

GEOETHICS, DIGITAL INTEGRATION, AND COMMUNITY EMPOWERMENT: ADVANCING GEOTOURISM FOR SUSTAINABLE DEVELOPMENT

Nelson Graburn¹

¹ Professor emeritus in Sociocultural Anthropology at University of California, Berkeley

Abstract

Modern geotourism is transforming from conventional interpretive frameworks to more dynamic models that incorporate digital technologies, geoethical principles, and inclusive participation of the community. This paper discusses how collaboration among technological innovation, geoeducation, and participatory practices boosts the ability of geotourism to facilitate sustainable development. It takes the leadership position that geoethics plays in promoting geoscientific responsibility to new levels and shows how experience with augmented reality (AR), local capacity building, and early educational interventions can turn geotourism into an agent of environmental stewardship and cultural conservation. The Aliaga Geological Park is explored again with these advancements in mind and presents a framework for evaluating geotourism's impact that is renewed.

Keywords: geoethics, smart geotourism, geoscience education, community-based geotourism, sustainability, digital interpretation

INTRODUCTION

Over the last few decades, geosciences have given increasing importance to the value of geological landscapes as geodiversity and geohistorical heritage—not only as scientific resources, but as crucial parts of cultural identity and regional development (Peppoloni & Di Capua, 2023). These geological features not only document Earth's history, but they are also invaluable resources for education, conservation, and

community involvement. Careful integration of geological knowledge can bring about local economic benefits in the context of international sustainable development (Zafeiropoulos & Drinia, 2023).

Based on this new consideration, geotourism has developed as a form of multidimensional tourism that is not only about passive observation. It originated in the 1990s and is built upon five principles: it must have a geological basis, be scientifically informative, promote environmental sustainability, aid local communities, and fulfill the expectations of the tourists (Peppoloni et al., 2019). With these principles, geotourism can be a means for balanced human contact with nature.

However, a persistent challenge remains: the widespread public disengagement from geoscientific knowledge and environmental literacy. Many populations still lack a fundamental understanding of natural systems, resource management, and the consequences of anthropogenic pressures on landscapes (Gill, 2021). This knowledge gap underscores the urgency of reintroducing geoscience education through innovative, inclusive approaches—especially outside of traditional classrooms. Geoparks, in particular, have gained recognition as ideal platforms for this educational revival, offering immersive, field-based learning experiences that seamlessly integrate local culture and environmental stewardship.

Within these settings, geotourism and geoscience education intersect to form a powerful strategy: one that not only educates visitors about the Earth's processes and the significance of geological formations but also empowers them with ethical frameworks for managing natural resources. Studies have shown that this approach can significantly enhance public understanding, improve land-use decisions, and support long-term territorial conservation. By combining empirical engagement with geoethical reflection, geotourism can thus be reimagined as a transformative tool for sustainable development—where tourism becomes an act of learning, preservation, and collective responsibility.

GEOLOGICAL PARK OF ALIAGA: A REASSESSMENT IN A SMART GEOTOURISM CONTEXT

The Geological Park of Aliaga, located in the Teruel Province of Spain (Figure 1), represents a paradigmatic example of how geological her-

itage can be harnessed for education, research, and sustainable tourism. Established in 1996, the park was envisioned as both an interpretive and pedagogical resource—designed to communicate the complexity of Earth’s history while stimulating regional development through geotourism. Its extensive stratigraphic record, which spans from the Upper Triassic to the Quaternary, provides a remarkable window into over 200 million years of geological evolution.



Figure 1: Indication of Park

What distinguishes Aliaga’s geological profile is not only the diversity of rock formations but also the exceptional structural complexity resulting from multiple tectonic episodes. Particularly notable are the folding patterns generated during the Alpine Orogeny, where two distinct systems—trending NNW–SSE and ENE–WSW—overlap to form intricate anticlines, synclines, and vertically meandering folds. This tectonic overprinting offers a textbook example of superimposed deformation processes, which have been further accentuated by selective erosion. Resistant lithologies such as limestone, dolostone, and conglomerates define rugged crests and escarpments, while softer sediments like marls and clays create smoother slopes—revealing the park’s structural archi-

texture with striking clarity (Gill, 2021).

In recent years, the interpretive strategies at Aliaga have been significantly enhanced through the integration of digital and smart tourism technologies. Visitors can now engage with interactive AR (augmented reality) applications that reconstruct past landscapes, visualize subsurface structures, and narrate geological events in real time. These tools have not only modernized the visitor experience but also improved accessibility to complex geoscientific information, especially for non-specialists (Capello et al., 2023). By embedding real-time data, multimedia storytelling, and user feedback mechanisms, Aliaga has effectively transitioned toward a “smart geotourism” model—positioning itself at the forefront of digitally enabled heritage conservation.

Moreover, the park’s geomorphological features, such as the globally recognized “La Olla” fold, serve as anchor points for thematic trails and educational modules Figure 2. These geosites are now supported by enhanced geospatial mapping and drone-assisted monitoring systems that track erosional dynamics, vegetation changes, and visitor impacts—ensuring that conservation goals are aligned with tourism development.

Thus, the Geological Park of Aliaga exemplifies how traditional geological interpretation can evolve into a data-informed, ethically grounded, and community-engaged model of geotourism. It demonstrates the potential of leveraging geoscientific excellence not only for academic enrichment but also for fostering local identity, environmental stewardship, and long-term sustainability.

GEOETHICS AND DIGITAL INTEGRATION IN GEOTOURISM

As geotourism grows around the world, the ethical aspects of its practice have become more important. Geoethics, a field focused on the ethical, social, and cultural effects of how humans interact with the Earth system, provides a crucial framework to guide this growth. In the geotourism context, geoethics goes beyond traditional ideas of professional responsibility in geosciences and calls for a broader understanding of how knowledge is created, shared, and acted upon by various stakeholders (Koupatsiaris & Drinia, 2023).

At its core, geoethics supports principles like respect for geodiversity,



Figure 2: Globally recognized “La Olla” fold

transparency in scientific communication, awareness of cultural contexts, and the responsible use of geological resources. When applied to geotourism, these values change the tourist experience from simply consuming the environment to actively and ethically engaging with the landscape (Németh & Moufti, [2024](#)).

Contemporary geotourism projects increasingly integrate geoethical principles into their planning and implementation, particularly through digital means. Mobile applications, virtual reality models, and augmented reality overlays not only serve as interpretive devices but also ethical intermediaries (Németh & Moufti, [2024](#)). These platforms can render intricate geological phenomena, accentuate conservation imperatives, and shed light on the cultural significance of geoheritage in a manner that is accessible, inclusive, and attuned to indigenous narratives (Ferdowsi, [2025](#)).

For example, tourists to geoparks are now able to participate in interactive ethical decision-making exercises, where they investigate the impacts of unsustainable mining, land loss, or water mismanagement. These gamified learning instruments, grounded in authentic data, en-

hance members of the public's awareness of geoethical challenges and instill critical thinking concerning sustainable land management (Morante-Carballo et al., [2023](#)).

Even with these innovations, issues still persist. There still is not enough systematic methods to assess how effectively geotourism promotes geoethical consciousness among tourists, tour guides, and government policymakers. Additionally, the inclusion of digital technologies needs to be done cautiously so that it does not replace local systems of knowledge or intensify digital exclusion in rural communities.

To address these challenges, scholars and practitioners are calling for the development of standardized geoethics guidelines specifically tailored for geotourism contexts. These would include:

- Ethical communication protocols for site interpretation and storytelling.
- Geoethical impact assessments embedded within tourism planning.
- Participatory frameworks that involve local communities in defining the ethical values associated with their geological heritage.
- Capacity-building programs to equip geotourism guides and developers with interdisciplinary skills in science, ethics, and digital media.

Ultimately, integrating geoethics into the digital transformation of geotourism offers a powerful means of enhancing both the educational depth and social responsibility of geotouristic experiences. It ensures that the growing popularity of geological heritage tourism aligns with broader objectives of sustainable development, planetary stewardship, and intergenerational justice.

THE EXPANDING ROLE OF THE GEOTOURISM GUIDE: FROM INTERPRETER TO STEWARD AND COMMUNITY EDUCATOR

In the evolving landscape of geotourism, the role of the geotouristic guide has expanded well beyond that of a conventional tour interpreter. Today, geotourism guides are not only expected to communicate geological knowledge effectively, but also to act as facilitators of ethical engagement, cultural ambassadors, conservation advocates, and agents

of sustainable development (Bindawas, 2025; Ferdowsi, 2025). This shift reflects a broader recognition that successful geotourism is deeply rooted in the human dimension of place-based learning and community participation.

In geoparks and other geoheritage sites, such as the Geological Park of Aliaga, guides play a pivotal role in contextualizing scientific narratives within the local ecological, cultural, and historical fabric. They help bridge the often wide gap between expert knowledge and public understanding, translating complex geomorphological and tectonic phenomena into relatable stories (Morante-Carballo et al., 2023). More importantly, when trained with a geoethical foundation, these guides promote values such as environmental responsibility, respect for local traditions, and critical reflection on human–Earth interactions.

The contemporary geotourism guide operates within a multidisciplinary space, combining competencies from geology, environmental education, cultural heritage interpretation, communication, and now increasingly, digital technologies. In progressive models, guides are trained to use augmented reality apps, GIS-enabled maps, and real-time environmental data to enhance the educational and immersive quality of their tours (Hutarova et al., 2021). They may also be involved in designing interpretive media, co-creating content with local communities, or gathering visitor feedback for adaptive site management.

A particularly transformative aspect is the emergence of local guiding enterprises, such as Jumidosiv in Aliaga, which exemplify the integration of geoeducation with rural empowerment. By empowering residents to become certified guides and educators, geotourism fosters a model of endogenous development—where economic opportunities, knowledge systems, and conservation practices are sustained from within the community rather than imposed externally.

Such models align with the new paradigm of rural development, which emphasizes participatory governance, cultural revitalization, and the preservation of traditional ecological knowledge. Unlike earlier top-down modernization approaches, this paradigm values the lived experiences of local populations, recognizing them as crucial actors in landscape stewardship.

To support this expanded role, there is growing advocacy for formal

certification programs and professional development pathways for geotourism guides. These programs would not only standardize competencies in geological interpretation but also incorporate training in:

- Geoethics and environmental philosophy
- Sustainable tourism planning and visitor management
- Culturally responsive communication
- Use of digital and immersive technologies for education
- Conflict resolution in stakeholder contexts

Furthermore, building networks of local geotourism professionals within geoparks can facilitate collaboration, knowledge exchange, and collective problem-solving. These networks can strengthen community bonds, amplify local voices in heritage governance, and create resilient geotourism systems that adapt to environmental, social, and economic change.

In essence, the modern geotourism guide is a key vector of sustainable territorial development—not merely informing visitors, but co-shaping values, practices, and futures. As both knowledge-bearers and community leaders, these professionals anchor geotourism in place, purpose, and planetary care.

EARLY GEOETHICS EDUCATION: BUILDING FOUNDATIONS FOR A SUSTAINABLE FUTURE

The cultivation of geoethical awareness must begin long before individuals assume professional or managerial roles in society. Children, as future stewards of the Earth, must be introduced to the principles of geoscience and sustainability from an early age. This early engagement not only enhances their understanding of geological processes and natural resources but also lays the ethical groundwork necessary for making informed decisions in the future. Early geoethics education thus plays a crucial role in fostering an environmentally conscious and scientifically literate society.

Recent pedagogical research emphasizes that introducing geoscientific concepts at the primary education level—especially through experiential and place-based learning—results in lasting cognitive and emotional

connections to the land. In geotouristic settings like the Geological Park of Aliaga, hands-on activities such as rock identification, fossil excavation, and landform mapping allow students to move beyond abstract textbook knowledge to a tangible understanding of Earth's systems. When combined with narratives of environmental care and intergenerational responsibility, these experiences cultivate a holistic environmental ethic.

More importantly, early education in geoethics supports the development of critical thinking skills, encouraging children to reflect on the consequences of human actions on geological and ecological systems. Through structured programs, students learn not only to observe and interpret the physical landscape, but to question its transformation over time, recognize human impact, and consider ethical responses to environmental challenges.

In Aliaga, initiatives have been launched in collaboration with local schools, universities, and educational NGOs to deliver interdisciplinary modules that integrate geology with ethics, ecology, history, and technology. These programs often employ storytelling, creative arts, and digital tools—such as interactive games and virtual field trips—to deepen engagement. Children participate in group discussions on topics like mining sustainability, land restoration, and water scarcity, allowing them to grapple with real-world dilemmas through an ethical lens.

Furthermore, embedding geoethics into formal curricula and informal educational outreach enables continuity across developmental stages. As students advance through different educational levels, their understanding of geoethical principles evolves—from basic environmental appreciation to complex reasoning about policy, conservation, and social equity. This continuum ensures that geoethics becomes not an isolated topic, but a foundational worldview.

Educators have also emphasized the importance of teacher training and resource development to effectively convey geoethical values. Workshops for educators, curricular toolkits, and partnerships with geoparks can equip teachers with the skills and materials necessary to guide meaningful learning experiences. In turn, this builds institutional capacity for sustained impact in both urban and rural education systems.

Ultimately, early geoethics education is not merely about transmitting

scientific facts—it is about cultivating a generation of reflective, responsible, and proactive citizens who can navigate complex environmental realities with ethical sensitivity and scientific understanding. These young learners will become the decision-makers of tomorrow, and their values will shape the sustainability pathways of the communities, ecosystems, and economies they inherit.

CONCLUSION

Geotourism, when enhanced through geoethics, digital integration, and inclusive community practices, becomes a powerful tool for sustainable development. The case of Aliaga exemplifies how natural heritage sites can adapt to global challenges by fostering ethical learning, technological innovation, and local empowerment. As future land managers, today's children equipped with geoethical values and geoscientific skills will inherit not just the knowledge of the Earth, but the responsibility to protect it.

REFERENCES

- Bindawas, A. M. (2025). Promoting sustainable tourism through employee skills: Contextualizing quality education and the human resource management perspective (sdg-4). *Sustainability*, 17(2), 748.
- Capello, M., Caslin, E., Stewart, I., Cox, D., Shaughnessy, A., Atekwana, E., Handley, H., Bakamjian, T., Wouters, L., & Winsten, M. (2023). Geoscience in action: Advancing sustainable development. *UNESCO Report Series*.
- Ferdowsi, S. (2025). Management of geoheritage conservation and vulnerability in tourism destinations. *Tourism Review*, 80(2), 601–623.
- Gill, J. C. (2021). Reshaping geoscience to help deliver the sustainable development goals. In *Geosciences and the sustainable development goals* (pp. 453–468). Springer.
- Hutarova, D., Kozelova, I., & Spulerova, J. (2021). Tourism development options in marginal and less-favored regions: A case study of slovakias gemer region. *Land*, 10(3), 229.
- Koupatsiaris, A. A., & Drinia, H. (2023). Exploring greek unesco global geoparks: A systematic review of grey literature on greek universities and future research avenues for sustainable development. *Geosciences*, 13(10), 296.
- Morante-Carballo, F., Apolo-Masache, B., Taranto-Moreira, F., Merchán-Sanmartín, B., Soto-Navarrete, L., Herrera-Franco, G., & Carrión-Mero, P. (2023). Geo-environmental assessment of tourist development and its impact on sustainability. *Heritage*, 6(3), 2863–2885.

- Németh, K., & Moufti, M. R. H. (2024). Geotourism development and opportunity of monogenetic volcanic fields of saudi arabia. In *Geoheritage and geodiversity of cenozoic volcanic fields in saudi arabia: Challenges of geoconservation and geotourism in a changing environment* (pp. 125–145). Springer.
- Peppoloni, S., Bilham, N., & Di Capua, G. (2019). Contemporary geoethics within the geosciences. In *Exploring geoethics: Ethical implications, societal contexts, and professional obligations of the geosciences* (pp. 25–70). Springer.
- Peppoloni, S., & Di Capua, G. (2023). The significance of geotourism through the lens of geoethics. In *Geotourism in the middle east* (pp. 41–52). Springer.
- Zafeiropoulos, G., & Drinia, H. (2023). Geoam: A holistic assessment tool for unveiling the geoeducational potential of geosites. *Geosciences*, 13(7), 210.