



Identification and Commercialization of the Nigerian Geo-Heritage and Medical Geology Resources

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Abstract

Nigerians vast geo-heritage resources are examined in this review with a focus on the importance of their systematic identification and preservation. These resources which include basins arcs belts and terrains are extremely important for bio-diversity, geo-diversity and environmental preservation on a global scale. These geo-heritage resources may also promote medical tourism, balneotherapy, senior citizen care and healthy living which would boost the economy and industry. With the right identification description and commercialization, the idea of geo-heritage medical geology can promote economic growth in accordance with global economic policies like geo-tourism and geo-sustainability. This review offers strategies for the successful commercialization of these resources by examining the opportunities and difficulties they present. It ends with suggestions for how communities, businesses, governments and researchers can best utilize these resources.

Keywords: geo-heritage, commercialization, resources, geosciences, conservation, medical geology, geo-tourism, geo-sustainability, Nigeria

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I. Introduction

Nigeria's geomorphology apex body, the Geological Survey Agency, which was established in 1919, was to provide a baseline of the country's geological endowment for exploitation and management of resources to contribute to the economy and welfare (Olujobi & Irumekehai, 2024). Several works on the rocks, sediments, minerals, structures, fossil fuels, and geodynamics have been completed in Nigeria since then. However, while previous work in conservation and geoheritage assesses the economic aspect as well as the educational or scientific potential, features that contain the cultural, aesthetic, and historical interpretations of Nigeria that are developed at local, regional, and national levels and distinct from similar sites worldwide have been examined (Nguno & Schneider, 2023). The object of heritage is protected in a way that the character of the site is preserved while ensuring that alternative uses may take place within the overall, multi-dimensional values and the social responsibilities. Moreover, increasing public consciousness may contribute to their survival and to the strengthening of local to national economies via eco-tourism, interpretation, and education (Chijioke et al., 2024).

This review introduces Nigerian geo-heritage and medical geology resources and to what extent and by what strategies they have been promoted. The two (2) main goals are as follows:

(i) an analysis of the ways and methods that have been developed and are being used to identify the unique sites, resources, and phenomena for conservation and domestic application by communities; and (ii) a review of the driving factors of the initiatives for the commercialization of the resources. It is suggested that apart from involving locales and major stakeholders in the entrepreneurship and conservation of these non-marketable natural endowments with direct and indirect benefits in finance, health, religion, culture, aesthetics, etc., scholars of different dimensions should interface in practical and other research collaborations with governments to evolve dynamic policies with inbuilt transparency, safety, and security cover in the industrial, engineering, and tourism applications of these resources (Matshusa & Leonard, 2024).

Geo-Heritage and Medical Geology: Concepts and Significance

Given the renewed impetus for mineral resource exploitation in Nigeria, there is a critical need to leverage the vast potential of the country's geo-heritage and medical geology resources (Finkelman et al., 2024). Geo-heritage encompasses Earth materials, landforms, and geological sites that offer scientific, historical, and cultural insights into planetary processes, while medical geology investigates the links between geological environments and human health (Li et al., 2023). These concepts have gained global prominence through scientific conferences and the establishment of national geoparks across three continents since the 19th century. Geo-heritage, in particular, includes geological features with intrinsic aesthetic, educational, and socio-cultural value, each evaluated for conservation based on its unique merits (Li & Wu, 2022). Medical geology serves as a public health framework, addressing how communities interact with hazardous or beneficial geological archives, such as mineral-rich soils including metals or toxic groundwater (Finkelman et al., 2024). Its integration into national policies aligns with global sustainability strategies to mitigate health risks and enhance environmental safety. As a communal science, medical geology also prioritizes equitable strategies for using geo-resources to improve public health outcomes in both developed and underdeveloped regions (Prashanth & Verma, 2022).

Geological Resources of Nigeria

Nigeria is blessed with diverse geological resources ranging from raw materials, such as water, clays, sands, and gravels; rocks, such as gemstones, minerals, ores, and hydrocarbons; low and medium grades of metamorphites, including fossils, petrified wood, and unconsolidated loose materials, to textural and structural geological wonders of cave formations, fairyland topography, spectacular outcrop scenery, natural stone formations, and karst landforms (Olaekan et al., 2024). These geo-resources are also referred to as the geological heritage, geo-heritage, or geo-sites. The unique geological features of Nigeria are distributed all over the country with varying characteristics. The rocks and mineral occurrences are spread across sixteen regions of the eight geological terrains, while the geomorphological heritage occurs throughout the twenty-four (24) environmental units in Nigeria (Jekayinfa et al., 2023). The smoky quartz geode in Julle, Plateau State, is the largest in the world. Nigeria is also reputed to have the largest deposit of bitumen in the world, estimated at 42 billion tonnes (Anupam et al., 2023).

These diverse geological heritages are valuable for educational, academic, and scientific studies; domestic and international tourist attractions; reference materials for research and study in the Earth sciences for qualitative understanding, appreciation, and utilization in the aspects of geology; speleology; mining and mineral processing; petrology and petroleum geochemistry; structural, tectonic, ore, engineering geology; physical and applied geology; environmental geochemistry, climate, and geo-stat domain studies. In addition to their economic importance, most of these geo-resources have local significance and are valuable for the environmental, cultural, and historical benefits of adjoining communities (Shaw and Mazumder, 2024). There are diverse challenges that may impede the exploitation and utilization of geological resources. First, there is the challenge of attaining a balance in the exploration and exploitation of these natural resources, which must be effectively managed, on the one hand, to prevent environmental degradation and defacement of the geological resources with potential value. The multiplicity of interwoven challenges, including those associated with the demands for increased consumption, tourism potential, economic and mass employment, technological and aesthetic appeals for these geo-resources, makes their planning and effective management imperative. In recent times, geological sites have developed into an important aspect of human-environment interaction and benefit, thereby championing their study and conservation in terms of sustainable management with a focus on benefits realization from the numerous activities that are sustainable and profitable while reducing risks such as geotomic, conservation, negative, and industrial hazards (Yi et al., 2023).

Identification Techniques for Geo-Heritage and Medical Geology Resources

Data to be used are generated through four main methods. The first method involves field-based analysis of the rocks and other components of Nigerian geology, while the second involves the analysis of existing satellite imagery acquired by remote sensing methods. The third method involves the collection of geophysical data through geophysical techniques, and the fourth method involves the acquisition of information through sound management tools such as the Global Positioning System (Errami & Elkaichi, 2024). Field-based methods have been consolidated, and they include field geological mapping, sampling/mapping, facies modification, and intensity of field variation studies. Remote sensing and geophysical tools were assimilated in identifying promising locations. Local knowledge was utilized in the data collection method to ensure participation and ownership of the impacted paths.

A combination of field techniques, such as geophysical methods and sampling, identified promising areas for the discovery of geo-heritage and medical geology resources in the Biu Plateau, covering an area of 12,221.25 km², with geological sightings using digital terrain elevation models (Oyelami et al., 2023). The land free from tectonic activity was determined by amplitude spectra modeled to identify free land in the study area. Similar successes were recorded in the medical geology of fluorspar in Keffi. Integrative methodologies between

geologists, conservation biologists, and health professionals were utilized by collecting geological and other attributes of public health records. The medical data collection inquired about farmers required to have been living or lived in the study area for at least 20 years and explained health practices in the specific area.

The field and mapping techniques identified possible health issues and other components of the resources. Integration of multidisciplinary functions for proper health and cultural sanitary land use planning in the study area was applied. As the multidisciplinary team requires wide multidisciplinary acquisition and assimilation, this work on resource identification forms part of the first planning and organizing steps of others to come. The next task is to carry out massive enlightenment and advocacy to the population living in the impact zone, as well as researchers and organizations or individuals desiring additional knowledge on identifications. Identifications are anchored on the collection and analysis of field data, existing information, the acquisition of new data, and a multidisciplinary approach for the findings (Louz et al., 2022). A Geographical Information System is utilized to collect base data on existing landforms and water bodies. Collecting base data is important to develop a database for the analysis of water bodies, hydrology, hydrogeology, hydrography and geology of the study area and resultant effects on geo-health resources to be identified. The physiography of the study area with prominent landforms like the Mandara Hills, which are fertile, providing the assurance of data to fix population and water demands. The implication of the findings is that identification involves multifaceted activities that require the cooperation and coordination of responsible bodies and individuals. Longitude and latitude, indicating and mapping zone numbers from GPS, were generated and overlaid by remote sensing applications.

Commercialization Strategies and Opportunities

Common commercialization models for Nigerian geo-heritage and medical geology resources include, but are not limited to, the following: I) Tourism – site visits (Ogbunike Cave, Anambra State, Olumo Rock, Abeokuta, Ogun state, Oguta lake, in Imo State, Osun-Oshogbo Sacred groove, in Osun State, Erin Ijesha Water falls, Osun State, Ikogosi warm spring, Ekiti State, Manbilla hills, in Plateau State, Gurara falls, Niger State, Gashaka-Gumti National park, Taraba State, Yankari Games reserves, Bauchi, Obudu cattle Ranch, Cross Rivers State) education, and improved local transportation are prerequisites, with hospitality and other services being part of the package;

II) Education – an excellent differentiator; also branded rehabilitation and youth development; III) Related health services – e.g., relaxation, resort spot, social support, and disability therapy following increasingly frequent sports-related injuries; IV) Health – a tourist attraction for medical tourism; V) Tourism (history, anthropology, ethnography, etc.); VI) Income – e.g., from long-term data collection; pioneering new products or services (Fitriaty et al., 2024). However, it is vital to understand how the market/business for these resources and services will work. What business model will be adopted? Who are the main players and what do they require? Who will be the customers, consumers and clientele? How much will they be willing to pay on average? And how frequently can they be expected to pay? (Das & Behera, 2024)

In Nigeria, opportunities are present for the public and private sectors to collaborate on infrastructure development for resource utilization. The availability of medical and allied institutions in several states in Nigeria provides opportunities for their inclusion in conventional medical curricula, both at undergraduate and postgraduate levels. Also, 'Health geosciences' and 'Environmental Health' are professional development areas for practicing physicians, and Nigeria is replete with exploited pans and salt lakes that can be modified for the purpose of this sub-discipline of geology (Ogundele, 2024). To exploit the above opportunities, each subgroup in Nigeria's scientific, professional, government policy, and some NGOs have roles to play. This must involve applying respect to the local community by researching the geo-resources concerned, what would be the economic returns thereof, and how these would be balanced. This is in view because the process requires 'community support and contribution.' This can only be so if such research is shared, both by way of dissemination of information and consultation, particularly feedback and stakeholders' feelings. Ownership of the geo-heritage and other resources determines the kind of commercialization that can be embarked upon. A win-win situation should be developed from which all needs, lobbies, interests, and benefits would be addressed (Ngare et al., 2024).

The marketing strategies available for Nigerian geo-resource commercialization include, but are not limited to, the following: i) Branding of Nigeria's geo-heritage for Nigerians: streams of revenue will be generated in the fields of tourism, education, health, and income generation; ii) Branding of Nigeria's health resources for the rest of the world: the health resources could include things like springs rich in sulfur or other thermal attributes, electrolyte or mineral density, non-communicable diseases and health conditions, and the environment and potential diseases that are prevalent there; iii) Branding of medical tourism resources: a few of these could include recreational healing/mineral baths, balneotherapy, spa health facilities, physical treatment/preventive therapy, environmental health services, health mines, etc. The commercialization business opportunity that Nigeria's geo-heritage and health afford is premised on non-financial returns, i.e., building a

brand image for the country as a tourist destination, which can be found in tourism, education, income streams, services or goods provided; training opportunities in Nigeria tailored for international tertiary students or researchers, traditional disease research market; and income opportunities, including research revenue (McLeod et al., 2022).

Challenges and Constraints in Commercializing Geo-Heritage and Medical Geology Resources

A lot of bottlenecks hinder the commercial reliance on the potentials of Nigeria's geo-heritage and medical geology resources. They range from the departmental to the ministerial, involving a plethora of documents for release and end-user/handler vocational certificates that can be secured only from the various parastatal agencies (Thomsen et al., 2023). The commercial promotion of Nigeria's geo-heritage endowment is a 'no-go' area until investors in this sector see a National Geo-conservation, Nationwide Eco-cultural, and National Geo-Park scheme approved by the government. Regulatory approvals may need to be in place at the states for projects that are already underway if they are to attract investment and go forward.

The most immediate need is likely to be technical assistance with zoning, identifying suitable geographies, geosites, and geoparks, and securing the approvals for the first sites to be funded and become operational. Poor infrastructure and inadequate funding have been identified as the major impediments to the effective generation of mineral resources and the development of high-technology metals that can influence the world market in favor of Nigeria. Other challenges include problems relating to inadequate technology for value addition and a strong legislative policy for the development and commercialization of our minerals for both economic and potential health benefits (Ayad and Hafez, 2023).

The conditions of the environment are also very important in the commercialization of Nigeria's geo-heritage and medical geology resources. The activities required for the commercialization of geology resources can contribute to environmental degradation that confronts the subsequent exploitation of the mineral resource. The terrestrial global community has been unable to contain the widespread challenges and constraints faced within the areas of geo-conservation and medical geology. The most fundamental problem facing commercial ventures related to the exploitation of geo-heritage resources is simply one of good governance. At a fundamental level, national laws and policies now need to be revised to incorporate the principles of geo-heritage conservation for future generations.

In order to become commercially viable, geoparks need to develop management policies to protect their sustainable development from threats from within and outside the community. One of the first challenges of establishing a geopark is to develop the support of the local community. Initial resistance to the idea of a geopark is a common response by communities. To address this, it is suggested that there is a need for strong outlet services for mass media, educational programs, and educators who can communicate the fact that a geopark brings significant social, cultural, and economic benefits. National laws and policies need to incorporate new measures, procedures, and concepts needed to properly use and exploit geo-heritage resources and medical geology potentials for national development. Additionally, programs need to be developed to inform the people and indigenous communities in areas of geo-heritage endowment and other Nigerians of the commercially viable economic potentials of geo-heritages and inculcate in them the need to conserve them. The development of Nigeria's geology and any future economic indexes must be based on race-against-time strategies, as with the strides Nigeria's population is currently growing, the preservation of the country's virtually held geo-heritage is of utmost importance in a competitive global village.

Case Studies of Successful Commercialization Initiatives

Over the past decade, several case studies of successful commercialization initiatives of geo-heritage were documented. Each of them can be called unique commercial initiatives in their strategy and tactics of implementation: the promotion principles and instruments of the geological heritage market, integrated approaches to marketing, the level of accountability of the subjects of commercialization, the historical context and landscape peculiarities, the regional and local importance of the mineral and floral resources, the specificity of the intended target markets, as well as the subject, etc. (Zhuang et al., 2024). In all cases, to solve all these elements, the general principle of cooperation between the authorities, entrepreneurs, non-governmental organizations, and scientists was used. First of all, the emphasis has always been on establishing long-term partnerships and cooperation among key stakeholders.

The successful development of any landmark is the result of clear local government support, which should be based on business plans or development strategies (Pantazopoulou et al., 2024). Over the years, most local leaders have increasingly accepted the need for a more multi-faceted approach to local economic development, encapsulated by the concept of a multifunctional landscape. In several countries, communities have become increasingly aware of their local geo-diversity and the need to manage and interpret this resource to a wider public. In each case, different solutions have been found to establish long-term partnerships for the growth and promotion of the minerals heritage resource.

The key aspect of any major developments of mineral or semi-mineral based food and health compound production will be the recognition and integration of the local cultural aspects, and, at the same time,

an appropriate partner to match with the project goals (La et al., 2024). Indeed, the culinary and wine heritage can be the added value of the local development strategy. The effective formal protection of the site is also important. In most case studies, the main task was the formulation of the market supply technique: demonstrative marketing. To assure understanding of it as a complex social system, it was essential to identify and define not only the oriented individuals but also the stakeholders in wildlife. Therefore, there are five directions of the commercial proposition: tourism, education, research, manufacturing and medicine. Each individual who was ready to pay for the service or product in these five directions is a stakeholder in the market royalty.

Policy Frameworks and Regulations for Sustainable Commercialization

The policy framework that will support the commercialization of geo-heritage and medical geology resources in Nigeria has not been made available. However, there are some national parks and recognized communities that have been put in place in Nigeria. The structures of these policy frameworks are neither appropriate in terms of their legal effectiveness nor are they guided towards sustainable conservation and exploitation of the resources. Besides, the policy frameworks have not been well-coordinated at the national, regional, and local authorities according to their competences (La et al., 2024). The concept of regional, local, and national policy coordination is required to make all the stakeholders have a similar understanding of the prudent use of the identified natural potentials in the region for the benefit of the international community on one hand, and the host communities on the other. Hence, policy formulation needs to accommodate natural resources conservation with economic development (Yıldız, 2023).

Recommendable regulatory standards to be put in place to ensure that both the geo-heritage and medical geology resources are well managed can be summarized to include: free prior and informed consent; ecological impact assessment; stakeholders' benefit sharing from the exploitation of the geo-heritage and medical geology resources; international stakeholders' consultation for any development that will impact international communities; maintaining water quality; and global geo-heritage recognition compliance (Fang et al., 2024). In adding value, the proliferation of quarries needs to be regulated; a condensed mineral approval process and sharing; monetary values put on national raw tonnage material; decreasing the raw numbers of materials that go through the infrastructure means that need further permission; and informing the archaeological community around the world. Because of the collaborative use of the natural resources, there is a need for a sustainable and inclusive policy frame of reference. Some best practices are recommended for Nigeria to adopt to create an enabling environment for national and international stakeholders to exploit these resources for the economic development of the sector. Specifically relevant to the synergies in Nigeria are the development of sustainable policies and programs and identifying appropriate stakeholders' need-based approaches (Thomsen et al., 2023).

Regulatory standards do not align with principles of international best practices such as resource efficiency and accountability, among others. This deficiency can promote the emergence of parallel economic activities that are not officially recognized, controlled, or protected in the regulatory environment (Qamruzzaman & Karim, 2024). This situation can diminish the competitiveness of the sector at international levels because such a lack of control on the registration of general effluent quality can affect the national measurement of the sector. Enforcement of the sustainable commercialization of the identified resources is a very important element in the policy frameworks. Enforcement strategies need to adapt to the dynamic nature of the resource rather than developing regulations that can be perceived as impractical. In addition, strong regulations in most cases may not sit well with the exploitation of the resource where little benefit can be seen going back to the local community. Policy measures need to be designed in such a way that they do not stagnate the dynamics of the interactions at the expense of other evolutionary or alternative forms of management. Therefore, policies need to be developed by taking into account the needs and wishes of the area and adjusting the strategies and actions to the reality of the exploitation. Hence, policies and efforts towards the commercialization of the identified resources need to be geared towards inter-institutional coordination, information policy, community education, and stakeholder consultation (Khan & Emon, 2024).

Community Engagement and Stakeholder Involvement

Community engagement and stakeholder involvement at the community level will ensure that existing endowment in geo-heritage is identified and effectively harnessed, while the involvement of stakeholders at the policy and regulation level with respect to available medical geology resources will ensure effective identification and utilization of these resources (Bentivenga et al., 2024). Efforts made in guiding engagement in resource utilization among the Zambian communities, from a radical standpoint, are instructive in understanding the importance of community participation and stakeholder engagement in natural resource management, emanating from the need to build mutual relationships between communities, government bodies, and the private sector.

Building citizenship through sustainable natural resource management can only be possible when there is transparency, accountability, inclusive growth, and capacity building (Chan & Talib, 2023). However, milestones and tangible goals are necessary in order to ensure that assets are created in tangible and intangible skills among the stakeholders involved, particularly the community. Effective community participation in the natural resource value creation process would require ongoing capacity building and a positive change in attitudes by all involved. Initiatives such as devolving the collection of national park fees to local community committees can lead to beneficial local-global linkages that will help in modeling the creation of community eco-cottages that would radiate from tourist enclaves (Jeon et al., 2023).

Ethical Considerations in the Commercialization of Geo-Heritage and Medical Geology Resources

In commercializing geo-heritage and medical geology resources, respecting the principle of good ethical conduct is of paramount importance. To respect good ethical conduct, we must consider the following issues: (1) the right of indigenes with reference to their cultural heritage, in which these landscapes represent significant elements; (2) the question of ownership, evaluation, and intellectual property rights of an individual who discovers a new use, and the local community that may hold historical knowledge about them; and (3) the potential impact (positive or negative) related to commercialization (Adaga et al., 2024). The specific issue regarding what is ethical, in addition to the assurance of benefits for all parties involved, is equitable profit sharing among indigenes, discoveries or intellectual property rights that may emerge, industrial partners, and organizations, especially in the area of genetics, the so-called shared benefits (Patel, 2024).

The commercialization of georesources also has its downside; it can bring about social impacts, which can sometimes lead to increasing investors' interests, higher land and property values, and rising housing costs, which in turn can force people out of their traditional homes and lands. If it is a consideration in the management of cultural landscapes, it becomes consistent with medical geology as part of the geodiversity and geo-heritage of a nation, which can motivate the protection and conservation of the environment from the perspective of the health of the people living there (Liu et al., 2024). Within the backdrop of competing interests inherent in any valuation of geoheritage, the commercialization of georesources can be seen not only as an economic boom but also as an ethical parchment, beckoning decision-making by managers, officials, and society at large who are caught in the crosshairs of selective preservation and secular development. Such value-based dilemmas warrant the evolution of an ethical framework of distinctive criteria that may well be employed worldwide to eventually inform management and decision-making. Ethical guidelines leading to processes of commercialization or large-scale tourism could include the elements of respect, mutual benefit, fairness, justice, respect for human rights, and due diligence (Hu et al., 2024).

All decisions to proceed toward partnership agreements involve a significant amount of judgment called 'ethics.' Foreign partners, governments, and regulators are guided in relation to such judgment by a number of principles, conventions, norms, laws, environmental regulations, codes of human rights, and the conduct of human rights (Stahl & Eke, 2024). However, it would seem that new guidelines are needed, which would include respect for human rights principles, ethical principles, parallel principles between environment and human health, and norms around due diligence tests on the governing framework adopted in relation to tourism and economic development of resources. It is believed that, especially, developed ethical frameworks around equitably dealing with the incomes from the sale of diseased georesources will contribute to ethical capitalism and the balanced pursuit of the interests of participating countries. Such ethical 'balances' will not only inform the internal ethics of company actions and strategic considerations but will also lead to increased capital of trust from foreign community partners, and the developed ethical frameworks are more likely to lead to responsible sustainable economic development that would maximize profit (Challoumis, 2024).

Future Prospects and Emerging Trends

In the future, geotourism, eco-tourism, and conservation are projected to continue to receive more attention both in Nigeria and at the global level. This implies that both local and international policymakers and development agencies are expected to continue to invest more in these concepts. It is expected that new countries, such as Nigeria, will come to take part in the sustainable management of geotourist attractions; as a result, the broader benefits of attentive management of geotourism are expected to reach a wider audience (Matshusa & Leonard, 2024). Additionally, continuously changing clusters of expenditures and consumer

interests are also expected to draw increasing attention to a consumer base increasingly interested in geotourism (Kareem-Onagun, 2023).

Nigeria shares with many countries a burgeoning and important potential as a commercial producer and supplier of geo-heritage and medical geology resources. Furthermore, Nigeria is a significant tourist and eco-tourist destination, and geotourism presents unique opportunities that will increase in importance as modern civilization creates more specific environmental atonements in society's consumer base (Imoagene and Ayo-Odifiri, 2024). These changes in clusters of expenditures linked to consumer interests and demand patterns are expected to influence the development of geotourism and eco-tourism significantly in the future. Collectively, these suggest a very promising future with few to no constraints for a greater number of countries that will come to manage geotourist attractions responsibly (Agboola et al., 2023).

II. Conclusion and Recommendations

A new evaluation of Nigeria's rich geological resources has led to the discovery of several significant resources that are vital for their potential exploitation. This fresh approach to resource management and commercialization emphasizes an integrated resource utilization strategy, recognizing the interconnections and synergies between economic well-being, environmental health, and social prosperity. The recommendations for key stakeholders are as follows:

1. Recognize and appreciate Nigeria's geological assets by comprehending their scientific significance and determining the value and applicability of these resources within the global market.
2. Formulate a legislative framework that acknowledges and endorses the importance of integrated resource identification and utilization, incorporating mechanisms to ensure resource sustainability, equitable resource valuation, ethical commercialization, broader benefits, and communal advantages.
3. Strategically address challenges arising from the exploitation of geological resources, involving all societal levels, from local communities to the government.
4. Allocate government educational and research funding towards understanding and advancing our geological landscape.
5. Assess the practical aspects of geological commercialization by responding to questions regarding which resources to commercialize, the appropriate scale for this, and how to manage development and exploitation effectively.
6. Embrace environmentally sustainable commercialization processes that promote community development.
7. Leverage the diplomatic skills of Nigerian professionals to advance the development and utilization of the nation's geo-heritage and natural resources both domestically and internationally.

With a growing interest in sustainability and ethical business practices, the overlap with commercialization as outlined above presents increasing potential. Continuous research and education, such as establishing an endowment chair to support geological research in Nigeria, can elevate the country's geological profile on national and international stages. Successful implementation of these recommendations hinges on fostering a sense of ownership in geological resource commercialization. All stakeholders—ranging from urban and rural communities to professional industrial partners—must perceive this process as beneficial beyond individual interests. Cooperative efforts among all parties, including the mineral industry, government, and local communities, are crucial for generating and disseminating knowledge that will lead to a thriving geotourism sector in Nigeria.

The future geotourism industry aims to operate sustainably and ethically where viable. The wonder found in a stone, the narrative inscribed in the earth, its abundance or scarcity, and its beneficial commercial potential sows that these elements persist. Our challenge is to embrace commercialization with wisdom and responsibility.

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