

Geoeducation and Geoculture: Concepts, Characteristics, and Contributions to Geoconservation in Brazil



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Abstract Geodiversity is notable for the diversity of the abiotic factors that compose it and for its importance for the occurrence and maintenance of natural and ecosystem processes fundamental to life on planet Earth. Considering the socio-economic risks of degradation, the need to develop projects, activities, and actions for (geo)conservation is peremptory. In this context, this work aims to present concepts, characteristics, and contributions of geoeducation and geoculture, strategies aimed at the knowledge, appreciation, and application of geoconservation. Methodologically, the research was based on a qualitative approach, with descriptive purposes; segmented in a careful and systematic bibliographic survey, readings and analysis of the theoretical framework, and several field surveys. As results are presented conceptualizations, assumptions, parameters, and bases are characteristics that substantiate possible contributions through their applications. It is expected that these strategies are consolidated and effective, contributing to the expansion of knowledge, appreciation, and conservation of geodiversity in various contexts and scales.

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1 Introduction

Geodiversity is notable for the heterogeneity of the abiotic factors that compose it, having in geology its basic aspects, including mineralogy, petrography, stratigraphy, and paleontology, among other branches. Derived from and intrinsically related to the geological elements are other abiotic factors, namely: geomorphology with its forms and processes, compartmentalized and classifiable through the geographical concept of scale; pedology, whose characteristics are directly derived from rocks and may have in the elements time and climate considerable means of classification and analysis; and hydrology, compartmentalized, finally, by segmentation between surface water and groundwater.

Despite such diversity and its importance for the occurrence and maintenance of natural and ecosystem processes, fundamental to life on the planet, geodiversity, as a scientific, educational, and/or heritage object, and considering the socio-economic risks of its degradation, demands more studies about its genesis, evolution, and interrelationships, with biodiversity, for example, as indicated by Uceda (1996; 2000), Erikstad (2014), Crofts (2014), Liccardo and Piekarz (2017), or with culture (Delphim 2009; Ruchkys and Machado 2010; Alvarenga et al. 2018; Lima and Carvalho 2020); besides generalizations and regional and local particularities, among other aspects.

In this context, it is peremptory the need that such studies may consider, approach, and/or reach, whenever possible, directly or indirectly, the nearby localities, where elements of geodiversity are even more remarkable, the geological sites or geosites. When referring to “localities” it refers, also and necessarily, to people (or communities, encompassing people and places) living in these places, who need to understand the importance, care, and participate in the management of these geosites, which, in turn, are assets that belong to them, in the most different ways—materially, historically and culturally, for example, among other aspects.

But how can this happen? Through geoconservation, can be understood as a set of activities designed and developed for the conservation of geodiversity (Brilha 2005) and all its aspects. In the set of geoconservationist activities, there are geotourism, geoeducation, and geoculture.

The first branch is more widely discussed, developed, and applied (Hose 1995; 2000; Moreira 2011; Ollier 2012; Urquí 2012; Arouca Declaration 2011; Dowling 2013; Guimarães et al. 2017; Liccardo and Piekarz 2017), the second and third branches are in process of theoretical and applied construction, being thought and directed to an essential public to any geoconservation proposal: the student public, the communities close to the geosites and, also, the various actors associated with these segments.

In this context, this manuscript aims to present concepts, characteristics, and contributions of geoeducation and geoculture, strategies aimed at the knowledge, appreciation, and application of geoconservation, especially in Brazil.

In the country, the geoconservation strategies have been developed on several fronts, to mention the geoeducation and geotourism strategies, through independent

actions and/or from the geopark territories, in the Project, Aspirant, and UNESCO Global Geopark (UGGp) levels, to mention the until then, the only one belonging to the International Geosciences and Geoparks Programme (IGGP), the Araripe UGGp.

It is also important to highlight that in November 2021 two projects of aspiring geoparks received the visit of UNESCO evaluators, in the search for the entrance to the IGGP, they were, the Caminhos dos Cânions do Sul aspiring UGGp (aUGGp), with 07 municipalities distributed in the states of Santa Catarina and Rio Grande do Sul, and the Seridó aUGGp, territory composed by 06 municipalities, in the state of Rio Grande do Norte -, respectively in the south and northeast regions of the country. In this sense, the visit of the evaluators is a decisive step for the approval of these territories and with this, it is expected that, soon, the country may have two more Geoparks in the program, thus strengthening the Brazilian geoconservation. In sixth statutory meeting held online between the 8th and 11th of December 2021, the UNESCO Global Geoparks Council proposed to forward the nomination of 8 new UNESCO Global Geoparks to the Executive Board of UNESCO, for its endorsement during the 2022 Spring session. Of these 8 are on the Caminhos dos Cânions do Sul and Seridó aUGGp list.

Still with regard to geoconservation in the country, a recent and unprecedented publication in the scope of Environmental Law, entitled, “New Directions in Environmental Law: a look at Geodiversity”, presented to society and the academic community, through 24 chapters, geoconservation experiences in various territories of Brazil and other countries in South America and Europe (Sousa-Fernandes et al. 2021).

In the publication Guimarães et al. (2021) presented, for example, a discussion about the geoconservation, highlighting three examples carried out in the country: the strategies developed in the Araripe UGGp, the geoeducation projects applied in formal and non-formal spaces through the extensionist activities linked to Higher Education Institutions and the initiatives taken based on the current legislation, through tombamentos, which have been carried out in the state of Paraná. According to the authors, until December 2019, six geosites were declared protected, two of geological interest, three paleontological, and one geomorphological, namely the Witmarsum Glacial Striae—given its didactic, scientific, and cultural values, in the district of Witmarsum—Palmeira/PR.

2 Methodological Roadmap

Seeking to achieve this objective, the nature of the research was based on a qualitative approach which, according to Gil (1996), aims at the understanding or interpretation of processes in a complex and contextualized manner and is characterized as an open and flexible plan, with descriptive purposes.

Regarding the research techniques, the methodological procedures used were based initially on a careful and systematic bibliographic survey. At this stage, we investigated materials published in relevant national and international journals,

books, and legal titles in force in Brazil and in Ceará, with a survey of the main theoretical and methodological references.

In the bibliographical survey specific consultation was made to journals in the areas of Geosciences, Geography, and Environmental Sciences, mainly, while most of the materials are available on the Google Scholar, SciELO, and CAPES Periodicals platforms. The Brazilian Digital Library of Theses and Dissertations (BDTD-IBICT) was also consulted.

The conceptual framework and the theoretical and methodological framework learned were problematized under different realities and natural contexts of geodiversity, from the realization of field surveys, made by the authors at different times and with different objectives about the natural and cultural heritage of European countries, cradle of the concept of geoparks, and especially in Brazil and its North-east region, with emphasis on the states of Ceará and Rio Grande do Norte, especially in the regions of Cariri cearense, Ibiapaba (south and northwest of Ceará), Seridó potiguar (RN), including also part of the southern coast of the state of Pernambuco.

The development of the methodological roadmap presented provided the preparation, discussion, and analysis of data and significant information for the scope and discussion of the results, presented in the sequence, in three interrelated topics.

3 The “1st C”: Concepts

Analytical focus of geoeducation and geoculture, from the conceptual point of view, geodiversity can be understood as the result of the interaction of several factors, such as rocks, climate, living beings, among others, enabling the appearance of distinct landscapes worldwide (Gray 2004; Brilha 2005), thus integrating geological diversity (minerals, rocks, fossils); geomorphological (landscapes, relief forms, and geoforms); pedological (regoliths, paleosols/fossil soils, current soils) and hydrological (surface and groundwater); (Moura-Fé et al. 2021a, b), in addition to the processes that originated them (Bétard et al. 2011) and currently shape them.

As scientific witness of the events that marked the evolutionary history of the Earth, the geodiversity should be conserved as a fundamental part of the natural heritage and used for scientific, educational, cultural, and geotourism purposes (Godoy et al. 2013). For this, it is important the classification of geological sites (geosites), is based on seven fundamental values: intrinsic, cultural, aesthetic, economic, functional, scientific, and didactic (Gray 2004; Nascimento et al. 2008; Mochiutti et al. 2012).

Despite its importance, however, it is known that geodiversity, as a representative of the Earth's abiotic elements, is impossible to be fully conserved, since society needs natural resources in their daily lives. However, there are elements that stand out in this larger scale, composed of all geodiversity (Guimarães 2016). In this sense, when evaluated and verified through appropriate methodologies, the superlative value of a certain element of the geodiversity, is classified as “Places of Geological Interest—LIGs” (Uceda 1996; García-Cortés and Urquí 2009) or geosites (Brilha 2005, 2016).

Due to the economic value, especially, there are many threats to geodiversity, in which the society is the main modifying and degrading agent (Gray 2005). In an attempt to reverse this vulnerability picture, strategies have been created aiming the conservation of the main elements of the geodiversity, or geoconservation, whose main objective is the conservation of geosites as basic units of the natural heritage, whose implementation requires the creation of a careful methodological systematization and divided into: specific inventory, evaluation (quantification and legal protection, as tombamento, registration or seal of cultural landscape), conservation, enhancement, dissemination and monitoring procedures (Brilha 2005; Lima 2008; Henriques et al. 2011).

Figure 1 presents the correlation between the concepts of heritage, natural heritage, and culture, their segments, with emphasis on geoconservation and their most widespread strategies and development.

One way to promote geoconservation, even if in several cases, it is not the central objective, is through the adoption of principles, objectives, strategies, and practices of Environmental Education (EE), despite its historical proximity with biodiversity (Reigota 2009) and the fact that EE is a field under construction of its theoretical and methodological aspects (Torres et al. 2014).

Understanding the EE as an important ally in environmental conservation, given its broad, significant, and diverse theoretical and methodological framework, analyzed more specifically in the next item, it was seen the possibility of working with its applicability in geodiversity, within more specific parameters and considering the intrinsic demands to geoconservation.

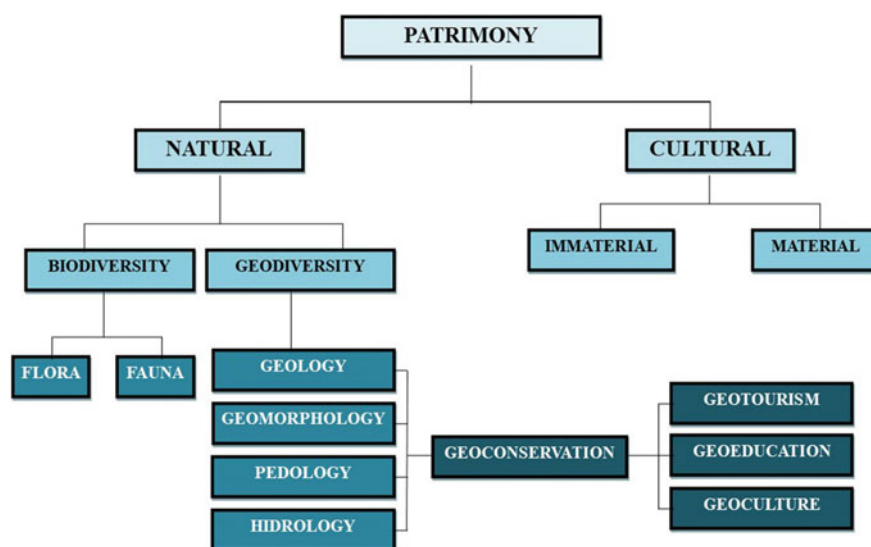


Fig. 1 Conceptual correlation between heritage, geodiversity, and geoconservation. Elaboration: Authors (2021)

Thus, Moura-Fé et al. (2016) proposed, considering the importance of geodiversity and the broad possibility of insertion of EE, the scientific concept of geoeducation, a geoconservationist strategy understood as a specific branch of Environmental Education to be applied in geoconservation of natural heritage, to be treated, fostered and developed in formal and/or non-formal education settings (Fig. 2) (Moura-Fé et al. 2017).

From then on, the geoeducation presented itself as a concept with methodological applicability in development, which can be applied in any place endowed with geodiversity, initially unbound from the compulsory nature of the curricula and school parameters, which brings the possibility of involving a larger audience, variable in age range, level of knowledge of environmental issues, in scope of approach, which may include primarily local aspects, among others.

For Zafeiropoulos et al. (2021), the Geoeducation can be understood as a broader component of environmental education, which aims to promote the geological

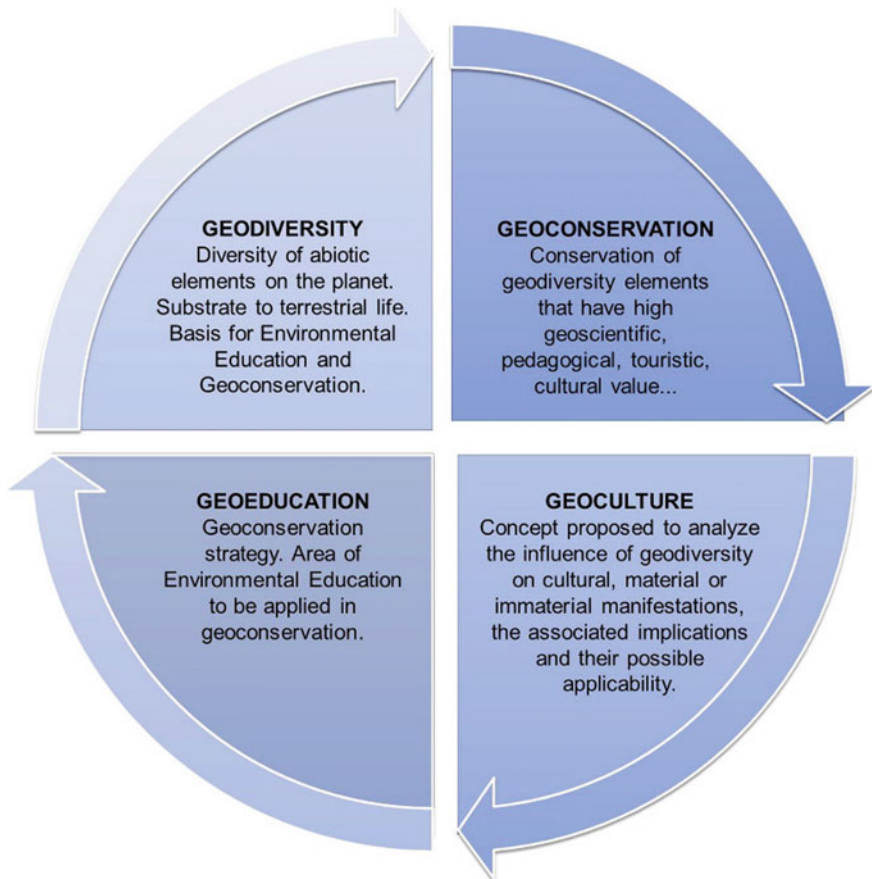


Fig. 2 Conceptual map with key concepts related to geoeducation. Elaboration: Authors (2021)

heritage of a place and its geoconservation. The authors point out that the initiatives aimed at the geological heritage protection since the 1970s and the strategies of Environmental Education, do not deepen or are directly aimed at the issues of geodiversity, geoheritage, and geoethics, for example. In this sense, the importance of promoting and encouraging the geoeducation, this yes, mainly focused on the abiotic elements of the planet, as well as its processes and dynamics. To this end, the aforementioned authors highlight the geotourism as an agent promoter of geoeducation and consequent geoconservation, through, among others, educational and recreational activities (Zafeiropoulos et al. 2021).

In turn, as a geoconservationist proposal with another scope and spectrum of approaches, geoculture was conceptualized as:

A scientific branch based on the geographic theoretical framework (in the concept of landscape and cultural geography), which should make the analysis of geodiversity and its segments: geoconservation, geotourism, and geoeducation, with emphasis on the influence that the rocks, minerals, fossils, reliefs, geofoms, and soils had and have on cultural manifestations, whether material or immaterial, the associated implications and their possible applicability (Moura-Fé et al. 2017, p. 3074).

Establishing an applicability essay, Silva and Moura-Fé (2018) present a script with indication of geoculture analysis categories, considering the cultural heritage (material and immaterial) and the geodiversity (geology, geomorphology, pedology, and hydrology), with a first stage of identification and inventory; a second stage of specific analysis of the relation between geodiversity and culture; presented in the territory of Araripe UGGp.

Pereira and Cunha (2021) indicate the importance of geotourism as a practice for the connection between the public of the geoheritage and the cultural heritage of a certain visited area, which can happen through geointerpretation strategies designed for the visiting public. Such interaction would still serve as a tool for education of the local population and tourists and for the dissemination of the Geosciences beyond the classrooms, preserving and managing, both the geoheritage and the associated cultural heritage.

4 The “2nd C”: Characteristics

The ideal support for geoeducation is in Environmental Education (EE) and its theoretical and methodological assumptions, developed by several researchers in recent decades; and in its already established legal bases (Moura-Fé et al. 2017), present in the current and associated legislation (Soares et al. 2018).

In general, the EA has as mission to form active citizens, presenting itself as a concrete possibility to be present in all spaces of coexistence, including geosites and surrounding communities, for example. Considering also the historically constructed goal of developing proposals by which society can maintain a relationship with the environment, a complex goal, but successful in several case studies throughout

the country, the EE presents itself as an educational process articulated, interdisciplinary, which seeks to promote social change, so eminently critical and innovative. In summary, it presents significant elements for the development of geoeducation.

The National Policy on Environmental Education (PNEA) (Brazil 1999) stands out as the main legal reference for EE throughout the country, which was defined by means of 7 (seven) lines of action (Loureiro 2010):

- (1) EE in formal education (build capacity of formal, supplementary, and vocational education systems);
- (2) Education in the environmental management process;
- (3) Conducting specific environmental education campaigns for natural resource users;
- (4) Cooperation with those who work in the media and with social communicators;
- (5) Articulation and integration of communities in favor of EE;
- (6) Intra- and inter-institutional articulation;
- (7) Creation of a network of centers specializing in AE, integrating universities, professional schools, and documentation centers, in all the states of the federation.

In turn, illustrating the important role of specific legal diplomas on broader scales (state and municipal), whose creation is part of PNEA (BRAZIL 1999; art. 16), was presented the State Plan for Environmental Education of the state of Ceará (PEACE) (Ceará 2011), a political-pedagogical instrument that presents guidelines, lines of action, objective and conceptions of EE, inserted in the National Environmental Policy, which is subdivided into 6 (six) subprograms (Nikokavouras and Matos 2012):

- (1) Capacity Building in Environmental Education;
- (2) Education in formal education;
- (3) EE and mechanisms for community articulation and mobilization;
- (4) EE and local natural resource management mechanisms;
- (5) AE, communication and art;
- (6) Study and research in Environmental Education.

It is worth mentioning that further studies may adopt the municipal sphere of legislation, expanding the scale of analysis and, therefore, being able to insert a larger contingent of local elements of geodiversity in the context of geoeducational proposals, an important aspect. The review of these parameters should also consider possible changes in the legal diplomas.

Moving on to the second branch addressed in this paper, a key concept for geoculture is that of landscape. The notion of landscape is already present in the memory of mankind even before the elaboration of the concept, whose embryonic idea already existed based on the observation of the environment. The idea linked to this concept, according to Maximiano (2004), seems to have emerged with Humboldt in the eighteenth century, who, in his analyses, started from the observation of vegetation to characterize the space, checking landscape differences of vegetation to apply an explanatory and comparative method (Wulf 2016).

Simply put, the concept of landscape, according to Castro (2007), is always linked to the visual language of the human being, i.e., to the sense of looking and identifying the elements that compose and are found in space. On the other hand, other authors, among them Ferrara (2012), deepen this concept by placing that the landscape is configured by what is beyond what the vision can reach, standing out for having a “semiotic” understood as a wider version of the visible, i.e., all the historical and cultural transformations that that particular location has undergone until today.

Geographic landscape, more specifically, was elaborated to address the set of natural and cultural forms associated with a given area, where the phenomena (or processes) that compose an area are not simply gathered but are associated and interdependent (Sauer 1998).

Thus, specifically regarding the anthropic and social dimension, the modification of a given area by society and its appropriation for its use are important for the occurrence of the succession of these landscapes as a succession of cultures. Thus, the natural landscape is submitted to a social transformation, the last and, in Sauer’s (1998) view, the most important factor.

This succession of landscapes seen as a succession of cultures, as well as the analysis of each of them, is a fundamental approach to think how nature, notably, geodiversity, has related to the cultural development of people, communities, and societies. That is, the concept of geographic landscape, by proposing the joint analysis between nature and cultural expressions of society, presents a consolidated theoretical basis that can be used for the development of geoculture (Moura-Fé et al. 2021a).

On the other hand, the Cultural Geography presents in its specific theoretical framework, the cultural approach to the relationship between nature and society, emphasizing and aiming to analyze the social marks printed in nature; allowing the counterposition of geoculture, which, in turn, is a form of analysis that seeks to propose ways to verify the influence of nature on culture, its elements and its material and immaterial manifestations (Moura-Fé et al. 2021a).

Thus, in short, the theoretical assumptions of cultural and landscape geography are the conceptual basis for the development of geoculture (Fig. 3).

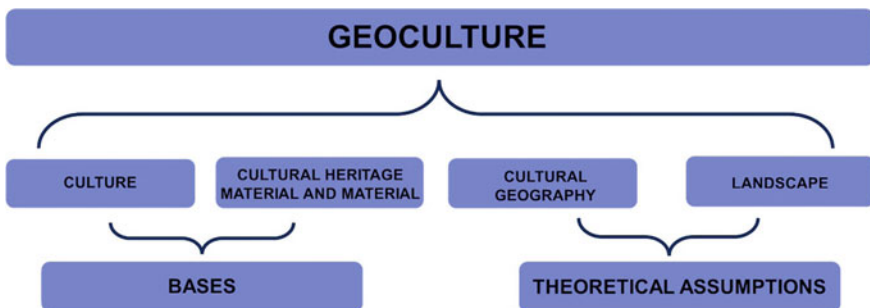


Fig. 3 Parameters, assumptions, and bases of Geoculture. Elaboration: Authors (2021)

5 The Final “C”: Contributions

Proposals of theoretical-methodological roadmaps for geoeducation (Moura-Fé et al. 2021b) and geoculture (Moura-Fé et al. 2021a) were elaborated and are being analyzed. While in this item, by way of disclosure and debate, general lines of them will be presented.

The theoretical-methodological roadmap of geoeducation, to be applied in formal and/or non-formal spaces, should take as a starting point, significant elements of local/regional geodiversity, i.e., geosites that can be identified, cultural and referential elements for the communities, regardless of whether they have national or international relevance.

Thus, considering the importance of geosites as starting points, it was decided to adopt the geoconservation strategies initially proposed by Uceda (2000) and then by Brilha (2005, 2016). Thus, the geoeducation itinerary should be preceded by (1) the geosites inventory, (2) the quantification (an important item, although not conditioning for the development of the other steps), (3) the legal protection or conservation and consider, finally, (4) the geosites conservation.

With the approach and development of these 04 (four) geoconservation strategies, there are conditions for the 5th and 6th stages, i.e., valuation and disclosure, in which geoeducation is included. This, which in turn, from what was raised and analyzed so far, is configured as geoconservationist strategy that can be developed, specifically, from the following steps: I—select the geosite; II—compartmentalize the geosite from the dimension of geodiversity and the respective category of analysis; III—make the analysis of the inventory of the geosite, including the information related to the possible realization of quantification, protection or tumbling and analysis of conservation (basic strategies of geoconservation); IV—define the scope of the Geoeducation Work Plan; and V—indicate the strategies of application of the Geoeducation Work Plan.

This theoretical and methodological proposal of geoeducation is composed of conceptual elements, guiding the proposition, and by an application proposal, to be developed in studies directed to specific areas, but that, a priori, can be thought of in the form of work plans, which, in turn, should consider the local and/or regional specificities of geodiversity.

In turn, the theoretical and methodological roadmap of geoculture, similar in its lines of development to the theoretical and methodological roadmap of geoeducation (Fig. 4), is based on specific parameters, assumptions, and bases, notably with regard to their inter-relationships and contributions to geoculture; should take as a starting point for its development the significant elements of local/regional geodiversity, i.e., the geosites that present themselves as identity, cultural, referential and/or symbolic elements for people, localities, communities, regardless of whether the geosites have national or international relevance from the scientific, aesthetic and/or economic point of view.

Thus, the geosites are the verification and analysis field of the term “geo”; and the term “culture” of the geoculture? The elements and cultural manifestations, whether

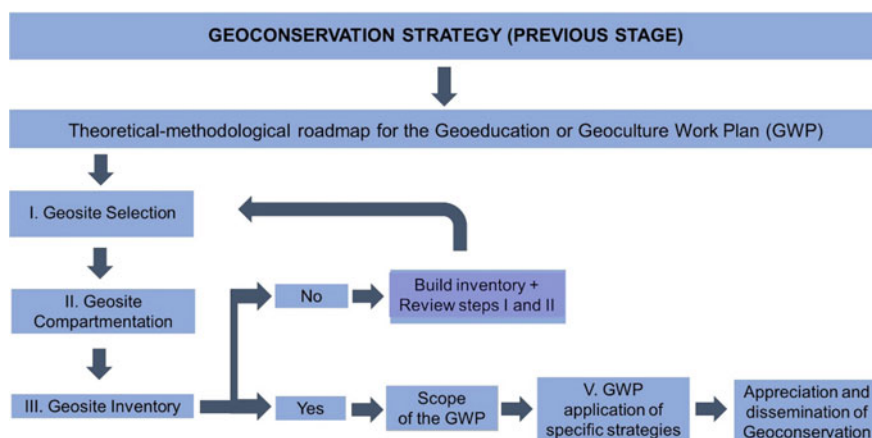


Fig. 4 Correlation of the stages of the Geoculture and Geoeducation theoretical-methodological guide

material and/or immaterial, will be emphasized in analyses made in communities and localities, directly and indirectly, associated, linked, referenced to/with the geosites and their different meanings, even if the people and their cultural manifestations do not recognize/present these places as “geosites”, where the geodiversity is the central element of their relations (Fig. 5). Moreover, such possible ignorance by the communities only justifies the gradual adoption of geoconservationist measures in their daily lives.

In a broader scale of analysis, the regions that encompass geosites and localities should also be considered and addressed, that is places and people, real or imaginary (legendary, mythological), making these relationships elements of their identities.

With the approach and development of the four geoconservation strategies mentioned above, there are conditions for the fifth and sixth steps, i.e., valuation and disclosure, in which geoculture is included, which, in turn, from what was raised and analyzed so far, is configured as a geoconservationist strategy that can be developed, specifically, from the following steps:

- I. Identify and select the geosite [with the verification of the respective associated locality(ies)].
- II. Characterize the geosite from the dimension of geodiversity and the respective category of analysis;
- III. Make the analysis of the geosite inventory, including information related to the possible realization of quantification, officinal protection and conservation analysis (basic geoconservation strategies);
- IV. Identify and characterize the forms of relationship between the elements of geodiversity of the geosite and the cultural heritage (material and/or immaterial), which will compose the scope of the Geoculture Work Plan (GWP);

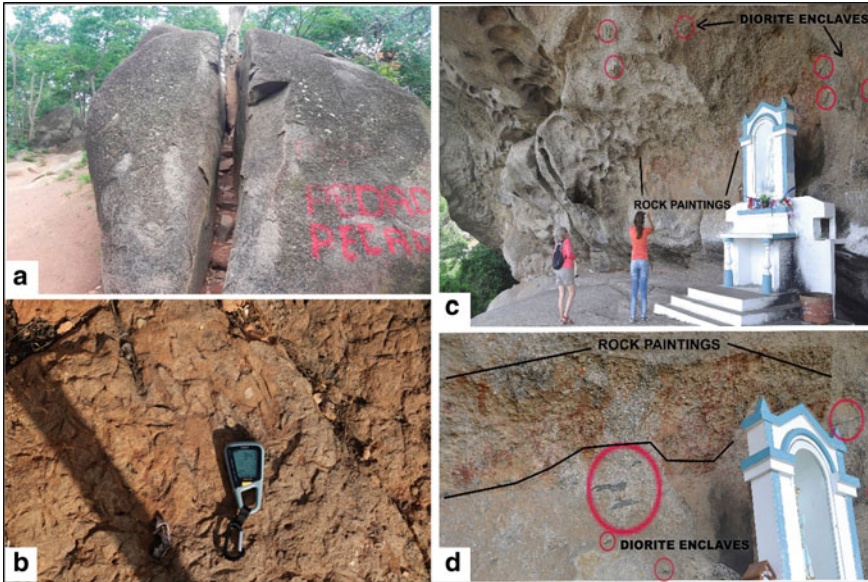


Fig. 5 **a** Stone of Sin. Thermoclasty acting on granite from the basement of the Araripe sedimentary basin, whose breach created by the natural process is culturally interpreted by religious devotees of Padre Cícero as proof of the absence of sin by those who pass by. Colina do Horto Geosite—GeoPark Araripe (Juazeiro do Norte/CE). Photo: Marcelo Moura Fé (Mar/2016). **b** Ichnofossils recorded in the silicified sandstones of the Mauriti Formation (Paleozoic age), formed in a lacustrine paleoenvironment and were interpreted by the population as bird tracks, which would have been embedded in the earth's mud after the waters of the biblical flood dried up. Cachoeira de Missão Velha Geosite—Araripe GeoPark (Missão Velha/CE). Photo: Marcelo Moura Fé (Nov/2019). **c–d** Pedra da Santa—Araruna/PB. Granite shelter with the occurrence of diorite enclaves and alveolar cavity, in the shelter there are cave paintings and there is a small sanctuary in honor of Our Lady of Fátima—in the place, geodiversity and religious tourism is mixed. Photo: Thaís Guimarães (Mar/2014)

- V. Elaborate the GWP with emphasis on strategies for the application of geoculture in localities/communities for the purposes of knowledge, appreciation, and application of geoconservation and, consequently, of local/regional cultural elements and manifestations.

The theoretical-methodological proposal of geoculture is composed of conceptual elements, guiding for the proposition, and by an application orientation, to be developed in studies directed to specific areas (geosites and localities/communities), but that, a priori, can be thought of in the form of work plans, which, in turn, should consider the local and/or regional specificities of geodiversity and, of course, of the localities, associated communities and their manifestations and specific cultural elements.

6 Final Considerations

The theoretical and methodological proposal of geoeducation, focused on the knowledge, appreciation, and application of geoconservation, gestated over the last years, presents itself as a geoconservationist strategy that can enhance the whole scope present in Environmental Education, directing it to the specificities of geodiversity, its dimensions and respective categories of analysis.

On the other hand, the theoretical and methodological proposal of geoculture, also developed over the last years, presents itself as an alternative for the consolidation of a geoconservationist strategy that seeks to identify, correlate and apply all (or, at least, part) of the diversity of relationships that occurs between geodiversity and the culture present in music, theater, poetry, constructions, sculptures, paintings, archaeological records, but still little captured under the geoscientific view.

What do they both have in common?

As it concerns the methodologies, notably as proposals, in general, the confrontation of these theoretical and methodological roadmaps (which consider theoretical and applicable elements, chosen from studies in various spaces of remarkable geodiversity and experiences of practical order) with the local realities and their respective and diverse specificities (the necessary clash between “theory versus reality”), to be made in more specific studies, should bring elements that can improve the proposals made and thus provide more consolidated forms for the preparation and effective implementation of work plans.

What do both have to offer to Brazilian geoconservation?

The expansion of debates and possibilities:

- (1) By bringing environmental education to the core of local geoconservationist demands, with more specific proposals that meet the scales of detail, thus expanding the possibilities of collaboration and contribution to the promotion of geoconservation in communities and localities of the country; and
- (2) In addition, by promoting the meeting of culture and geodiversity under a scientific analytical bias, it will also provide the inclusion of various fields of knowledge in the context of reflection, debate, and construction about the scope, importance, and relative urgency of taking geoscientific knowledge to as many spaces as possible.

It is hoped that, finally, the ideas and methods contained in Geoeducation and Geoculture may gain experiences and advances, so that on the “geodiversity table” new chairs are placed, that we have researchers and researchers from the most diverse backgrounds, and that, together, innovations and new contributions come, because the Brazilian geoconservation, in the most diverse places and contexts, needs and deserves.

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Dedicated to the memory and legacy of Professor Kenitiro Suguio.

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