




Editorial

Geoheritage and Geotourism Resources: Education, Recreation, Sustainability II

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In recent years, the world's fascination with the geoenvironment has experienced a remarkable surge. Concepts such as “geosites”, “geoparks”, and “geodiversity” have become pivotal in the cultural and economic resurgence of various regions. These terms are not mere geological jargon but are intrinsically linked with the revitalization of local communities, fostering newfound growth and sustainability. At the heart of this burgeoning interest lies the exchange of information, skills, experience, and personnel among the world's significant geosites, which are recognized globally for their geopark activities.

Central to this movement is the concept of geotourism, an alternative form of tourism that enables visitors to delve into the geological wonders of the areas they explore while immersing themselves in the diverse tapestry of natural and human resources. Geoeducation, another pivotal element, finds its nexus in the operational heart of geoparks, as they are deemed ideal settings for educational endeavors.

The content of this Special Issue, entitled “Geoheritage and Geotourism Resources: Education, Recreation, and Sustainability II”, covers a diverse range of topics related to geology, geoeducation, geotourism, and the preservation of geological heritage. This Special Issue highlights the growing interest in the geoenvironment and its significance in various aspects of local economic and cultural development. It emphasizes the importance of geoeducation in geoparks and the promotion and preservation of geological heritage and geoethical values.

In this second volume, we continue our journey to assemble a comprehensive collection of papers that elucidate the paramount role of the promotion and conservation of geoheritage in the nurturing of geoethical values and the enhancement of sustainability. Beyond research articles encompassing a wide array of geological heritage approaches, researchers responded to our call to submit papers focusing on novel cases and shedding light on contemporary challenges or unexplored knowledge gaps. Additionally, we welcomed long-term review articles that provide an insightful panorama of the evolution within this field.

Fourteen papers explore a wide array of subjects, including scientific studies of geoheritage, techniques for enhancing geoheritage, the significance of geoheritage in human life, geosciences education for sustainability, sustainable geotourism, the sustainable use of natural and cultural heritage, and the valorization of geoheritage for sustainable and innovative tourism development. These papers present research findings, case studies, and methodologies that contribute to a deeper understanding of how geological heritage can be integrated into education, tourism, and sustainable development.

In their review, Mosios et al. [1] conducted a comprehensive assessment of geoethics in Greece, with a particular emphasis on its presence within the educational system and the Greek geoscientific community. They found that although concerns about geoethics were on the rise in Greece, the incorporation of geoethics into educational curricula was limited across all educational levels. Furthermore, the review exposed a notable absence of initiatives aimed at fostering geoethical thinking and instilling the values associated with



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geological heritage and its preservation. This lack of emphasis on geoethics highlighted the need for a more concerted effort to promote ethical considerations and responsible practices within both the geoscientific community and broader society in Greece, particularly concerning the safeguarding of geological heritage.

In their comprehensive review, Quesada-Valverde et al. [2] conducted a systematic analysis of global research in geoconservation and geotourism, spanning the years 2011 to 2021. Through an in-depth examination of 169 research papers, their study illuminated several key findings. Notably, it showcased a burgeoning interest in geoconservation and geotourism research on a global scale, with Italy, Poland, Brazil, Russia, and China emerging as leading contributors. The study highlighted a diverse range of geomorphological environments under investigation and identified fundamental methods for assessment and promotion, such as geomorphological mapping, economic valuation, fieldwork, geoheritage management, and documentation. Moreover, the review identified critical resources, including UNESCO Global Geoparks, educational programs, digital tools, geomanagement strategies, and geotourism itineraries. This pioneering research provides a valuable resource for countries embarking on geoheritage studies, offering insights into successful methods and resources to advance geoconservation and geotourism efforts worldwide.

In their article, Valentini et al. [3] emphasize the significance of geoheritage as a valuable geotourism resource that holds the potential to contribute significantly to the sustainable development of society. They highlight that geoheritage serves multiple purposes, including enhancing knowledge about geological and geomorphological characteristics, facilitating education, raising public awareness about geoconservation, and aiding in landscape protection efforts. However, they note that despite its importance, the understanding of this cultural wealth remains limited, with it often being confined to specialized information accessible to a select few. Recognizing the need for more effective communication, the research group embarked on a comprehensive study focusing on central Italy. Their work involved exploring various communication methods, including publications, social media announcements, conferences, live performances, and field excursions, all designed to emotionally engage the public. The study also involved assessing the emotional response of the audience through a digital survey. The researchers found that utilizing diverse forms of art to narrate the landscape established a personal connection with the audience, effectively conveying scientific and cultural themes such as the origin of geological landforms, the cultural traditions associated with the site, and the challenges related to its protection and conservation. This approach demonstrated the effectiveness of emotional engagement in disseminating knowledge about geoheritage and promoting geoconservation among a broad and diverse audience, transcending social, cultural, and age boundaries.

Herrera-Franco et al. [4] underscore the often-overlooked importance of geodiversity in the broader context of biodiversity, emphasizing that geodiversity, which encompasses geological and landscape variety within a region, plays a pivotal role with far-reaching social, economic, educational, scientific, and technological impacts. They focus their study on Guayaquil, a port city in Ecuador, with the objective of assessing the geoheritage values of the region and proposing guidelines and strategies for raising awareness and promoting the understanding of this geoheritage. The researchers employed a comprehensive methodology that encompassed a historical review of Guayaquil's landmarks, surveys to gauge the local population's perception of the city's geoheritage, data analysis, and the development of geodiversity strategies using computer tools. Their findings revealed that individuals initially engage with areas of interest in Guayaquil due to their biodiversity, but once there, they could acquire knowledge about the city's geology, geodiversity, and urban geotourism. Consequently, the study highlights the imperative role of geoheritage in shaping educational plans, initiatives, and promotion strategies, especially regarding using geotourism as a sustainable means of showcasing the city's historical and scientific significance in the context of sustainability. This research underscores the importance of recognizing and preserving a city's geological heritage and its socio-economic and educational value within the broader framework of conservation and sustainable development.

In their article, Drinia et al. [5] underscore the unique geological heritage of Athens, the capital of Greece, which often takes a backseat to its archaeological and historical wealth. The authors specifically focus on the geological aspects of the Acropolis monuments, including the iconic Acropolis Rock. While the Acropolis is celebrated globally for its cultural and historical significance, it is also a remarkable geological monument. Drinia et al. aimed to quantify and recognize the geological features of such monuments, evaluating their educational, touristic, cultural, and accessibility value. They stress the importance of highlighting these geological aspects for both public and scientific communities, emphasizing their potential for geoeducation and geotourism. The article emphasizes the substantial economic and educational benefits that can be derived from promoting these geosites and raising visitor awareness about environmental, geological, and geoconservation issues. Their study also emphasizes the critical need for better integration of geological heritage with cultural heritage and the importance of strategic educational planning and incorporating geo-environmental education into school curricula.

In their study, Fedorov et al. [6] address the crucial factor of accessibility in the utilization of geoheritage resources. They propose an innovative multi-criterion, score-based approach for evaluating the large-scale accessibility of areas abundant in geoheritage. This approach takes into consideration a range of factors, including external and internal public transportation, road infrastructure, local services (including accommodation options), and general settings, to comprehensively assess accessibility. The researchers applied this method to the Russian South, a region featuring three geoheritage-rich areas: the Lower Don, Abrau, and Mountainous Adygeya. The results of their analysis revealed varying levels of accessibility across these regions, with the Lower Don demonstrating excellent accessibility, while Abrau and Mountainous Adygeya showed a moderate level. Importantly, the study highlights the fact that the mere coexistence of geoheritage-rich areas and popular tourist destinations does not guarantee excellent accessibility. These findings hold significance for shaping effective geoheritage resource policies, as well as for planning research and educational endeavors, such as ongoing geochemical investigations and field educational campaigns in the Russian South. The research serves as a valuable contribution to enhancing the utilization of geoheritage resources while considering practical accessibility challenges.

Farabollini and Bendia [7] emphasize the captivating role of geologists in deciphering the physical landscape, revealing its history through the lens of geological and geomorphological processes that have shaped the Earth's terrain over time. They underscore the critical need to disseminate the extensive knowledge and skills within this field, particularly in the context of promoting geodiversity and advocating for its preservation and promotion. The authors present their work as a means of sharing tangible examples of projects that have come to fruition through collaborative agreements among various public entities in the Apennine region of the Marche Region in Italy. This partnership involves the Geology Section of the University of Camerino, the "Consorzio Frasassi" responsible for managing the Frasassi cave complex, and the municipality of Genga, home to the renowned Frasassi Caves. This joint effort has led to the creation of didactic geological notebooks tailored for school groups visiting the caves and interactive museum laboratories in 3D, which illustrate the geological evolution of the area. This knowledge-sharing initiative is poised to educate communities about the significance of their geological heritage while also serving as an inspiration for similar collaborative endeavors in regions where comparable projects can be replicated, thereby furthering the cause of geological education and conservation.

Ozkaya de Juanas et al. [8] emphasize the significance of accessible palaeontological sites as highly suitable environments for meaningful learning experiences in both formal and non-formal geoscience education. Their project focuses on two closely related Cenomanian–Turonian (Upper Cretaceous) outcrops in the Iberian Peninsula—specifically, the sections of Figueira da Foz in Portugal and Tamajón in Spain. Additionally, they consider the Palaeontological and Archaeological Interpretation Centre of Tamajón (CIPAT) as a key component of this initiative. The researchers leveraged modern technology to

create three-dimensional virtual models of fossil samples and the main fossil tracks through techniques such as phase-shift scanning, photogrammetry, and structured light and laser triangulation. These virtual fossils have served as the foundation for developing transdisciplinary didactic activities tailored to various educational levels and the general public. The activities are detailed in file cards, including information about participant age, objectives, multiple intelligences, European Union key competencies, required resources, implementation steps, and additional observations. The overarching goal of this work is to enhance the design and execution of didactic sequences for out-of-school education at these palaeontological sites, fostering the creation of effective transdisciplinary teaching tools and cultivating awareness, values, and responsibility toward geoheritage. This project exemplifies the commitment to promoting geoscience education and the preservation of geological heritage through innovative and accessible educational approaches.

Martínez-Martín et al. [9] underscore the significance of UNESCO Global Geoparks (UGGs) as exceptional regions for fostering educational activities on an international scale. They emphasize the didactic potential, multidisciplinary, and importance of UGGs in facilitating non-formal and informal educational initiatives. These aspects have garnered significant attention from institutions, organizations, and governments in numerous countries. This interest is so pronounced that the number of UGGs continues to grow, with 177 territories spanning 46 countries currently designated as UGGs. These geoparks diligently work to develop diverse educational activities and proposals aimed at contributing to the attainment of “Quality Education”, which is the fourth objective of the Sustainable Development Goals (SDGs) outlined in the United Nations 2030 Agenda. The study focuses on describing the various educational initiatives and activities featured on the official websites of Spanish and Portuguese UGGs, with the goal of assessing their visibility prior to visiting these territories and highlighting their importance within the broader framework of educational development. In essence, the research seeks to shed light on the role of UGGs in promoting quality education and their unique contributions to the field of education through accessible and adaptable educational plans.

Nomikou et al. [10] present Nisyros Geopark, situated in the Southeastern Aegean Sea, Greece, as a candidate for the official UNESCO Global Geoparks designation. The geopark is characterized by remarkable geological, natural, and cultural attributes deeply linked to its volcanic origins. It encompasses an extensive area of 481 square kilometers, comprising the main island of Nisyros, an active volcano, as well as the surrounding islets of Pachia, Strongyli, Pergousa, Kandeliousa, and the marine regions connecting them. Nisyros Geopark boasts 24 geosites and a well-established network of walking trails for visitors. Additionally, the entire area is covered by two internationally designated Natura 2000 areas, highlighting its ecological significance. Beyond its geological wonders, the geopark showcases exceptional archaeological and cultural sites, including fortresses, remnants of ancient settlements, and numerous churches and monasteries, making it a unique destination in the broader Eastern Mediterranean region. The management body and scientific team of Nisyros Geopark have undertaken various initiatives to promote its exceptional geodiversity, including the development of an official website, the creation of a mobile application called “Nisyros Volcano App”, the production of informative materials like leaflets and guidebooks, as well as the installation of panels and signs at the geosites, all aimed at enhancing the visitor experience and raising awareness about the geopark’s unique features.

Tropeano et al. [11] describe the official nomination of a significant area in Puglia, Southern Italy, as an aspiring UNESCO Global Geopark (aUGGp) by the Italian National Commission of UNESCO in November 2021. This designated area encompasses the north-western part of the Murge territory, where a Cretaceous sector of the Apulia Carbonate Platform is exposed, as well as a portion of the adjacent Premurge territory, where the south-westward lateral extension of the same platform, flexed toward the Southern Apennines Chain, is overlain by thin Plio-Quaternary foredeep deposits. The exceptional geological uniqueness of the aspiring Geopark, known as Murge aUGGp, lies in the fact that it

represents the only in situ remnant of the Adria Plate, an ancient continental plate that has largely been compressed between the Africa and Eurasia Plates. In the Murge area of the Apulia Foreland, Adria's crust remains virtually undeformed, contrasting with other regions of the plate that have been involved in subduction and collision processes. The aspiring Geopark preserves the connection between Adria's crust and mantle, and the Cretaceous evolution of the continent is well-documented in the Murge area through the carbonate succession of the Apulia Carbonate Platform, one of the largest peri-Tethys carbonate platforms. Additionally, the Geopark includes the Premurge area, which showcases the remarkable Plio-Quaternary evolution of the outer Southern Apennines foredeep, characterized by an "anomalous" regional uplift during the middle-late Quaternary period. Despite harboring numerous geological features of international significance, the authors highlight the importance of presenting a regional geological framework for the aUGGp to provide context for visitors before delving into the individual geosites. This approach can enhance the appreciation of the individual geosites within the broader geoevolutionary context of the Murge aUGGp and enrich the geotourism experience.

Triantaphyllou et al. [12] highlight the exceptional geosites of Lemnos, emphasizing that these sites not only possess aesthetic beauty but also hold profound scientific connections to the island's geological history, prehistory, archaeology, mythology, and religious heritage. The richness of Lemnos' geosites, coupled with the abundance of archaeological sites, cultural monuments, and museums, forms the foundation of what the authors term "Geo-Archaeo-Routes." These routes are well-defined geographical paths that can be offered, guided, and followed by tourists. The quantitative assessment of Lemnos' geosites conducted by the authors serves as a valuable decision-making tool, facilitating the sustainable development of Geo-Archaeo-tourism at the local level and laying the groundwork for the creation of these specialized routes. These "Geo-Archaeo-Routes" are particularly suited to environmentally friendly forms of tourism, catering to naturalists, hikers, cultural enthusiasts, and those interested in religious heritage—reflecting the diverse needs of 21st century tourists. The established hiking and road routes on Lemnos Island offer a unique touristic product that combines "nature with culture", providing a holistic geotouristic experience that blends natural entertainment with cultural exploration. In essence, these routes offer a distinctive way to appreciate the geological, archaeological, and cultural heritage of Lemnos while embracing sustainable and eco-friendly tourism practices.

Melelli et al. [13] present a method for revitalizing abandoned mines, whose existence had faded from both the physical landscape and collective memory. They illustrate this approach with two case studies in the Umbria region of central Italy. The selected sites, located in the Upper Tiber River Valley in northern Umbria, were once lignite mines that had been completely erased over time. Given their rural locations, recovering the memory of these places, and repositioning them as geosites posed an intriguing challenge. The authors embarked on a comprehensive process to restore and valorize these abandoned mines. They began by recovering and preserving historical documents related to the Caiperino–Terranera and Carsuga lignite mines, subsequently digitizing these materials. This digital archive served as the foundation for the creation of a geolocalized database within a geographic information system (GIS) environment. Building on this framework, Melelli et al. [13] developed a digital media app enriched with multimedia elements, including video content, 3D models, and augmented reality (AR) features. This innovative app enhances the touristic and educational experiences, offering a dynamic and engaging way to explore these "ghost places" while promoting the cultural heritage of the region. In essence, this method not only revitalizes abandoned mines but also reintroduces them into the collective consciousness, transforming them into valuable geosites with historical and educational significance.

In their article, Iranzo-García et al. [14] conducted research that focused on the intersection of environmental concerns, the preservation of geological heritage, and local development in Spanish geoparks. Iranzo-García et al. recognized the growing interest in environmental problems and the need to protect and manage sites to ensure that geoecological processes remain unaffected by human activities. They conducted research to address these concerns and understand how geoparks could play a role in safeguarding geological heritage. Moreover, the researchers adopted an inductive and qualitative research approach which involves collecting and analyzing data to develop theories and insights rather than testing predefined hypotheses and allowed them to explore the complex relationships between geoparks, private initiatives, and local development in a nuanced manner. The researchers identified and analyzed 48 land stewardship initiatives within 11 of the 15 Spanish geoparks. This involved studying how various organizations and individuals were working to protect and manage the geological and cultural heritage within these geoparks. The study also touched on the presence of nature-based schools within geoparks. It noted that such schools were relatively rare within geoparks, with a notable exception in Central Catalonia. This observation prompted discussions about the potential for integrating nature-based education into geopark operations. They emphasized the positive impact of early years education in natural environments in fostering pro-environmental skills and behaviors that extend into adulthood.

We hope that this Special Issue will serve as a valuable resource for scholars, educators, and professionals interested in the intersection of geology, education, tourism, and conservation, offering insights and practical approaches for harnessing the potential of geological heritage for the benefit of both local communities and the broader public.

Conflicts of Interest: The authors declare no conflict of interest.

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