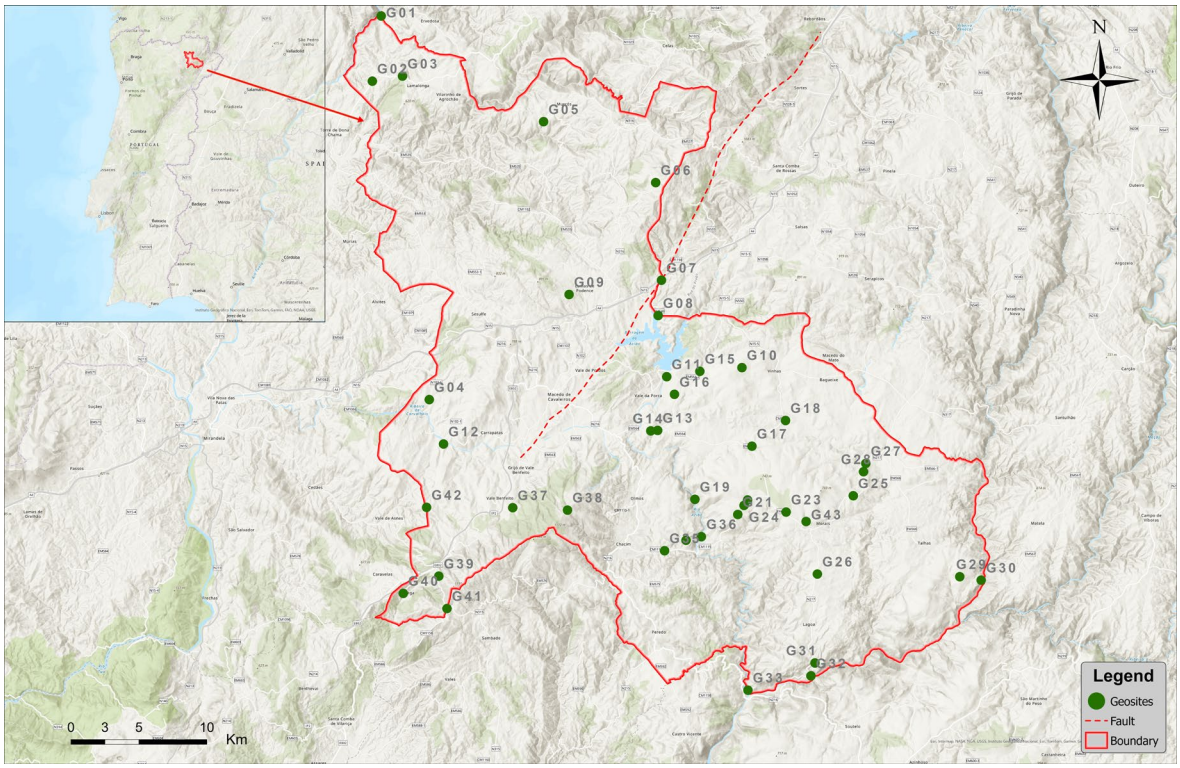


Figure 2-3. Location and Geosites Distribution of Terras de Cavaleiros UGGP

The core geological unit of TCG is the Morais Massif, which exposes a rare ophiolite–continental

crustal stacking sequence. This area is a key site for studying the evolution of ancient ocean basins and continental collision orogeny, holding significant scientific value for understanding the geological history of Europe (Pereira & Pereira, 2020).

The park has identified 42 geosites, 16 of which are notable for their geomorphological and structural significance. Representative sites include:

G31: Gneiss outcrops of the Armorican basement;

G32: Deep structural section exposing the Moho and Conrad discontinuities;

G36: Gabbroic dikes formed by upwelling magma during the expansion of the Rheic Ocean.

These sites serve not only scientific and educational purposes but also offer aesthetic and cultural value, making them key assets for geotourism.

Additionally, TCG features a rich combination of natural and cultural heritage, such as the Azibo Reservoir - renowned as one of Portugal's best inland beaches - and the *Caretos* Carnival of Podence, a representative form of intangible cultural heritage, reflecting the deep integration of geological and cultural landscapes.

Chapter 3 Results

3.1 Chinese analysis

3.1.1 Literature-based Analysis of Geotourism

This section analyzes 172 relevant publications from 2011 to 2024 retrieved from WOS and CNKI using keywords such as “geotourism” and its Chinese equivalents, meaning “geological tourism” and “geoscience tourism”. After normalized the keywords and removing irrelevant major keywords (e.g., “Landscape”, “Geopark Network”), the study identifies key research themes and their evolution through keyword frequency, trend heatmaps, and Gephi-based co-occurrence networks.

1. Core Framework: Resource Survey – Tourism Development – Management

As shown in Figure 3-1, the top three major categories are Geotourism_P (257 occurrences), Geoheritage_P (153), and Research Methodology (97), followed by Geopark Management_P (72) and Community Development (66). Here, the "_P" suffix indicates that the category label also appears at the subcategory level and is used to distinguish its role as a major classification. This reflects a shift from geological resources to governance and societal impacts.

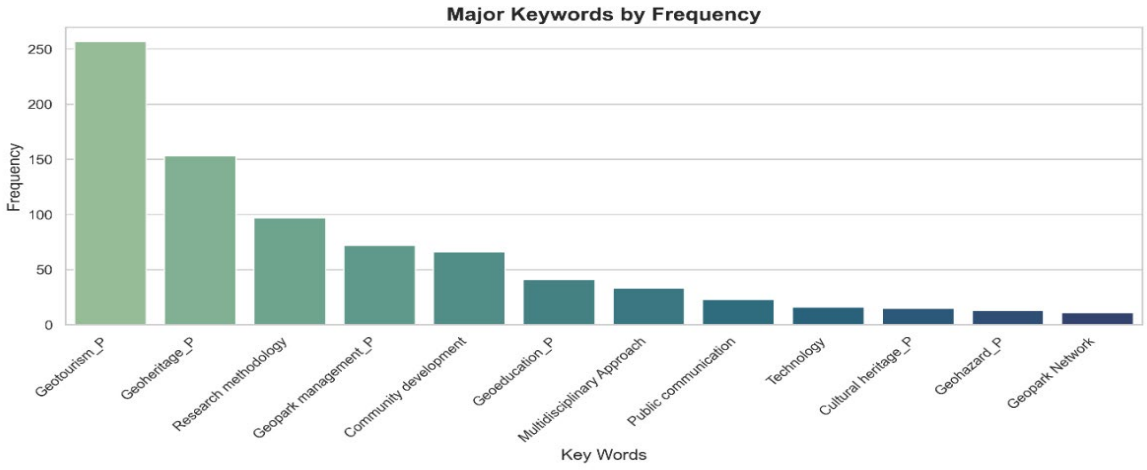


Figure 3-1. Keyword by Frequency of Chinese Literature

The co-occurrence and two-level network analyses (Figure 3-2 and Figure 3-3) reveal a knowledge structure centered on resource development, tourism practice, and policy management.

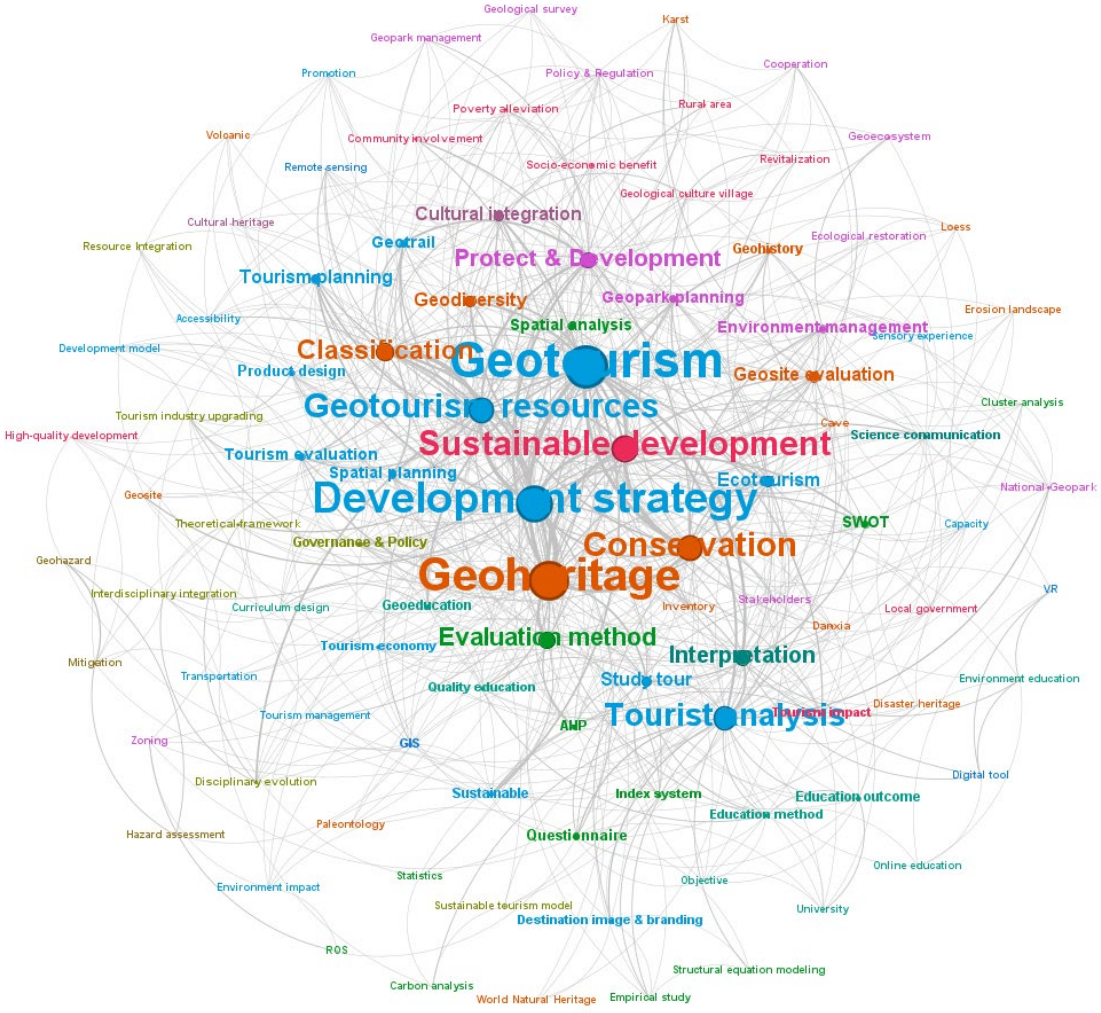


Figure 3-2. Co-occurrence Network of Subcategory Keywords in Chinese Literature (2011–2024)

Node size represents keyword frequency. Node color corresponds to the assigned major category: blue = Geotourism_P, orange-red = Geoheritage_P, red = Community Development, purple = Geopark Management, green = Research Methodology, and dark green = Public Communication.

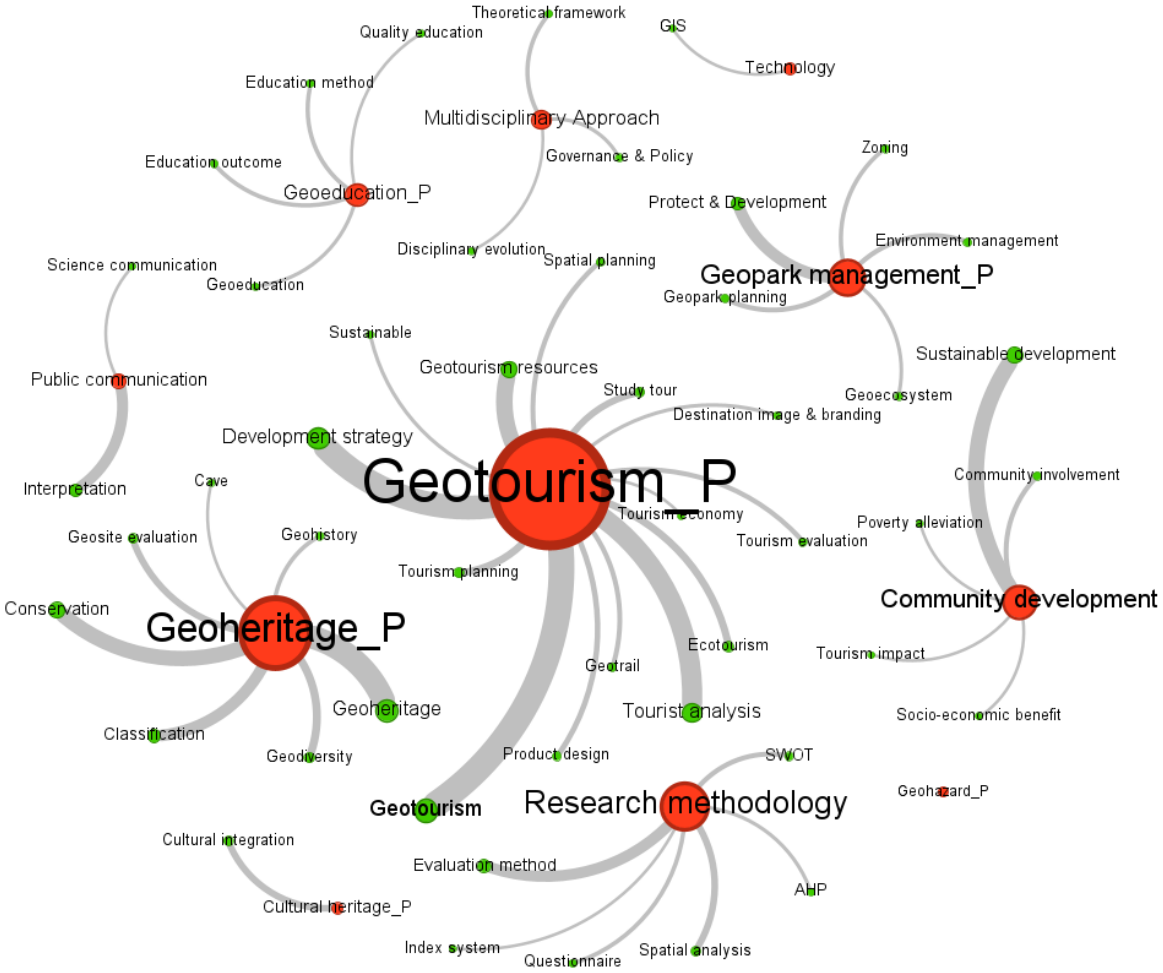


Figure 3-3. Two-Level Co-occurrence Network of Chinese Literature (Keywords with Frequency ≥ 3)

In this network, red nodes represent major categories, while green nodes represent subcategories. Node size corresponds to keyword frequency. The figure illustrates the main research focuses of Chinese scholars within each major category.

Geotourism_P focuses on tourism resources, tourist behavior, and development strategies;

Geoheritage_P centers on classification, evaluation, and protection;

Community Development is linked to “poverty alleviation” and “community involvement”, showing its policy tool role;

Geoeducation_P emphasizes science communication through “education methods” and “quality education” in natural environments.

2. Research Trends and Local Characteristics

To illustrate evolving trends, a 2011–2024 heatmap (Figure 3-4) was created using annual normalized keyword frequencies, with ten intensity levels for cross-regional comparison (Japan and Europe). Combined with the two-level network, it highlights China's specific research focuses.

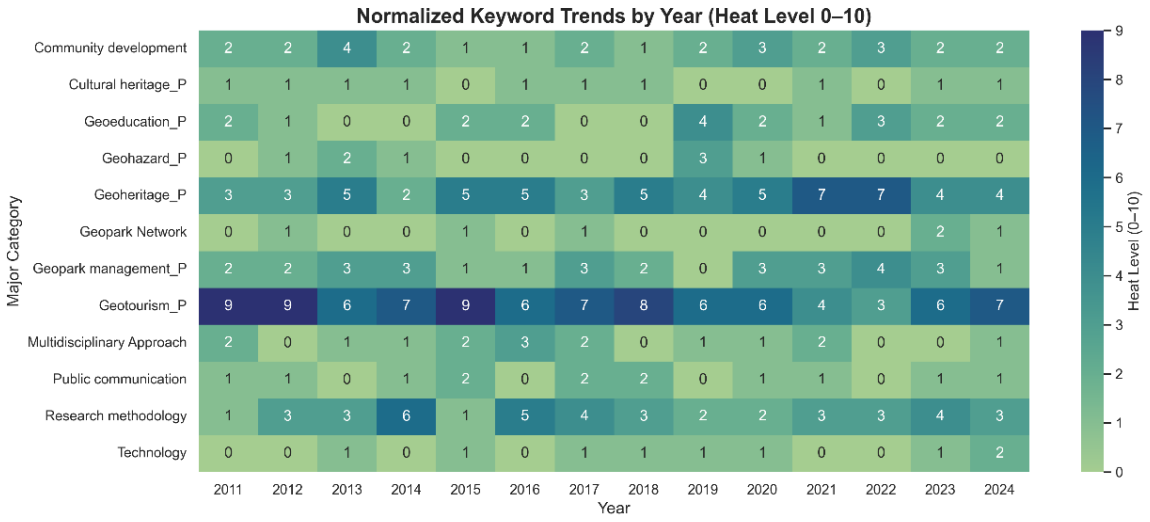


Figure 3-4. Heatmap of Chinese Research Trends

From 2011–2015, studies centered on resource identification and classification. After 2015, heritage protection and geo-education gained momentum, while community development maintained steady interest.

Distinctive Chinese research focuses include:

A. Under Geotourism_P, strong attention is paid to tourism resources, tourist behavior, and development. The concept of "study tour" emerges as a uniquely Chinese tourism-education hybrid, closely linked with Geoeducation in the network.

B. Geoheritage_P is closely tied to "classification", "conservation", and "evaluation", reflecting its role as the foundation for tourism development. Community Development emphasizes poverty reduction and community engagement, underscoring geotourism's role in local development.

C. Cultural heritage_P and Cultural integration, though peripheral, show growing efforts to

integrate geological and cultural elements. The notion of “Geological Cultural Village”, though absent from the figure due to low frequency, represents a unique Chinese approach to link geoheritage with local cultural assets. While many remain in a templated form with weak geological identity, this model offers potential for deeper integration in the future.

3. Research Trends and Local Characteristics

China’s geotourism research has evolved from a focus on resource development toward a broader structure encompassing tourism planning, heritage conservation, education, and community engagement. Geotourism and Geoheritage form the research core, with increasing attention to spatial planning, social functions, and cultural integration.

The research exhibits strong local orientation: concepts like “study tour” and “education method” highlight China’s unique tourism-education model, while terms like “poverty alleviation” and “community involvement” reflect geotourism’s policy role in regional development.

Emerging ideas such as the “Geological Cultural Village” also indicate initial efforts to merge geology and culture - still in early stages, but pointing toward future innovation.

3.1.2 Chinese case study: Danxiashan UGGP

3.1.2.1 Danxiashan UGGP Policy and Governance Framework

Danxiashan UGGP adopts a typical government-led governance model. Its managing authority, the Danxiashan Administrative Committee, operates under the Shaoguan municipal government and is responsible for conservation, infrastructure, law enforcement coordination, and planning approvals. However, coordination with other government departments remains limited. For instance, repeated proposals from the committee to improve pedestrian safety near a major road have received little response from traffic authorities.

In terms of operations, Danxiashan implements a separation of administration and operations model. The committee oversees administrative affairs, while a state-owned enterprise manages ticketing, concessions, and daily operations. Although the enterprise formally operates as a market entity, it undertakes extensive public service tasks. This division often leads to tensions between public-

interest objectives and profit-driven operations between the committee and the enterprise.

An academic advisory board composed of university experts provides scientific consultation and evaluation. However, the park lacks a systematic platform for stakeholder participation. Current interactions with stakeholders - such as communities, businesses, and tourists - are mainly channeled through village committees and other traditional administrative mechanisms. As a result, public involvement remains largely top-down and institutionally driven.

The description is based on an official functional overview provided on the park's website (*Functions and Structure of the Danxiashan Administrative Committee – Official Website of Danxiashan Scenic Area*, 2024) and supplemented by informal interviews with administrative staff during the author's site visit in October 2024.

3.1.2.2 Integration of Education and Tourism Programs

Danxiashan UGGP actively integrates educational content into its tourism offerings. Its current education initiatives can be categorized into four main types:

1. General Science Education and Conventional Tourism

As a scenic site predating its geopark designation, Danxiashan provides educational content through visitor guides, museums, interpretive panels, and brochures. Occasional public activities such as birdwatching and photography tours are also offered. However, the current science communication system faces challenges: content often relies on technical language, lacks accessibility, and offers limited engagement formats.

2. Study Tour Programs: The Core of Geotourism

The study tour program is the park's most mature geotourism initiative, targeting schools, family groups, and institutions. Funded by the committee, academic partners provide expertise and help translate scientific knowledge into educational materials. These are then packaged into modular courses by tourism operators (the state-owned enterprise we talked before), emphasizing hands-on and experiential learning.

Over 200 course modules have been developed, covering four themes: astronomy, geology,

ecology, and culture. These are offered as customizable half-day to multi-day programs, supported by a WeChat mini-program that allows users to select tutors, plan routes, and make reservations - enabling platform-based delivery (Figure 3-5).

Figure 3-5. A Typical 3-day Study Tour Organized by Danxiashan UGGP and the Online Booking Interface for Study Tours

A–I depict the full itinerary of a 3-day study tour program. A: Opening ceremony on the morning of Day 1, where team members get acquainted through interactive activities. B: Geology and flora/fauna classes in the morning of Day 1. C: Nighttime insect observation activity on the evening of Day 1. D: Plant ecology observation as part of the geology and biology class on the morning of Day 2. E: Geological observation activity on the morning of Day 2. F: River ecosystem study on the afternoon of Day 2. G: Bird watching and pine wilt disease ecology observation on the morning of Day 3. H: Traditional rice wine-making workshop on the afternoon of Day 3. I: Closing ceremony on the afternoon of Day 3. J: Sedimentary rock simulation experiment from another study tour group. K: Interface of a WeChat mini program for purchasing tour guide and study tour services. L: Interface for selecting a guide/study tour guider, displaying personal information, pricing, available time slots, and customer reviews.

Despite its scale, the program has limitations. Curriculum development is dominated by tourism companies, with limited input from primary and secondary school educators, leading to insufficient pedagogical structure. Most tutors are former tour guides, skilled in delivery but often lacking scientific depth or interdisciplinary integration.

In response, the park has initiated a "local knowledge leaders" initiative to train community members and guides in educational content development, aiming to build a grassroots curriculum system and talent pipeline (LI et al., 2023).

3. Teacher and Volunteer Training

Teacher Training: In partnership with local education authorities, the park regularly organizes training programs to enhance science literacy and promote integration of local resources into school curricula.

Volunteer Training: Since 2014, the park has operated a science volunteer training camp, recruiting university students and residents as geo-guides. Outstanding volunteers assist with museum interpretation, study tours, and activity planning. A community-based knowledge-sharing network has emerged, with some volunteers becoming long-term science educators and program facilitators.

However, course design remains largely enterprise-driven, lacking systematic educational theory and interdisciplinary depth.

4. Citizen Science Initiatives

In 2020, Danxiashan launched a firefly conservation citizen science project in collaboration with Sun Yat-sen University. Open to families and volunteer teams, the program combines observation, data collection, and science communication. It has successfully engaged the public and raised awareness of biodiversity, exemplifying the "science as education" model. Nevertheless, participation remains limited, and a more inclusive and sustainable citizen science framework is needed.

3.1.2.3 Community Participation and Local Revitalization

In recent years, Danxiashan UGGP has promoted community participation and local revitalization through heritage education, study tours, volunteer training, and livelihood transformation.

1. Community Engagement Mechanisms

Under the leadership of the park administration, local residents play an active role in the heritage education system. Community members are widely involved in receiving study tour groups, guiding services, and curriculum support. Since 2014, over 600 residents have participated in the volunteer training program, with some transitioning into study tour instructors or science communicators. Villages such as Yaotang have integrated into the tourism economy by offering homestays, shops, and services through land leasing and community enterprises.

2. Knowledge and Digital Economy Initiatives

Since 2019, the park has advanced a "Science Town" initiative, transforming selected villages into experiential knowledge hubs with themes such as geology, astronomy, and traditional crafts. For example, a resident in Shitang village turned rice wine brewing into a study tour course now listed in the park's educational product catalog. Another example is a local farmer, known as "Mr. Dendrobium" (a nickname derived from the Chinese term *Shihu Dashu*) who gained widespread attention and income through social media by promoting local agricultural knowledge. These cases demonstrate how community members are increasingly empowered to express local identity and participate in science-based tourism (MENG et al., 2021).

3. Uneven Participation and Development Gaps

Despite these successes, participation varies across communities. Villages near the scenic entrance, like Yaotang, have become model examples, while historically rich but more remote areas, such as Xiafu village, remain under-integrated. This disparity reflects differences in location, resource availability, and institutional support.

Overall, the geopark has fostered a transition from conventional to knowledge-based tourism within the local service economy. However, this transformation is largely top-down, initiated by the park administration, with community involvement still primarily reactive rather than proactive.

3.1.2.4 Guide-tour and Storytelling Strategies

While Danxiashan UGGP has made progress in integrating education and tourism, its guide

system and interpretive content still face several challenges.

1. Incomplete Interpretation System

Most visitors explore the park independently. However, the current interpretive materials - designed primarily by scientific experts - lack accessibility. Many panels and brochures rely heavily on technical terminology, some even directly reproducing textbook content, and generally lack visual appeal and narrative engagement (Figure 3-6).

Figure 3-6. Illustrative Examples of Science Interpretation Panels at Danxiashan UGGP

Panels A and B represent older and newer versions from approximately the same area, showing significant improvement in visual design. Panel C is a geology-focused panel explaining differential weathering; however, the bilingual diagrams do not cover all the content, and the Chinese explanation heavily relies on geological terminology (e.g., hard rock, soft rock, vertical joints).

2. Guide System: Initial Scale but Mixed Effectiveness

Danxiashan maintains two types of guides: paid study tour instructors and volunteer interpreters. Since 2014, its science volunteer program has trained over 1,000 guides nationwide. Training is

provided either by university experts or professional companies, but often emphasizes technical geological knowledge. As a result, many volunteers tend to “recite” rather than “reinterpret” information, with limited interdisciplinary integration.

Most study tour instructors are former tour guides. Field observations reveal that many find geological content too complex or unengaging, and consequently focus more on ecological themes than on geology in their tours.

3. Fragmented Storytelling and Lack of Thematic Coherence

Field investigations indicate significant gaps in narrative integration.

First, course content often lacks interdisciplinary connections. For example, in one lesson on antlion (Myrmeleontidae) observation, the instructor explained hunting behavior in sand pits and separately discussed jointed weathering of the cliff face - but failed to link the two. In fact, the sand used by antlions is a direct product of sandstone weathering, offering an ideal opportunity to construct a biogeological narrative. Similar disconnects appear in other programs, missing chances to showcase interactions between geological, ecological, and cultural elements.

Second, existing tour routes are based on standard scenic paths, with content presented in a reactive, site-by-site manner. There is a lack of integrated storytelling frameworks based on geological-ecological succession or cultural timelines, making it difficult for visitors to form a cohesive understanding.

Finally, the study tour handbooks often follow textbook formatting, with dense terminology and poor visual design, reducing readability and engagement - especially for younger audiences.

3.1.2.5 Information Accessibility and Visitor-Friendliness

Danxiashan UGGP has developed a relatively effective information system for domestic visitors. Through official WeChat accounts and mini-programs, the park provides detailed information on ticketing, recommended routes, and a mobile-based 3D navigation platform. These tools also support direct bookings for entrance tickets, guided tours, and study tour programs. Given WeChat’s dominance in China’s digital ecosystem, this approach significantly enhances service accessibility and

response efficiency for local tourists.

However, information accessibility for international visitors remains limited. Key issues include: (1) Limited English Website Content: The park's English website lacks interactive maps and comprehensive site descriptions. (2) Poor Design of Promotional Materials: Bilingual leaflets often combine inconsistent formatting with dense technical language, reducing readability and appeal. (3) In terms of on-site infrastructure, although facilities are generally well-developed, information services are fragmented. For example, tour brochures are difficult to obtain outside the museum (visitor center), limiting access for self-guided visitors.

Furthermore, the latest interpretation panels - though bilingual - rely heavily on technical terms and appear to be literal translations with minimal adaptation. Most panels adopt a "phenomenon–definition–diagram" structure, lacking narrative continuity or contextual storytelling. As a result, visitors often struggle to construct a coherent understanding from isolated information points.

3.1.2.6 Funding Structure and Sustainable Development

According to official data, Danxiashan UGGP received over 2 million visitors in 2024, generating tourism revenue of approximately 61.1 million CNY (7.35 million EUR) (Danxiashan Scenic Area Administration, n.d.). However, this income is not directly managed by the park administration. Instead, it is collected by a state-owned enterprise and submitted to the municipal government as state-owned land-use revenue. The government then allocates part of the funds to the park administration, which uses these to "purchase operational services" from the same enterprise.

This institutional arrangement has drawn academic criticism for creating a reverse subsidy mechanism, where public funds indirectly support a profit-oriented enterprise. Nevertheless, from a fiscal efficiency perspective, the current tourism revenue is sufficient to cover the park's administrative and conservation expenditures. According to the 2024 budget, the park's annual operating budget was 55.97 million CNY (6.74 million EUR).

Moreover, tourism activities have positively impacted surrounding rural economies, contributing to village-level development through increased visitor spending. While the existing model does not yet constitute a fully integrated revenue feedback system, Danxiashan has demonstrated the practical

potential of a “tourism-driven conservation” approach.

3.2 Japanese analysis

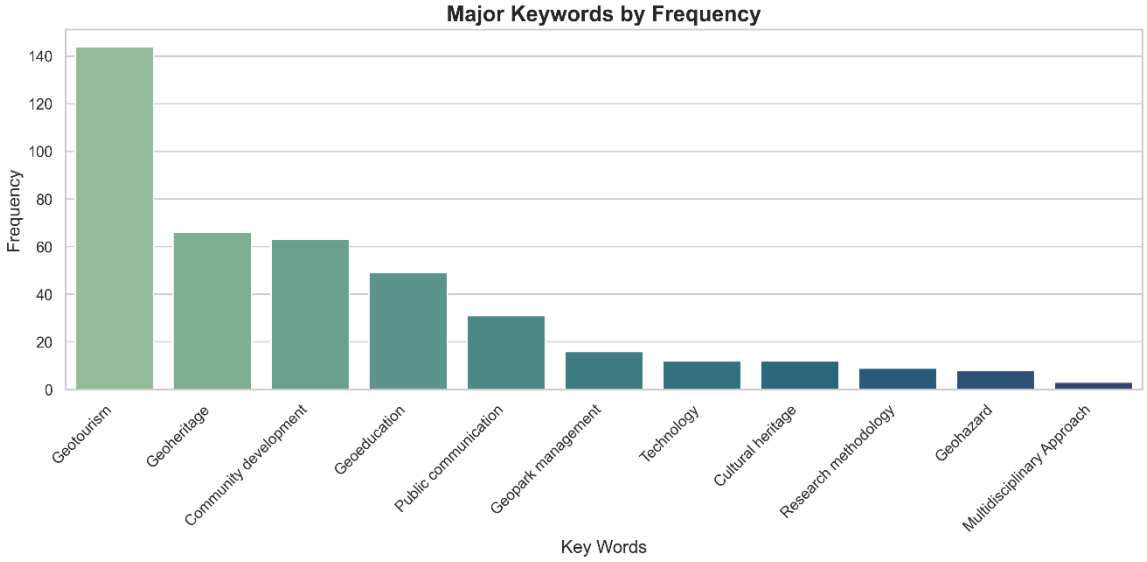
3.2.1 Literature-based Analysis of Geotourism

This section examines 112 academic articles retrieved from the Japanese academic database CiNii (https://cir.nii.ac.jp/) published between 2011 and 2024, using “geotourism” as the keyword. Keywords were normalized and major categories unrelated to geotourism (such as “Landscape,” “Geopark,” “Geopark Network,” “Geoscience Features,” and “region names”) were excluded. The analysis integrates keyword frequency statistics, temporal heatmap trends, and co-occurrence network structures to explore the core themes and developmental characteristics of geotourism research in Japan.

1. Core Framework: Guiding – Community Involvement – Education

As shown in Figures 3-7 and 3-8, Japanese geotourism research centers around Geotourism_P, which has the highest frequency and co-occurs closely with subcategories such as Guide and Guide Training. This highlights a strong emphasis on the construction of professional guiding systems. The Community Development category ranks among the top in frequency, indicating the central role of community engagement in Japan’s geotourism framework. Subcategories such as Community Involvement, Revitalization, and Local Community form high-density clusters in the network, reflecting Japan’s strategic use of geotourism for regional revitalization.

The Geoheritage_P category focuses on cultural transformation of geological heritage and the transmission of disaster memory, with “disaster heritage tourism” emerging as a uniquely Japanese research direction. Meanwhile, Geoeducation_P is closely linked in the network with subcategories such as Disaster Education and Field Trip, suggesting a multi-level approach to education that spans from formal schooling to public science communication.



Figures 3-7. Keywords Listed by Frequency of Japanese literature

2. Trend Evolution and Local Characteristics

The heatmap (Figure 3-9) reveals that geotourism-related keywords in Japan have maintained a high level of academic attention since 2011. Notably, keywords such as Community Development and Public Communication surged in prominence after the 2011 Great East Japan Earthquake, highlighting the strategic role of geotourism in post-disaster recovery and rural revitalization.

The keyword Public Communication reached a peak in 2016, accounting for 25.71% of all normalized occurrences in that category, reflecting heightened scholarly focus on narrative strategies and science communication during that period.

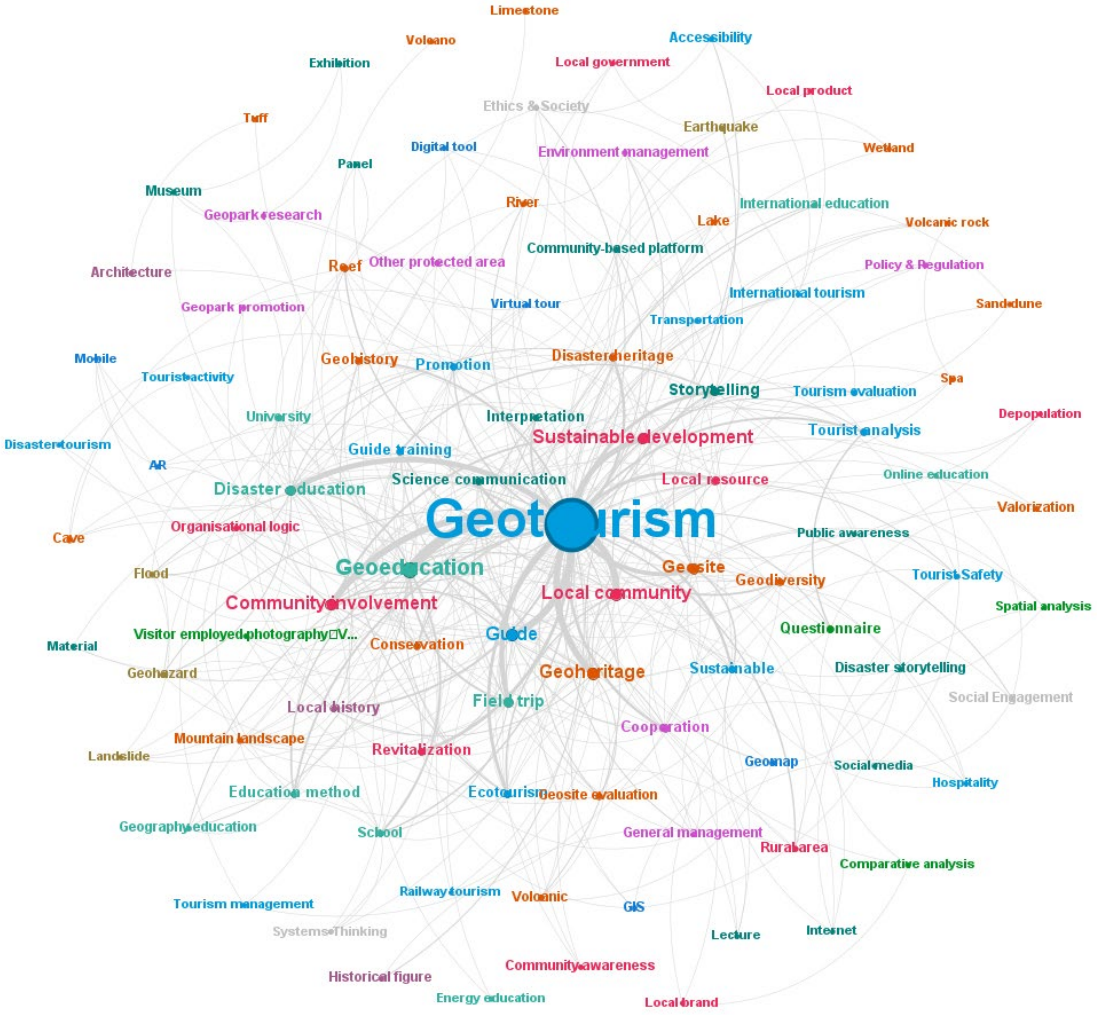


Figure 3-8. Co-occurrence Network of Subcategory Keywords in Japanese Literature (2011–2024)

Node size represents keyword frequency. Node color corresponds to the assigned major category: blue = Geotourism_P, orange-red = Geoheritage_P, red = Community Development, purple = Geopark Management, green = Research Methodology, and dark green = Public Communication.

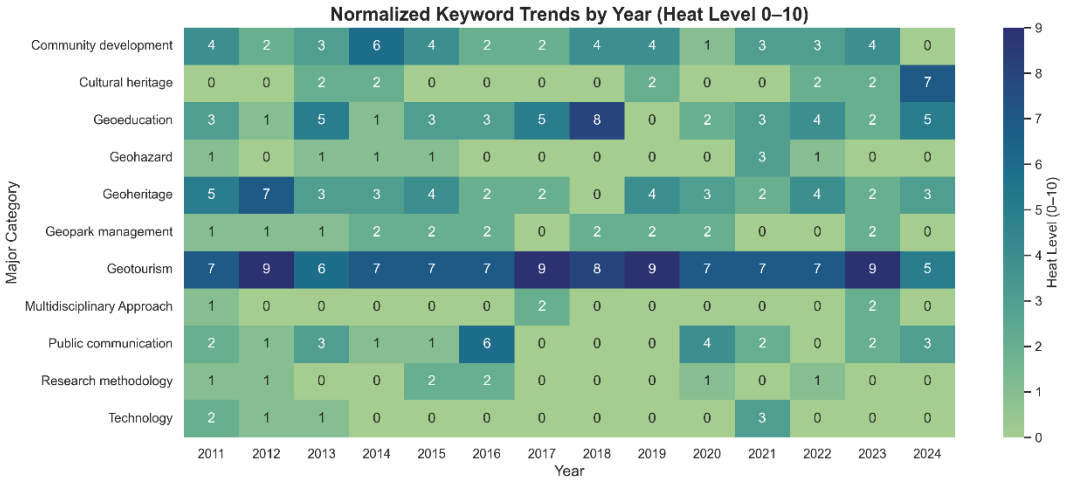


Figure 3-9. Heatmap of Japanese Research Trend

3. Key Research Themes

According to the two level co-occurrence network (Figure 3-10), Japanese geotourism research is concentrated in the following areas:

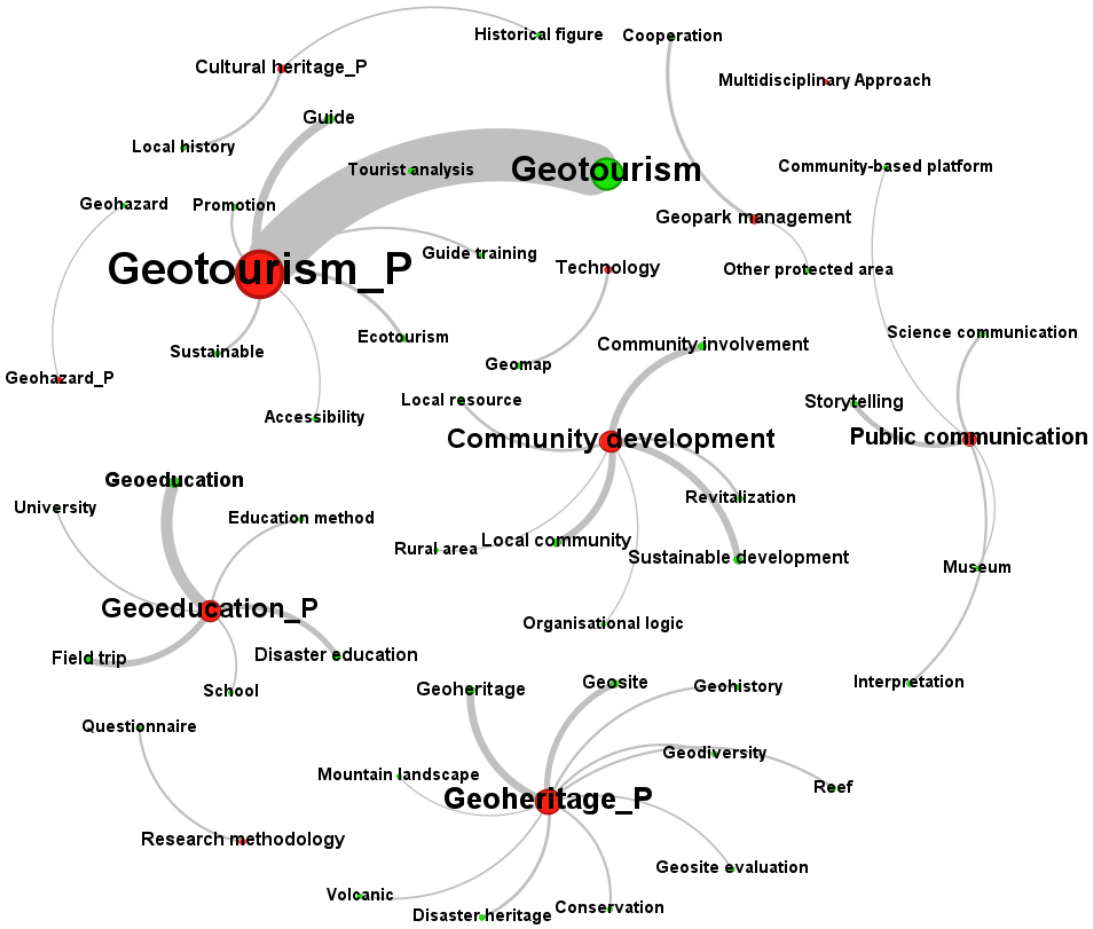


Figure 3-10. Two-Level Co-occurrence Network of Japanese Literature (Keywords with Frequency ≥ 3)

In this network, red nodes represent major categories, while green nodes represent subcategories. Node size corresponds to keyword frequency. The figure illustrates the main research focuses of Japanese scholars within each major category.

A. Geotourism_P: Guiding Systems and Tourist Experience.

This theme explores how professional guiding enhances the geotourism experience. In practice, standardized Guide Training systems have been developed, alongside a strong emphasis on Interpretation and storytelling strategies. For example, Gangala Valley in Okinawa offers a theatrical-style tour where visitors journey through forests and caves while immersed in a geological narrative (Takahashi, 2017).

B. Community Development: Community Participation and Regional Revitalization.

A community-driven model is widely adopted in Japanese geoparks. Local residents actively participate in designing interpretation systems and geotourism products. Notably, projects such as Docogeo and Geocafe in Wakayama Prefecture were co-designed and operated by local communities, serving as platforms for public engagement (Furukubo & NAKAKUSHI, 2020; Nishitani et al., 2021). Interpreter guides are also recruited from among elderly residents and homemakers (Hasegawa & Tsuruta, 2020; Isono, 2019; Kohmoto, 2020; TAKENOUCHI, 2011).

C. Geoheritage_P: Disaster Heritage and Cultural Integration.

In contrast to China's focus on classification and conservation, Japanese studies on geoheritage emphasize cultural narratives and disaster memory. For instance, Unzen Volcanic Area UGGP integrates hot springs, local legends, and “onsen eggs” into a “culture + geology” storytelling system (OHNO, 2011). “Disaster heritage tourism” has also emerged as a distinct form of tourism, especially in regions like Sanriku with disaster-themed education programs (Kawamura et al., 2022; Koshiro, 2014; Sato, 2013b).

D. Geoeducation_P: Public Education and Disaster Awareness.

Japan’s geotourism framework highlights a comprehensive geoeducation system spanning schools and public outreach. Some programs even involve high school students designing field trips for younger students to enhance engagement. Disaster Education is a central subtheme, illustrating the integration of geological literacy with disaster preparedness (IMURA, 2011; KURIHARA, 2016; Murakosih et al., 2010; Sato, 2013a; TAKENOUCHI, 2011; Xiao, 2016).

E. Public Communication: Storytelling Strategies and Outreach.

Keywords like Storytelling and Public Communication appear frequently, indicating a strong emphasis on narrative methods in geotourism. Initiatives such as the “Jade Road” in Itoigawa (TAKENOUCHI, 2011) and the geological time-based tour route in the San’in Kaigan UGGP (MORINO, 2023) reflect how storytelling is used to emotionally connect visitors with geoheritage.

As a conclusion, Japanese geotourism research is anchored in the theme of Geotourism,

emphasizing a four-pillar model of professional guiding, community engagement, educational value, and narrative strategies. In contrast to China's resource development-focused approach, Japan places greater emphasis on geotourism's integration with local society and cultural systems. This reflects a unique model built on grassroots participation, educational outreach, and interpretive storytelling as bridges between geology, community, and culture.

3.2.2 Case study of Itoigawa UNESCO Global Geopark

3.2.2.1 Itoigawa UGGP Policy and Governance Framework

The governance structure of Itoigawa UGGP follows a typical local government-led model. As of the end of 2024, the geopark is directly operated under the leadership of the Itoigawa City Government. Its core management body is the Geopark Promotion Office, housed within the city's tourism department, which is responsible for daily operations and interdepartmental coordination.

In addition to this vertical administrative structure, Itoigawa UGGP has established a Geopark Council composed of 34 stakeholders, including government representatives, academic institutions, private enterprises, and civil society groups. This council supports horizontal collaboration and decentralization of governance. The park also utilizes the Japanese community-based "Kōminkan" system to implement educational and environmental initiatives at the neighborhood level.

The Kōminkan, or citizens' public halls, are unique Japanese institutions founded by the government to provide diverse cultural services to local communities. Since their establishment in the 1940s, these centers have been embedded in nearly every town and village across Japan. They regularly organize educational programs and community events, publish monthly bulletins, and serve as hubs of communication and engagement. Their organizational role in Japanese communities has been likened to that of churches - without the religious function - offering strong social cohesion and grassroots mobilization.

However, as an internal municipal office, the GPO faces institutional limitations in terms of funding flexibility and external partnerships. Its structure makes it difficult to efficiently respond to market dynamics. To address these challenges, Itoigawa is currently planning a governance reform, aiming to transfer geopark operations to a sub-organization under the Itoigawa Tourism Association.

This reform seeks to enhance operational autonomy, improve market responsiveness, and promote long-term sustainability.

3.2.2.2 Education and Tourism Programs

Itoigawa UGGP has developed an integrated tripartite system that combines school education, public science communication, and tourism experiences, providing multi-level geoscience education from early childhood to adulthood.

1. School Education

Led by the municipal Board of Education, the geopark and its affiliated museum have collaboratively developed a full-spectrum geoscience education framework covering ages 0 to 18 (Figure 3-11). Curriculum topics include nature observation, landform understanding, and disaster preparedness. Students at various stages participate in field excursions and thematic research projects. For instance, kindergarteners engage with geoscience through illustrated card games, elementary students help design signage and assist in park maintenance, while middle school students produce TV programs or promotional videos to strengthen outreach and local identity.

Ages/Period	Family Education	School Education	Community Engagement
0-8 Early Childhood	Explore nature and wildlife with parents; visit rivers and mountains; participate in Geopark activities; learn about rocks and stones	Study living things and natural environments with teachers; engage in activities within natural settings; develop curiosity through hands-on experiences	Cooperate with local community; participate in local activities; learn about Geopark areas in the region
9-10 Early Elementary	Actively participate in Geopark visits; engage in school Geopark learning activities; discuss Geopark topics as a family	Study themes like "Let's Learn About Plants" and "Let's Explore Our Local Area"; participate in nature observation activities	Support school learning needs; share information about local points of interest; provide safety guidance for field activities
11-12 Late Elementary	Make Geopark topics part of regular family discussion; join Geopark research activities	Study topics like "Moving Water and Landforms" and "Our Sustainable Future"; conduct environmental surveys	Guide safe observation activities; facilitate exchanges between schools and community
13-15 Middle School	Support school activities; develop volunteer mindset	Conduct local habitat research; study relationships between services and daily life; participate in environmental education	Provide learning support programs; arrange guest teachers; assist with research activities
16-18 High School	Continue deepening Geopark research participation	Integrate Geopark studies with high school subjects; conduct SDG-based regional research; study disaster prevention	Engage in marine resource management activities; participate in manufacturing and sales research projects; develop regional exchange programs

Figure 3-11. The 0–18 Geological Education System Developed by the Municipal Education Department in Itoigawa UGGP

2. Public Education and Geotourism

A. Museum-led Science Tourism Services

The Fossa Magna Museum serves as a key hub for integrating education and tourism within the geopark. It offers tiered educational programs tailored to different visitor groups, such as families with children, individual tourists, and local residents.

The museum has established a structured volunteer guide training and certification system to deliver professional interpretation services. It also offers participatory programs, such as the “Fossil Valley” project (Figure 3-12A) - conducted in cooperation with a local quarry - where visitors can engage in fossil hunting and identification under museum guidance. These activities enhance both visitor engagement and public understanding of earth sciences.

In addition, the geopark operates a “Geopark Master” certification program, targeting service industry professionals such as those in food, accommodation, and retail. Trainees who complete the program gain the skills to informally communicate geoscience knowledge during everyday interactions with tourists. As of 2023, more than 600 individuals have been certified, significantly expanding the park’s outreach network.

B. Commercial Geotourism Involving Private Enterprises

A small number of private entities also contribute to geotourism activities. For example, Tinkering Base (https://tinkeringbase.com/) offers nature experiences for children, such as collecting rock samples along the coast (Figure 3-12B). However, these programs are often part of broader childcare services rather than focused geoscience education. Most instructors are non-specialists, and the content tends to be poorly aligned with students' comprehension levels, resulting in limited educational impact.

Other participants include traditional tourism companies affiliated with the Geotourism Association (https://discover-itoigawa.com/category/see-do/), which offer train excursions, jade bracelet making, farm visits, jade gorge fishing, and cycling tours. However, these activities generally utilize geosites without providing in-depth geological interpretation, making them more experiential

than educational.

Figure 3-12. Educational Programs and Panel Examples from Itoigawa UGGP

A – The Fossil Valley exhibit inside the museum and a family participating in a fossil-finding activity; B – A coastal rock collection activity organized by Tinkering Base. This is a childcare-style program where children are dropped off by parents in the morning, engage in rock collection and identification activities, study related geological knowledge indoors in the afternoon, and are picked up by their parents in the evening; C – A shop run by a local vocational high school, where all food products are designed by students. The faces on the packaging represent the students who created the products; D – The man in green is one of the volunteers, giving an explanation about the ISTL.

3.2.2.3 Community Participation and Local Revitalization

Itoigawa UGGP actively promotes community participation through volunteer training, guide systems, and geoproduct development, effectively contributing to local revitalization.

1. Mechanisms for Resident Involvement

Leveraging Japan's unique Kōminkan system, local residents can easily take part in the park's daily operations and educational activities, including environmental clean-ups, safety patrols, and interpretive services. Since 2009, the geopark has introduced a Geopark Certification Exam and a Volunteer Guide Program to engage the public in geoscience communication. The exam is offered in basic, intermediate, and advanced levels. By 2021, it had been held 13 times with a total of 2,673

participants. Successful candidates receive discount vouchers for use at partner shops and become eligible for an annual student exchange program with Hong Kong UNESCO Global Geopark. Since its launch in 2011, approximately 30 students have participated in this exchange each year, establishing a long-term cross-regional education mechanism.

These initiatives have significantly increased public awareness of the geopark. According to a national survey, community awareness of Itoigawa UGGP is significantly above the Japanese average (*Survey on Travel and Tourism Consumption Trends | Tourism Statistics and White Paper*, n.d.).

2. The "Geopark Master" Program

To further expand the park's outreach capacity, the Geopark Master Program targets individuals in the food service, accommodation, and personal care industries. Certified participants receive training and are allowed to display certification signage at their place of work, signaling that tourists can ask them about geoscience-related information. To date, 612 people have obtained this certification.

3. School Participation

The geopark also encourages active participation from the formal education sector. In addition to close collaboration with the city's education department, vocational high schools are also engaged. For example, a local marine vocational school in the Nou area operates a student-run food kiosk at the Marine Dream Nou geosite. Students independently design, produce, and manage the products, which have become symbolic of the site and contributed to local branding efforts in the Nou district (Figure 3-12C).

4. Impact on Local Development

The geopark has significantly enhanced the visibility of Itoigawa City and driven consistent growth in tourism, becoming a key engine for local economic recovery and community revitalization. At Fossa Magna Museum, annual visitor numbers increased from 40,000 in 2007 to over 100,000 at its peak in 2015. Even after a fire in 2016, visitation remained above 90,000. By 2021, in the aftermath of the COVID-19 pandemic, attendance had recovered to 53,000, reflecting strong brand resilience.

According to the 2023 Tourism Trends Report (Itoigawa Geopark Promotion Office, n.d.), the average tourist expenditure per person in Itoigawa was 25,300 yen, including 15,051 yen for accommodation, 3,732 yen for food and beverages, and 6,547 yen for souvenirs. These expenditures directly benefit local businesses in hospitality, handicrafts, and transportation, while also strengthening the brand identity of local geo-assets such as “jade culture” and “volcanic heritage.”

Public recognition and loyalty are also rising. Survey results show that 78.3% of visitors reported knowing or having heard of Itoigawa UGGP, and 89% expressed willingness to return, indicating that the geopark has become a key platform for education, outreach, and regional identity.

3.2.2.4 Guide-tour and Storytelling Strategies

Itoigawa UGGP has developed a relatively comprehensive system for tour guiding and interpretive storytelling.

1. Commercial Tour Guide Services

In collaboration with various local organizations - such as the regional tourism association, the Geopark Guide Association, and the Itoigawa Junior Chamber - the geopark offers a wide range of guided tours covering caves, volcanic formations, forests, and jade gorges. Most of these are structured as day tours, catering to diverse visitor interests.

2. Volunteer Guide Program

A volunteer guide system (Figure 3-12D) has been established. Residents must pass a basic certification exam and attend at least four training sessions before they can officially register as geopark guides. To maintain quality and professionalism, certified guides have formed self-organized support groups that host regular observation sessions and workshops. However, the program currently faces several challenges: limited participation from younger generations, irregular guiding assignments, and long inactive periods for some guides, all of which affect service consistency. In response, the geopark is planning to introduce digital tools and audience segmentation strategies to attract new members and enhance system sustainability.

3. Guided Tour Buses

To address the region's challenging terrain and limited self-driving accessibility, the park operates full-day guided bus tours featuring onboard interpretation and light meals. During peak tourist seasons, a city loop bus also runs, connecting urban areas, the museum, and key nearby sites, thereby improving visitor accessibility and convenience.

4. Diverse Storytelling Themes and Interpretive Approaches

The geopark actively adopts storytelling strategies that integrate geological phenomena with local legends and daily life, making tours more engaging. For example, at Kotakigawa Jade Gorge, interpretation not only explains the geological formation of jade but also incorporates the myth of Princess Nunakawa and prehistoric jadecraft culture - creating a narrative that links "stone stories" with "human stories." Another case, the Salt Trail, leverages the spatial overlap between geological structures and ancient trade routes to illustrate the interaction between geology and human livelihoods.

3.2.2.5 Information Accessibility and Visitor-Friendliness

Itoigawa UGGP demonstrates strong performance in providing information services, particularly for international visitors. However, there is still room for improvement in terms of content design and user comprehension.

1. Accessibility of Information

Like most Japanese UNESCO Global Geoparks, the official website of Itoigawa UGGP is available in four languages: Japanese, English, Chinese, and Korean. It includes detailed information on geosites, transportation, annual events, and local cuisine. The geopark also offers "Point-and-Say Cards", which help reduce language barriers for foreign visitors. Maps, brochures, and recommended travel routes are freely available for download, making trip planning easier for tourists.

Within the city, a large visitor information center is located at the train station, offering an overview of the geopark and its main attractions along with free guidebooks. These materials are also available in multiple local shops, significantly increasing the visibility and reach of geopark information. In recent years, the geopark has launched an integrated mobile application that allows visitors to access real-time routes, transportation guidance, and site descriptions more conveniently.

The geopark's brochures are designed with general audiences in mind. They integrate storytelling with geography and local cultural elements, following an experience-based layout that is visually appealing and user-friendly, helping visitors plan meaningful and engaging itineraries.

2. Remaining Challenges

Despite its wide-ranging coverage, the geopark's informational content still faces some limitations in user comprehension. First, both the official website and printed brochures contain a substantial amount of technical terminology. Many outdoor interpretation panels rely heavily on stratigraphic diagrams and scientific language, which lack intuitive narrative structures (Figure 3-13A). Even at the Fossa Magna Museum (Figure 3-13B), which has adopted timeline-based storytelling, 3D models, and multimedia videos, visitors have reported difficulties in understanding the scientific content.

Figure 3-13. Interpretation Panels from Itoigawa UGGP

A – An outdoor interpretation panel. Visually appealing with diagrams, though the content still contains a considerable amount of geological terminology; B – Interpretive displays inside the museum, which also feature a large number of geological terms.

3.2.2.6 Funding Structure and Sustainable Development

The sustainable development of UNESCO Global Geoparks depends not only on geoconservation and community development but also on stable financial support. Itoigawa UGGP adopts a hybrid funding model characterized by government leadership, internal revenue generation, and external project-based subsidies.

Among these, municipal government funding serves as the primary financial backbone, covering the majority of the park's operational budget. In particular, personnel salaries and routine maintenance costs are almost entirely borne by government allocations.

Additional financial resources include local donations and sales of geopark-related merchandise and publications, although these account for a relatively small proportion of the total budget.

3.3 Europe analysis

3.3.1 Literature-based Analysis of Geotourism

In analyzing the developmental characteristics of geotourism research in Europe, the keyword "geotourism" was used to retrieve relevant literature from the Web of Science database (https://www.webofscience.com/wos/) covering the period from 2011 to 2024. A total of 342 articles were obtained. The keyword processing and analytical procedures followed the same methodology as in the previous two sections. The key research foci and structural features of European studies are summarized as follows:

1. Core Features: Investigation, Conservation, and Evaluation of Geoheritage

As shown in Figures 3-14 and 3-15, the most frequently occurring primary keyword is Geoheritage_P (546 times), followed by Geotourism_P (269 times). In the co-occurrence network, subcategories under Geoheritage_P - such as Geoheritage, Geosite, Geodiversity, and Geosite Evaluation - form a distinct and prominent cluster located at the network core. In contrast, among the subcategories of Geotourism_P, only Geotourism itself appears near the center, while the remaining nodes are scattered and positioned at the periphery. This pattern indicates that European research

places strong emphasis on the investigation, conservation, and evaluation of geoheritage.

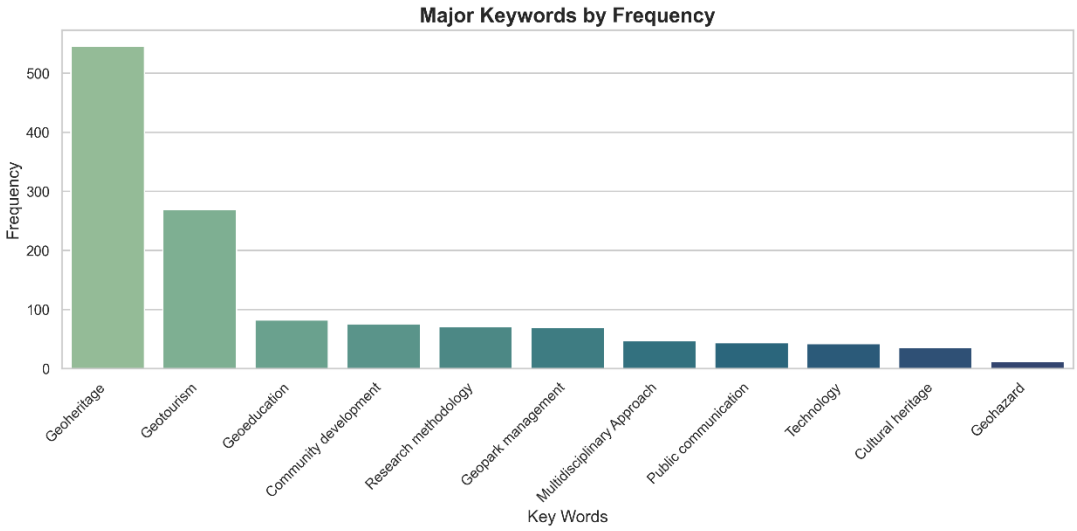


Figure 3-14. Keywords by Frequency of Europe Literature

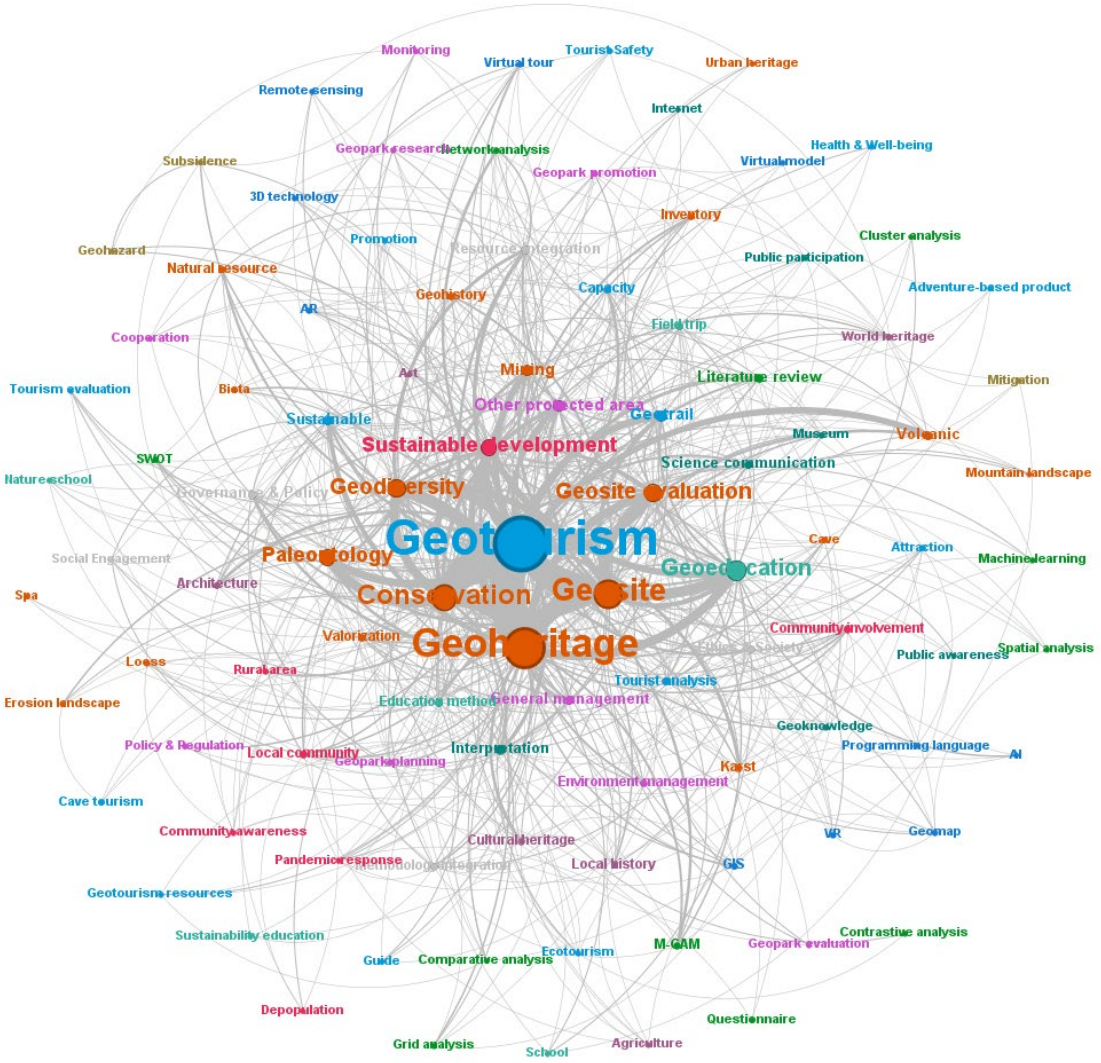


Figure 3-15. Co-occurrence Network of Subcategory Keywords in Europe Literature (2011–2024)

Node size represents keyword frequency. Node color corresponds to the assigned major category: blue = Geotourism_P, orange-red = Geoheritage_P, red = Community Development, purple = Geopark Management, green = Research Methodology, and dark green = Public Communication.

2. Research Trends and Local Characteristics

As illustrated in Figure 3-16, the keyword heatmap depicts the evolution of major research themes in European geotourism from 2011 to 2024. Overall:

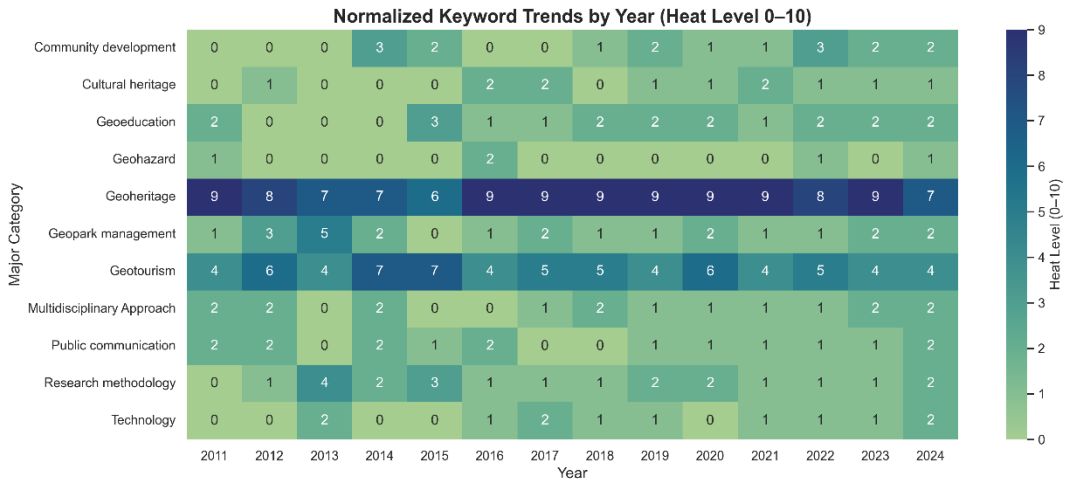


Figure 3-16. Heatmap of Europe Research Trend

Geoheritage_P has remained a long-standing and consistently high-intensity topic across the years.

Although *Geotourism_P* ranks second in frequency, its research heat is moderate to low in many years, with a clear downward trend since 2021, which may related to the pandamic.

Themes related to education, communication, and community involvement (e.g., *Geoeducation*, *Public Communication*, *Community Development*) appear sporadically without sustained growth.

This trend suggests that European geotourism research tends to emphasize geoheritage conservation and academic value, with relatively limited attention to educational translation and tourism practice. This may be due to the lack of a unified political or research system in Europe, resulting in significant differences in national research priorities.

3. Key Research Themes

After filtering out low-frequency nodes (frequency < 3), the two-level keyword co-occurrence network reveals a generally dispersed structure, with only a few major categories forming distinct subcategory clusters:

Geoheritage_P stands out with a well-defined core, comprising Geoheritage, Geosite, Geodiversity, and Geosite Evaluation. This highlights a strong emphasis on the classification, evaluation, and

conservation of geoheritage in European research.

In contrast, Geotourism_P shows limited coherence: aside from Geotourism itself, other subcategories such as Tourist Analysis, Capacity, and Geotrail are marginal and loosely connected.

Geoeducation_P themes (e.g., Field Trip, Education Method, School) are infrequent and lack network cohesion, suggesting this domain is still emerging.

Community Development_P and Public Communication_P are weakly represented, with sparse, peripheral nodes and no significant clustering.

Overall, European research shows a clear thematic concentration on Geoheritage_P, while practice-oriented, educational, and social themes remain fragmented and underdeveloped.

3.3.2 Case study of Terras de Caveleiros UGGP

3.3.2.1 Polocy and Governance Framework

The governance of Terras de Cavaleiros UGGP has transitioned from a bottom-up association to a municipally led institution. Before 2021, it was operated by the non-profit Associação Geoparque Terras de Cavaleiros, which - despite relying on municipal funding - retained a degree of autonomy. Since 2021, management has been integrated into the Macedo de Cavaleiros municipal government, under a joint structure with the local tourism office. This shift confirms the park's status as a government-led model.

An UGGP Council also exists, composed of representatives from government and academia, covering fields such as geology, biology, and science communication. However, interviews revealed limited engagement from certain experts, especially in biology and science communication, who lacked consistent interaction with park operations.

3.3.2.2 Education and Tourism Programs

Education programs at Terras de Cavaleiros UGGP are primarily led by park staff and include school-based activities, public interpretation programs, and commercial tourism offerings.

1. **School Programs**

Educational activities span from preschool to higher education, employing age-specific strategies. For young children, experiential methods are used - such as observing live beehives and tasting honey to learn about ecosystems (Figure 3-17A). Older students engage in lectures, fieldwork, and hands-on exercises (Figure 3-17B). To enhance accessibility of complex geological content, the park contextualizes minerals and rocks with everyday objects (e.g., light bulbs for tungsten, talcum powder for talc). However, the lack of interactive elements remains a challenge.

Figure 3-17. Educational Programs in Terras de Cavaleiros UGGP

A- An ecological education activity organized by the geopark for kindergarten students. The person in yellow is a partner of the geopark, who provides free explanations and materials for the children. B- High school students participating in a field trip.

The park also conducts teacher training to support Portugal's curriculum, where geology is taught from lower secondary level. Program design is coordinated regularly with local schools, but both students and teachers often find the content too difficult, indicating a need for more engaging methods.

2. Public Education

Public education relies mainly on interpretation panels, discussed in detail later. A small museum is available at the park headquarters, but lacks detailed explanations and requires prior booking for guided tours, which only two staff members can provide (Figure 3-18).

The park also trains local residents to act as volunteer interpreters during events and tours, covering geological, ecological, and cultural topics.

Figure 3-18. The Museum Inside the Headquarter of Terras de Cavaleiros UGGP

This museum uses everyday objects to illustrate the connection between minerals and daily life. However, it lacks explanatory materials, and only two staff members are available to provide interpretation.

3. Commercial Tourism

Various local companies offer activities such as kayaking, cycling, hiking, birdwatching, and geosite visits. While the park promotes multi-themed routes (geology, nature, culture, religion), most focus on outdoor recreation rather than structured education. Only a few routes - e.g., birdwatching and geo-cultural experiences - integrate educational elements.

3.3.2.3 Community Participation and Local Revitalization

1. Community Engagement Mechanisms

Local involvement includes cultural events, the GeoFood initiative, interpretive services, and school collaboration. The Entrudo Chocalheiro festival in Podence is a key example, combining performance, cultural transmission, and tourism attraction.

The GeoFood program engages locals in storytelling, recipe sharing, and traditional food promotion, strengthening park branding and sustainable development.

Residents also contribute as "knowledge providers" for interpretive materials and serve as volunteer guides after informal training. In some cases, such as beekeeper-led workshops for students, local knowledge is integrated into educational programming, enhancing place-based learning (Figure 3-17A).

2. Impact on Local Development

The park has helped counter rural depopulation by creating opportunities through cultural events and heritage-based tourism. Podence's festival draws tens of thousands of visitors annually, but its economic impact remains seasonal and short-term. Field visits revealed limited year-round habitation, with many youth returning only during festival periods.

Visitor flow is concentrated between July and September, which constrains the park's long-term community development potential.

3.3.2.4 Guide-Tour and Storytelling Strategies

Terras de Cavaleiros UGGP uses both organized and self-guided interpretation strategies.

Organized tours - such as harvest festivals and the "Geosites Route" - require booking and are led by staff or partners. Self-guided visitors rely on site-based interpretation panels and printed maps. Some tours, like Sun Azibo's electric boat excursions, are conducted by partner companies with guides.

Narrative strategies occasionally integrate cultural and geological content, such as in the "Discovering Treasures" route. However, interviews and material analysis suggest these combinations

are additive rather than truly integrated.

Many interpretation materials are dense with technical terms and dual-language formatting, reducing readability. Older panels use heavy text and geological maps, while newer designs are more visually appealing but still text-heavy and jargon-laden (Figure 3-19).

Figure 3-19. An Example of Interpretation Panel Inside the Terras de Cavaleiros UGGP

This is a new-generation interpretation panel in the geopark. While visually appealing, the dense text in the upper left corner hinders readability, and the illustrated content relies heavily on geological terminology.

3.3.2.5 Information Accessibility and Visitor-Friendliness

1. Information Access

The official website offers content in four languages and includes park overviews, geosites, education programs, and an interactive map. Print brochures are available at select locations.

2. Current Issues

Despite multilingual access, the website lacks practical route planning tools. Geosite descriptions are fragmented, with minimal visitor guidance or thematic grouping.

Content is highly technical, with few visuals and little effort to explain why a site is worth visiting.

Unlike other parks such as Itoigawa UGGP, there is no downloadable brochure or map.

Printed brochures are only available at limited sites and are better suited to outdoor recreation than geotourism - they focus on trail data, not geosite interpretation.

3.3.2.6 Funding Structure

According to interviews, the park is primarily funded by the municipal government. Revenue from tours and educational activities contributes only a minor share.Even low-cost educational programs (e.g., €5/day) are sometimes unaffordable for students, indicating socioeconomic barriers to participation and a need for more inclusive funding strategies.

Chapter 4 Discussion

4.1 Summary of Geotourism Characteristics in Different Areas

To facilitate a comprehensive comparison of geotourism research characteristics across China, Japan, and Europe, the analyses conducted in Chapter 3 are summarized and presented in the following tables. This comparative analysis reveals that each region exhibits its own unique research priorities and geotourism practices.

Table 4-1. Comparison of Literature-Based Research Characteristics in China, Japan, and Europe

Comparison Dimension	China	Japan	Europe
Core Research Themes	Equal emphasis on Geotourism and Geoheritage, with the latter serving the former	Geotourism as the core theme	Geoheritage as the core theme
Trend of Education-related Studies	Clearly increasing, integrated with "study tours"	High interest in disaster education、public communication and community involvement	Fragmented and marginalized
Co-occurrence Network Characteristics	Highly centralized network with well-defined thematic clusters	Dense clusters around public communication and community development	Tight clustering of Geoheritage-related themes; others are scattered
Region-specific Keywords	Study tour, Poverty alleviation	Storytelling, Disaster heritage, Community involvement	Evaluation, Geosite classification, Conservation
Research Orientation	Practice-oriented, policy-linked	Community development, narrative strategies, culturally driven	Academic-oriented, prioritizing conservation

Table 4-2. Comparison of Field-Based Case Study Characteristics

Comparison Dimension	China	Japan	Europe
Governance Model	Government-led, but operated by state-owned enterprises; lacks effective coordination mechanisms	Led by city government, currently transitioning to association-based management	Transitioned from association-led to government-led; now managed as part of the tourism department
Integration of Education and Tourism	Commercialized and modularized curriculum packages, integrated with study tours	Led by the education system; establishes a full educational framework for ages 0–18, supplemented by some commercial nature programs	Geopark-led; schools participate in curriculum design, but lacks a systematic educational framework
Community Participation	Policy-driven, with uneven levels of engagement; incentive mechanisms focus on commercial benefits	Diverse community participation channels covering guiding, volunteering, product development, and daily operations	Primarily festival-based participation; lacks consistent engagement mechanisms; limited community involvement in daily operations, though some collaborators exist
Guiding and Storytelling Strategies	Structured volunteer training and paid guide programs; attempts at integrating geology, ecology, and culture, but fragmented and lacks coherent educational logic	Structured volunteer guiding programs and commercial guiding services; actively explores storytelling with an emphasis on geological and cultural integration	Guided primarily by geopark staff; no evident storytelling strategy; some ecological education exists but is not systematized
Information Accessibility	High accessibility for local visitors, but very low for foreign tourists; interpretation panels are fragmented, jargon-heavy, and visually poor	High accessibility; comprehensive website information enables all visitors to easily plan their routes; interpretation panels are well-designed but still contain many technical terms that can hinder understanding	Moderate accessibility; website information is scattered, making trip planning difficult; interpretation panels are well-designed but rely heavily on technical terminology and dense text
Financial Structure and Sustainability	Sustainable solely through ticket revenue from tourists	Mainly funded by government, supplemented by certification programs and merchandise sales	Mainly government-funded; education programs are low-cost but have low participation, resulting in weak financial autonomy

4.2 Analysis of the Chinese Model

The Chinese model is characterized by strong policy support, commercial orientation, and modular curriculum design. Since the 1980s, local governments across China have actively developed scenic areas and relied on entrance ticket revenue as a source of public funding - a practice still maintained in many geoparks today. This has enabled some high-quality parks to achieve financial sustainability.

In 2016, China's Ministry of Education and ten other ministries jointly issued the "Guidelines on Promoting Study Tours for Primary and Secondary School Students," officially incorporating "study tours" into national education policy. The guidelines called for geoparks and similar institutions to participate in curriculum development and study tour base construction.

Against this policy backdrop, public acceptance of study tours increased significantly. Geoparks and tourism companies began collaborating to develop modular, product-based curricula, supported by digital platforms for booking and information dissemination. These services now cater to both school groups and family-based tourists. This model has not only promoted the systematic development of educational content but has also facilitated a gradual shift from a tourism-driven economy to a knowledge-based one.

Applicability to Europe:

Although the Chinese model has achieved notable results, it is not directly transferable to Europe. The European education system is more decentralized, and most geoparks lack the manpower and financial resources to develop standardized courses. Furthermore, public and parental acceptance of study tours is relatively low. However, the Chinese model offers valuable long-term development insights for Europe: (1) How to develop structured educational products based on geological resources; (2) How to reduce the cost of educational services through digital tools; (3) How to use knowledge-based economies to support local community development.

4.3 Analysis of the Japanese Model

The Japanese model emphasizes community participation, educational continuity, and storytelling-based interpretation systems. Led by educational authorities and supported by community institutions such as Kōminkan (public community centers), Japan has developed a multilayered geoeducation network covering ages 0 to 18.

Japan's practices in narrative strategies are also noteworthy. By embedding scientific content within cultural or disaster memory contexts (e.g., "geology + culture" or "geology + disaster"), Japan

reconstructs tourist experiences in ways that foster emotional engagement and public understanding.

Additionally, Japan's geopark websites demonstrate remarkable information accessibility. Even foreign tourists unfamiliar with Japanese can easily understand the unique features of each geopark and plan their visit accordingly.

Applicability to Europe:

Although Japan's institutional background differs from Europe's, its strategies - such as volunteer guide training, community participation mechanisms, narrative-based interpretation, and accessible online information - are highly transferable. These practices are low-cost, adaptable, and culturally non-invasive, making them especially suitable for Europe's early-stage exploration of education-tourism integration.

4.4 Analysis of the European Model

Europe has a rich academic tradition in geoheritage research, with a focus on the investigation, evaluation, and conservation of geoheritage resources. However, the conversion of this research into educational and tourism practices has lagged behind. Interpretation systems in many geoparks are highly technical and lack engaging narratives, resulting in low public accessibility. Mechanisms for community involvement are also often underdeveloped.

While some geoparks have initiated educational tours and guide services, many of these lack structured pedagogical frameworks and sustainable funding. Most rely on municipal financial support, with minimal and unstable income from tourism.

Recommendations:

Europe should not attempt to replicate the systematic education models of China or Japan wholesale. Instead, it would be more effective to pursue a gradual development strategy. In the short term, this could include improving narrative-based interpretation systems and enhancing online information accessibility. Over the long term, Europe could learn from the Chinese model by developing modular educational packages and integrating geology with ecology, culture, and tourism. The ultimate

goal would be to shift from traditional tourism toward a knowledge-driven model.

4.5 Example: Narrative-Based Interpretation Panel System

As revealed in the previous analysis, interpretation panels in China, Japan, and Europe commonly suffer from ineffective storytelling. Most panels are designed by geological experts who lack experience in public communication, resulting in content overloaded with technical jargon, poor readability, and excessive text density that often hinders comprehension.

Drawing on the author's practical experience in science communication, a narrative-centered geological interpretation system was developed during an internship at the Terras de Cavaleiros UGGP in Portugal (see Figure 4-2, full-sized panels in Appendix A).

In this system, each panel is designed as an independent “story unit” (Figure 4-1). By incorporating titles, visual prompts, explanatory text, and question-driven narratives, complex geological processes are transformed into accessible, easy-to-understand content. Some panels also attempt to integrate geological knowledge with local history, culture heritege, or everyday experiences. QR codes are included to provide extended reading and multimedia resources.

All text was evaluated using the Flesch Reading Ease formula to ensure readability for primary and secondary school students. Furthermore, each panel is designed to logically lead to the next, forming a cohesive storytelling pathway that narrates the geological evolution of the geopark while emphasizing both scientific and cultural significance.

This attempt demonstrates that even without major infrastructure investment, optimizing the content and method of interpretation can enhance visitor comprehension and engagement. Moreover, this model lays a practical foundation for future development of place-based curricula, community co-creation mechanisms, and educational tourism routes.

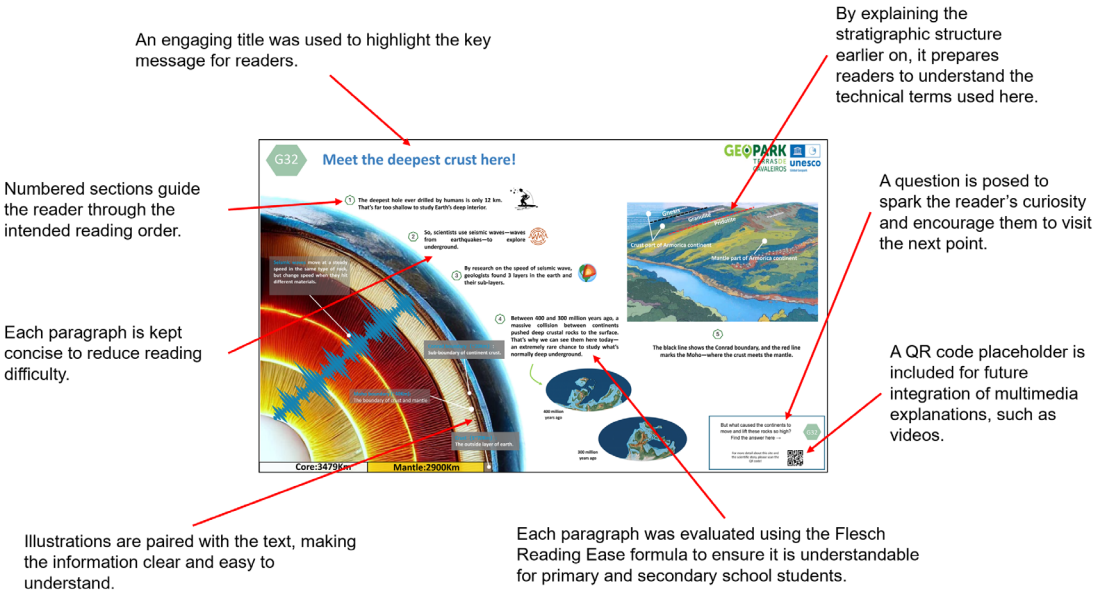


Figure 4-1. Sample Design of a Storytelling-based Interpretation Panel

This example illustrates how scientific content is made more engaging through narrative techniques, simplified language, and graphic support.

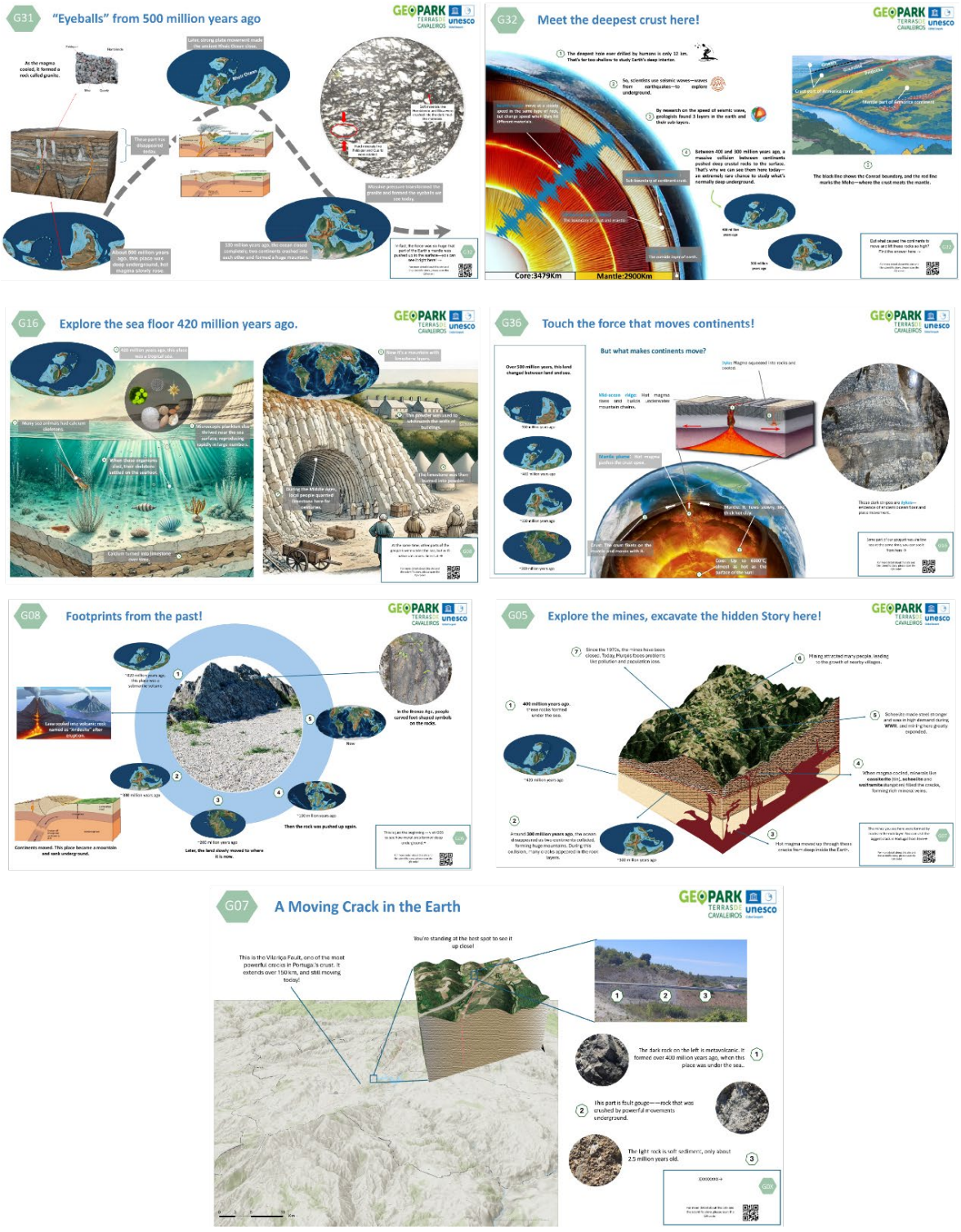


Figure 4-2. Storytelling Panel System Developed for the Terras de Cavaleiros UGGP

Chapter 5 Conclusion

This study systematically compared the ways in which geoeducation and geotourism are integrated across China, Japan, and Europe, identifying three representative regional models and their current states of development. The research aimed to identify transferable elements from Asian experiences and explore their applicability and potential within the European geopark context.

The findings show that the Chinese model is driven by policy and guided by commercialized study tours, with modular course packages and early attempts at integrating geology, ecology, and culture. The Japanese model emphasizes community engagement and narrative-based interpretation, with a complete 0–18 geoeducation framework and superior information accessibility compared to China and Europe. Meanwhile, Europe, despite leading in geoheritage research, lags behind in education integration, interpretation systems, and public engagement.

Based on the comparative analysis, the study recommends a stepwise development strategy for European geoparks. Initial efforts should focus on building narrative-driven public communication systems and improving access to tourism information. At the same time, exploration of community engagement mechanisms, modular educational tools, and the integration of geology, ecology, and culture should be encouraged. These efforts should be tailored to align with Europe's cultural and institutional context.

In addition to the theoretical proposals, this study also undertook a practical design experiment. During the author's internship at the Terras de Cavaleiros UGGP in Portugal, a storytelling-based interpretation panel system was created to enhance the public accessibility and comprehension of geological knowledge through science communication techniques. This low-cost, replicable design provides a practical example of how to implement narrative strategies in educational geotourism and serves as empirical support for the "gradual integration" pathway proposed in this research.

Although the study combines literature analysis with field-based case studies, it still has certain limitations. First, its data sources mainly include academic literature and a small number of case studies, which may not fully capture internal differences across Chinese, Japanese, and European

geoparks. Second, the narrative-based panel system developed as a pilot experiment remains to be tested in real-world applications, and its long-term impact remains uncertain.

Future research could focus on the following areas: (1) In-depth studies on the interaction between storytelling strategies and visitor experiences in geoparks; (2) Evaluation of educational program outcomes and communication mechanisms; (3) Exploration of adaptive pathways under different European governance models; (4) Expansion of comparative research across more European case studies.

As the fields of geotourism and educational outreach become increasingly intertwined, researchers must also broaden their interdisciplinary knowledge to include tourism studies, geography, and environmental management - allowing for more comprehensive theoretical development and practical innovation in this domain.

References

ARIMA, T. (2016). Overview: The educational capabilities of geoparks: from education to learning. *Journal of Geography (Chigaku Zasshi)*, *125*(6), 775–778. https://doi.org/10.5026/jgeography.125.775

Brilha, J. (2016). Inventory and Quantitative Assessment of Geosites and Geodiversity Sites: A Review. *Geoheritage*, *8*(2), 119–134. https://doi.org/10.1007/s12371-014-0139-3

Brilha, J. (2018). Chapter 18—Geoheritage and geoparks. In E. Reynard & J. Brilha (Eds.), *Geoheritage* (pp. 323–335). Elsevier. https://doi.org/10.1016/B978-0-12-809531-7.00018-6

Catana, M. M., & Brilha, J. (2022). Environmental Education in Naturtejo UNESCO Global Geopark (Portugal): A Nature-Based Approach. In C. Vasconcelos & C. S. C. Calheiros (Eds.), *Enhancing Environmental Education Through Nature-Based Solutions* (pp. 269–282). Springer International Publishing. https://doi.org/10.1007/978-3-030-91843-9_17

CHEN L., GUO F., SHAO C., & DU D. (2022). Geodiversity characterization of the Danxiashan UNESCO Global Geopark of China. *International Journal of Geoheritage and Parks*, *10*(4), 459–476. https://doi.org/10.1016/j.ijgeop.2022.07.003

Danxiashan Scenic Area Administration. (n.d.). *2024 Tourism Data of Danxiashan Scenic Area*. Danxiashan Official Website. Retrieved June 17, 2025, from https://dxs.sg.gov.cn/zwgk/lysj/content/post_2744932.html

Dowling, R. K. (2014). Global Geotourism – An Emerging Form of Sustainable Tourism. *Czech Journal of Tourism*, *2*(2), 59–79. https://doi.org/10.2478/cjot-2013-0004

Duarte, A., Braga, V., Marques, C., & Sá, A. A. (2020). Geotourism and territorial development: A systematic literature review and research agenda. *Geoheritage*, *12*(3), 65. https://doi.org/10.1007/s12371-020-00478-z

Fernández Álvarez, R. (2020). Geoparks and Education: UNESCO Global Geopark Villuercas-Ibores-Jara as a Case Study in Spain. *Geosciences*, *10*(1), Article 1. https://doi.org/10.3390/geosciences10010027

Functions and Structure of the Danxiashan Administrative Committee – Official Website of Danxiashan Scenic Area. (2024). Danxiashan Scenic Area Official Website. https://dxs.sg.gov.cn/zwgk/jgzn/content/post_2677277.html

Furukubo, A., & NAKAKUSHI, T. (2020). Geocafe: Possibility of contributions to the local community linking researchers and residents through science communications. *Tourism Studies*, *23*, 85–93. https://doi.org/10.19002/aa12438820.23.85

Gray, M. (2004). *Geodiversity: Valuing and conserving abiotic nature*. John Wiley & Sons.

Hasegawa, S., & Tsuruta, S. (2020). Trial geo-tours by geo-guides who are certificated by the public lecture program of kagawa university. *Research Review of Center for Regional Partnership and*

Lifelong Learning, Kagawa University, *25*, 11–31.

Henriques, M. H., & Brilha, J. (2017). *UNESCO global geoparks: A strategy towards global understanding and sustainability*. https://doi.org/10.18814/epiiugs/2017/v40i4/017036

Herrera-Franco, G., Montalván-Burbano, N., Carrión-Mero, P., Jaya-Montalvo, M., & Gurumendi-Noriega, M. (2021). Worldwide Research on Geoparks through Bibliometric Analysis. *Sustainability*, *13*(3), Article 3. https://doi.org/10.3390/su13031175

IMURA, R. (2011). Activities of kirishima geopark and 2011 shinmoedake eruption. *Proceedings of the General Meeting of the Association of Japanese Geographers*, *2011f*(0), 100121–100121. https://doi.org/10.14866/ajg.2011f.0.100121.0

Isono, T. (2019). A review of geopark and geotourism literatures and the perspective on tourism geography in japan. *Proceedings of the General Meeting of the Association of Japanese Geographers*, *2019a*(0), 117. https://doi.org/10.14866/ajg.2019a.0_117

Itoigawa Geopark Promotion Office. (n.d.). *Tourism Trends Survey of Itoigawa UNESCO Global Geopark*. Itoigawa City Official Website. Retrieved June 14, 2025, from https://www.city.itoigawa.lg.jp/page/2253.html

Kawamura N., Obase M., Yoshimoto N., Sakiyama M., Fujioka T., & Okada D. (2022). Results and subjects of geotour from view of disaster prevention class. *Research Journal of Disaster Education*, *3*(1), 75–85. https://doi.org/10.51004/rjde.3.1_75

Kohmoto, D. (2020). How the geopark concepts have been illustrated? *Proceedings of the General Meeting of the Association of Japanese Geographers*, *2020a*(0), 144. https://doi.org/10.14866/ajg.2020a.0_144

Koshiro, S. (2014). Geoparks as sites for dark tourism. *E-Journal GEO*, *9*(1), 73–83. https://doi.org/10.4157/ejgeo.9.73

KURIHARA, K. (2016). Role of museum activities in geoparks:Example of Activities at the Mikasa City Museum, Mikasa Geopark, Japan. *Journal of Geography (Chigaku Zasshi)*, *125*(6), 831–839. https://doi.org/10.5026/jgeography.125.831

LI G., XIE jia, & LIU J. (2023). A Study on the Mechanism of Intellectual Elites' Development in the Knowledge-oriented Community Tourism. *Tourism Tribune*, *38*(1), 109–121.

Li, Q. J., Zhu, F. N., & Ng, Y. (2022). Benchmarking the quality of Chinese to English geotourism interpretation: The SSC model based on eco-translatology. *Geoheritage*, *14*(3), 93. https://doi.org/10.1007/s12371-022-00725-5

MENG Y., CHEN F., LI X., LI P., & HAN F. (2021). Exploration and Practice of Popular Science Education Through Socialized Participation in Danxiashan. *Natural Protected Areas*, *1*(4), 65–71. https://doi.org/10.12335/2096-8981.2021011501

MORINO, Y. (2023). Geotourism of the formation of the Japan Sea in the Kyotango area, San'in Kaigan UNESCO Global Geopark. *Annual Meeting of the Geological Society of Japan*, *2023*, 147. https://doi.org/10.14863/geosocabst.2023.0_147

Murakosih, S., Koyama, M., & Uenishi, T. (2010). 1-A08 understanding of local geological history and awareness of its value by local high school students though geotours in izu peninsula. *PROGRAMME AND ABSTRACTS THE VOLCANOLOGICAL SOCIETY OF JAPAN*, *2010*(0), 8–9. https://doi.org/10.18940/vsj.2010.0_8

Newsome, D., & Dowling, R. (2018). Chapter 17—Geoheritage and Geotourism. In E. Reynard & J. Brilha (Eds.), *Geoheritage* (pp. 305–321). Elsevier. https://doi.org/10.1016/B978-0-12-809531-7.00017-4

Nishitani, K., Nakagawa, K., & Nagamatsu, S. (2021). Geotourism and disaster storytelling: Lessons from 2013 izu-oshima island debris flow disaster. *Journal of Disaster Research*, *16*(2), 170–175. https://doi.org/10.20965/jdr.2021.p0170

OHNO, M. (2011). Local sustainable development using geoheritage: *Journal of Geography (Chigaku Zasshi)*, *120*(5), 834–845. https://doi.org/10.5026/jgeography.120.834

Ólafsdóttir, R., & Tverijonaite, E. (2018). Geotourism: A Systematic Literature Review. *Geosciences*, *8*(7), Article 7. https://doi.org/10.3390/geosciences8070234

Pereira, D. I., & Pereira, P. (2020). Terras de cavaleiros geopark: A UNESCO global geopark. In G. Vieira, J. L. Zêzere, & C. Mora (Eds.), *Landscapes and Landforms of Portugal* (pp. 315–327). Springer International Publishing. https://doi.org/10.1007/978-3-319-03641-0_25

Prendivoj, S. M. (2018). Tailoring Signs to Engage Two Distinct Types of Geotourists to Geological Sites. *Geosciences*, *8*(9), Article 9. https://doi.org/10.3390/geosciences8090329

Sato, H. (2013a). A1-11 records of natural disasters and geo-tours of their sites. *PROGRAMME AND ABSTRACTS THE VOLCANOLOGICAL SOCIETY OF JAPAN*, *2013*(0), 11. https://doi.org/10.18940/vsj.2013.0_11

Sato, H. (2013b). P2 put the study in the field to geo-tours. *PROGRAMME AND ABSTRACTS THE VOLCANOLOGICAL SOCIETY OF JAPAN*, *2013*(0), 102. https://doi.org/10.18940/vsj.2013.0_102

Shah, C., Trupp, A., & Stephenson, M. L. (2022). Deciphering tourism and the acquisition of knowledge: Advancing a new typology of 'Research-related Tourism (RrT).' *Journal of Hospitality and Tourism Management*, *50*, 21–30. https://doi.org/10.1016/j.jhtm.2021.12.003

Stolz, J., & Megerle, H. E. (2022). Geotrails as a medium for education and geotourism: Recommendations for quality improvement based on the results of a research project in the swabian alb UNESCO global geopark. *Land*, *11*(9), Article 9. https://doi.org/10.3390/land11091422

Survey on Travel and Tourism Consumption Trends | Tourism Statistics and White Paper. (n.d.). Japan Tourism Agency. Retrieved June 15, 2025, from https://www.mlit.go.jp/kankocho/tokei_hakusyo/shohidoko.html

Takahashi, K. (2017). Introduction of a guided tour in the gangala valley, okinawa, focusing on geotourism resources. *The Quaternary Research (Daiyonki-Kenkyu)*, *56*(3), 131–136. https://doi.org/10.4116/jaqua.56.131

TAKENOUCHI K. (2011). Regional development in itoigawa geopark. *Journal of Geography*

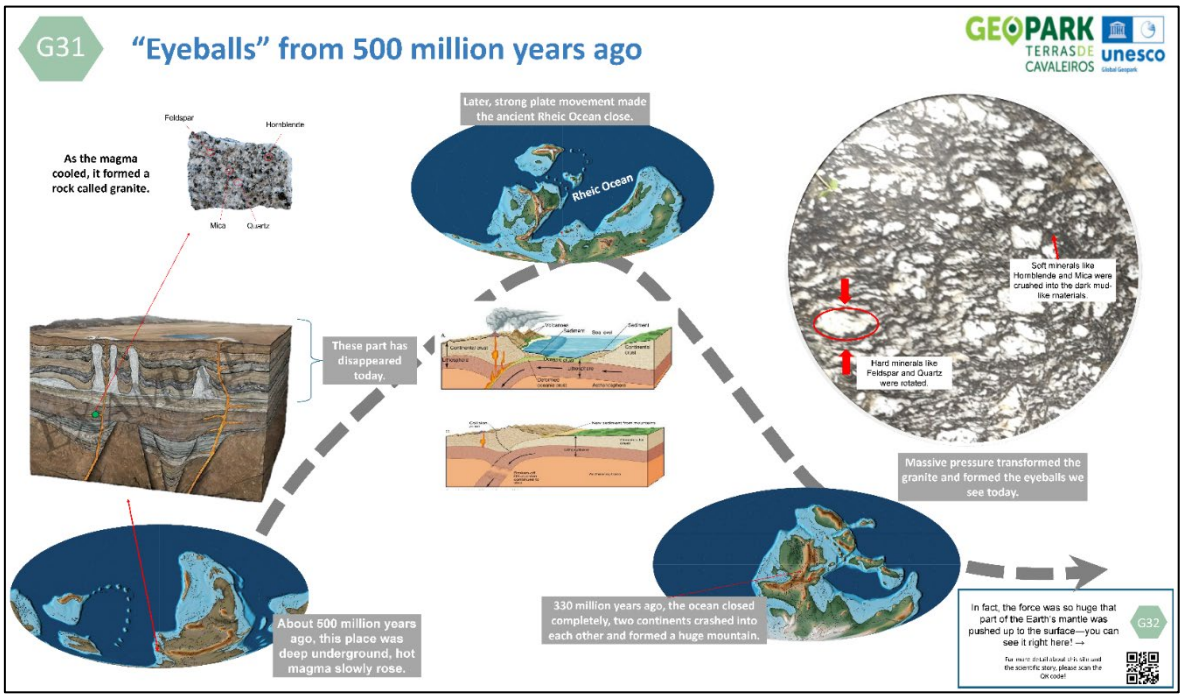
(Chigaku Zasshi), *120*(5), 819–833. https://doi.org/10.5026/jgeography.120.819

Takenouchi, K., Torigoe, H., & Brown, T. (2018). *Chapter 26: Geotourism in Itoigawa UNESCO Global Geopark, Japan*. https://www.elgaronline.com/edcollchap/edcoll/9781785368851/9781785368851.00039.xml

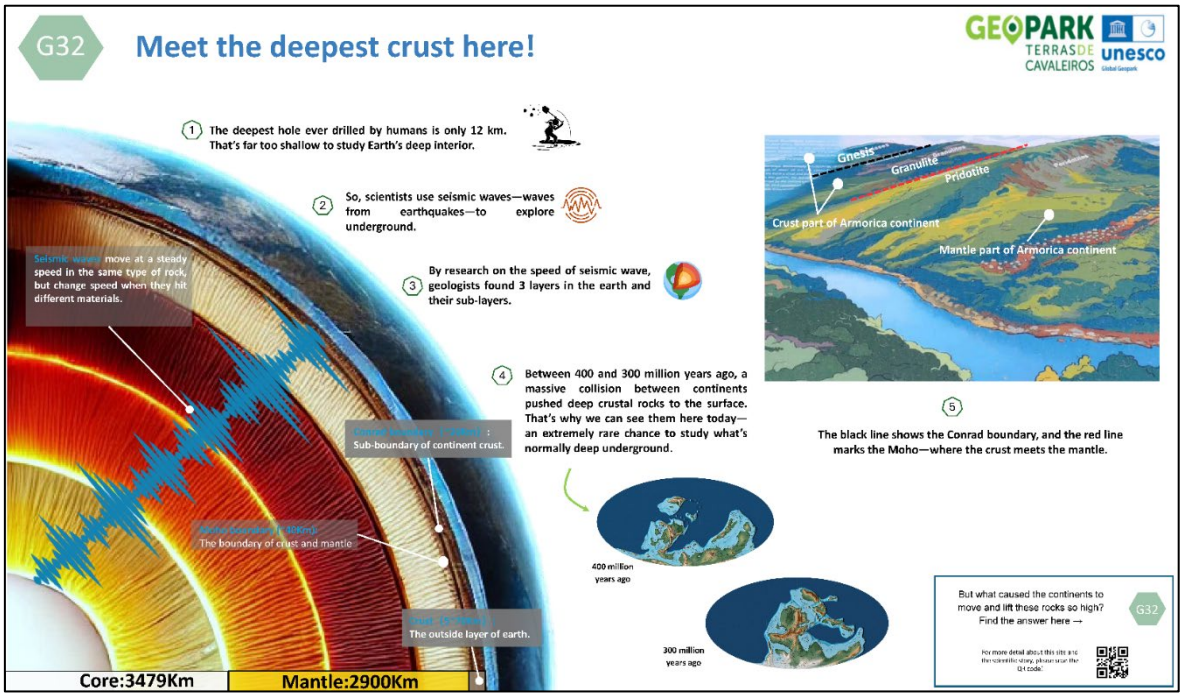
Xiao, K. (2016). The present situation and problems of geo-tourism in geo-parks of japan: A case study of naeba mountain geopark. *Research Journal of the Graduate School of Humanities and Human Sciences*, *16*, 231–243. https://doi.org/10.14943/rjgsl.16.l231

Zhu, Z., Liu, J., Zhu, H., & Zhao, W. (2024). Evaluating Scientific Tourism of Geoheritage: An Empirical Study of Fangshan Global Geopark in Beijing. *Land*, *13*(12), 2119. https://doi.org/10.3390/land13122119

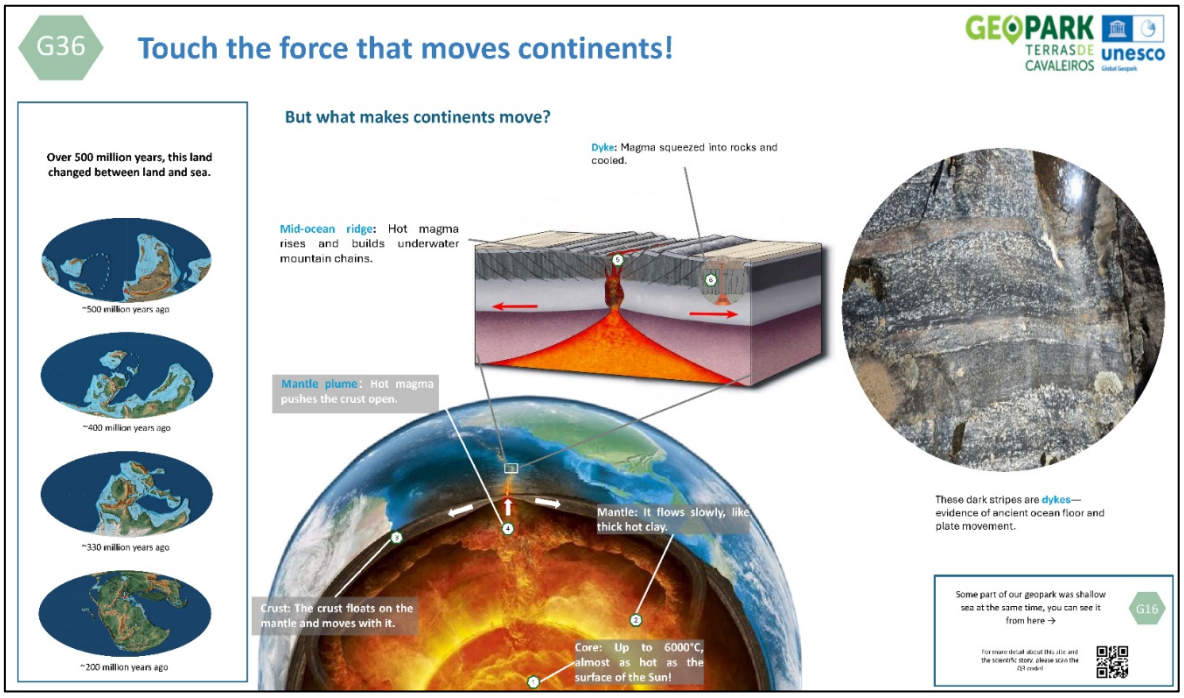
Appendix A. Panel System Designed for Terras de Cavaleiros UGGP



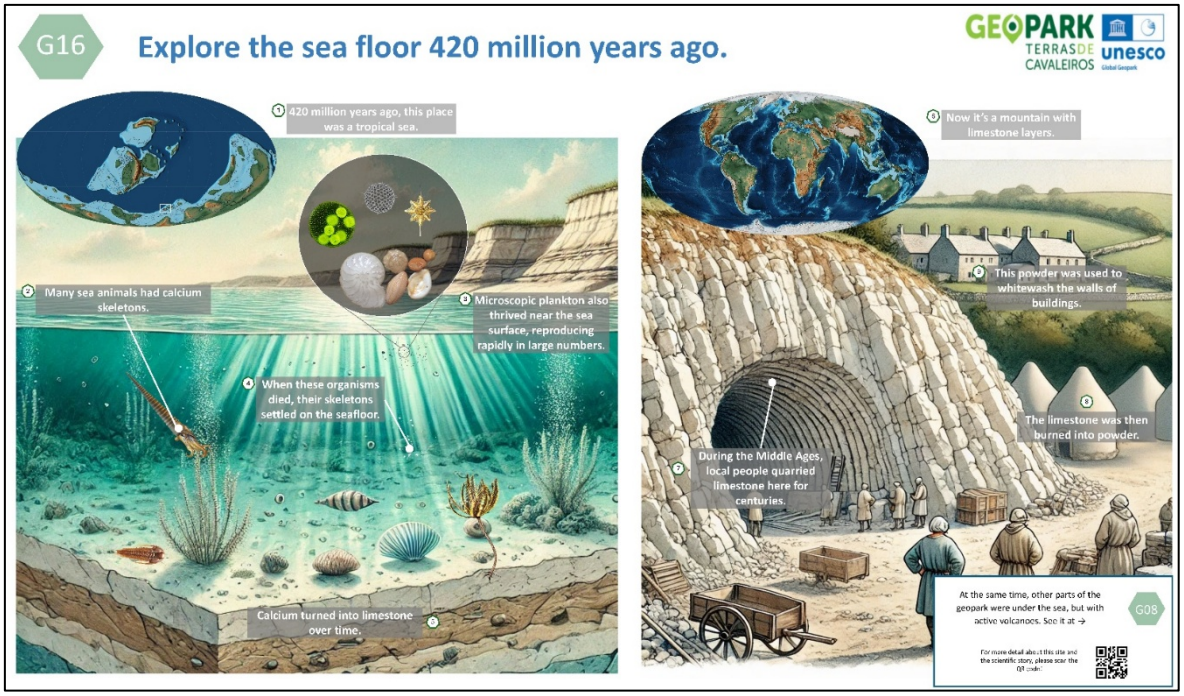
G31, titled "Eyeballs from 500 million years ago", explains the transformation of deep-seated granitic rocks from the Armorican microcontinent into augen gneiss through dynamic metamorphism.



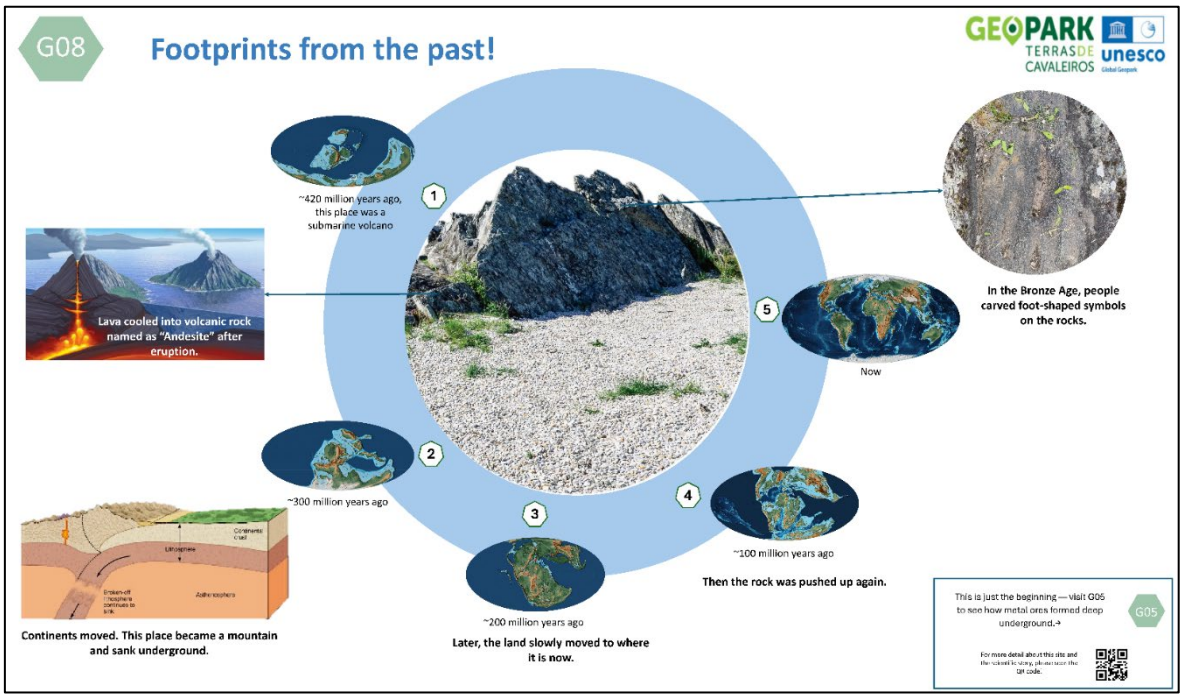
G32, titled "Meet the deepest crust here!", presents the Conrad and Moho discontinuities, aiming to help visitors understand deep crustal structures and tectonic suturing.



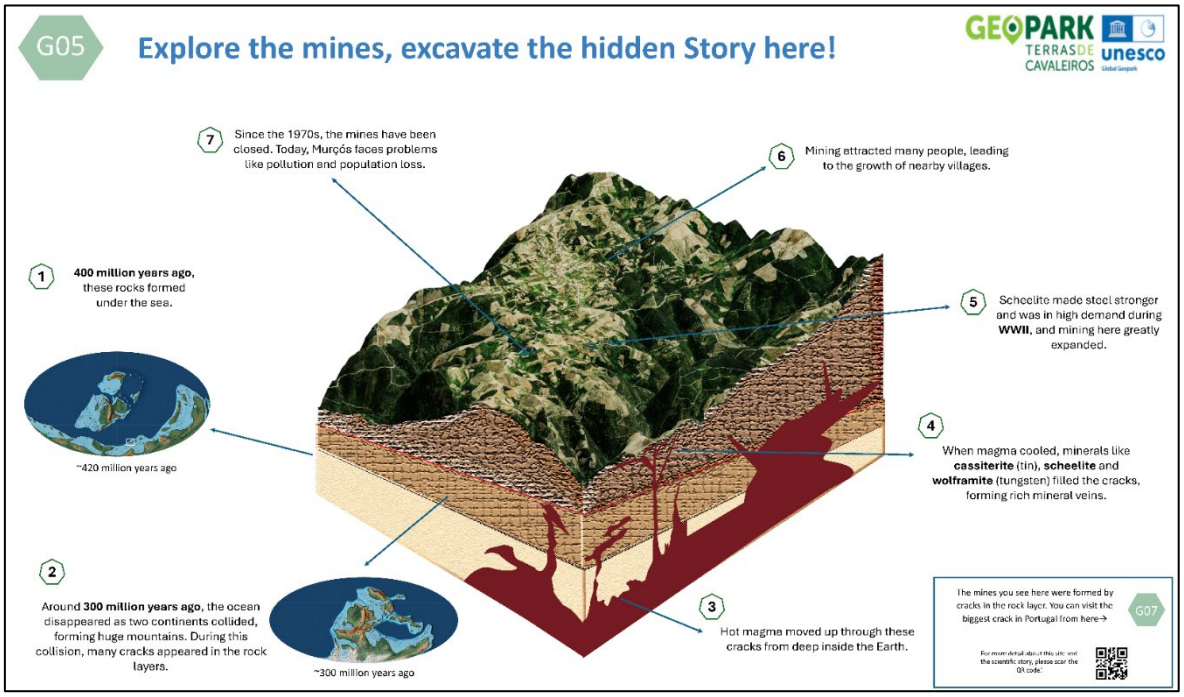
G36, titled “Touch the force that moves continents!”, showcases evidence of Rheic oceanic spreading, highlighting mid-ocean ridge dynamics and magma intrusion.



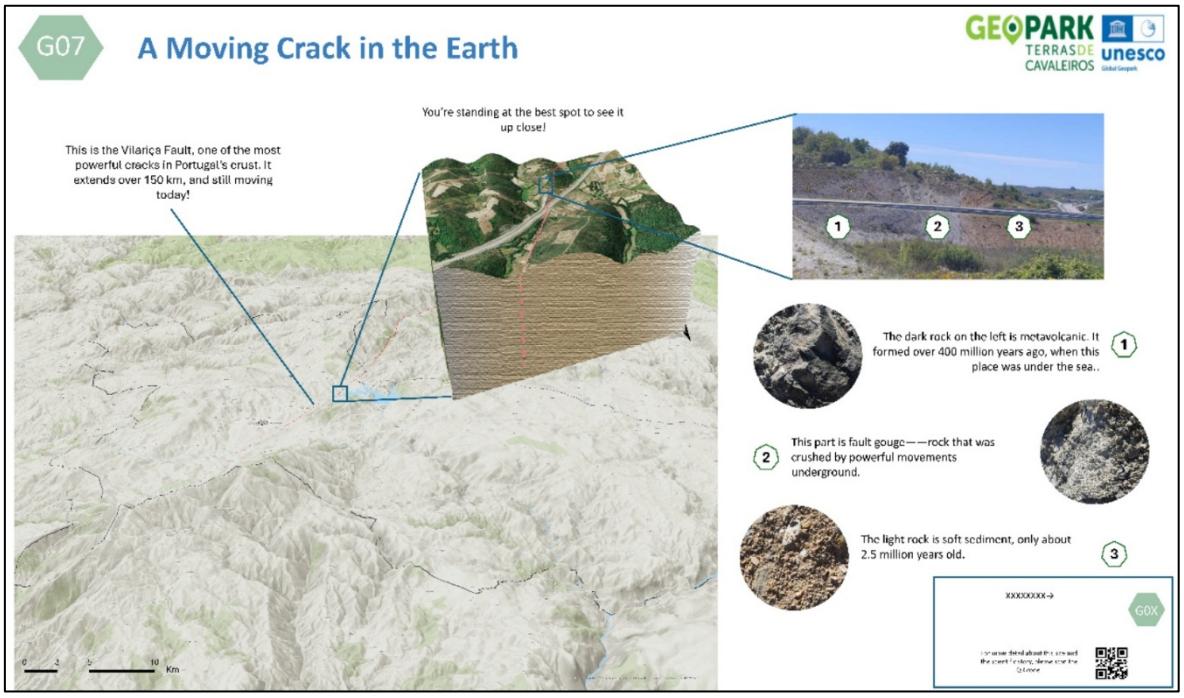
G16, titled “Explore the sea floor 420 million years ago”, illustrates the Silurian carbonate platform deposits along the Gondwanan margin, while also connecting the limestone resource with local historical use.



G08, titled "Footprints from the past!", features metamorphosed volcanic rocks that preserve ancient carved footprints, serving as evidence of Silurian–Devonian volcanic arc activity along the continental margin.



G05, titled "Explore the mines, excavate the hidden story here!", interprets the formation of local ore deposits in relation to the closure of the Rheic Ocean and further links the geological history with regional human activity.



G07, titled “A Moving Crack in the Earth”, introduces the Vilariça Fault Zone, one of the most active strike-slip faults in northern Portugal.