Shahrood University of Technology

Journal of Mining and Environment (JME)

Journal homepage: www.jme.shahroodut.ac.ir

Iranian Society of Mining Engineering (IRSME)

Protection of Geological Heritage by a New Phenomenon in Earth Sciences: Geoconservation

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Article Info

Received 2 August 2023
Received in Revised form 7 September 2023
Accepted 25 September 2023
Published online 25 September 2023

DOI: 10.22044/jme.2023.13434.2478

Keywords

Geoconservation
Earth sciences
New phenomenon
Protection
Geological heritage

Abstract

Geosites and their contents including minerals, fossils, etc. can strongly represent the history of a region. They greatly help our understanding of the evolution of Earth, volcanic activities, plate tectonics, and the characteristics of different environments. These are some of the vital information about 4500 million years of the Earth's life, and are our common international heritage. Geoconservation's main purpose is the protection of geosites as major units of geoheritage, and this principle is achieved through the application of specific methods such as indexing geological phenomena, assessment, preservation, valuation, and estimating the importance of each geosite, as well as monitoring (or watching these phenomena). In this paper, geoconservation is introduced as a specialized and essential branch of geological science, which is currently under development. Therefore, geoconservation principles are presented here, and their relation to other geosciences is discussed. In addition, through scientific and cultural education related to sustainable development (in regard to the geoscience), citizens can be informed that lack of conserving natural resources would reduce geo-resources, and on the other hand, is a serious threat to geoheritage of the planet Earth. This crucial subject can be achieved by making information available and by teaching skills by which making prospective and correct decisions is possible.

1. Introduction

In most countries, managers of protected areas are primarily interested in biology [1]. This view of nature is not suitable for effective preservation. Geology is critical in all environmental planning and design projects because geology is part of the whole system of nature. Understanding of climate, landforms, and biodiversity is dependent on geological studies. In addition, nowadays, geoheritage is in danger of being destroyed due to the changing lifestyles of the people and industrialization of many countries. These changes are based on high rates of consumption of resources such as energy, materials, and soil, as well as increased production of tailings and waste [2]. This hypothetical
scenario supports the common opinion that "compared to all-natural erosion factors, we move and destroy more materials at ground level" [3]. In addition, the preservation of natural renewable resources (geoheritage of the Earth), for future generations, is the responsibility of each individual in the society, which must be accompanied by geoscience professionals who work in the field of geological knowledge. In this regard, two general ideas can be taken into consideration: First, the resource discovery methods should be improved so that they make their sustainable use possible and strengthened. In this case, geologists in cooperation with other professionals bear the responsibility of thinking and implementing technologies and more effective tools for the operation and extraction of resources [4, 5]. Secondly, fundamental changes

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in the rates of consumption by citizens must be made to mitigate common problems in an efficient society. For these ideas to come true, as UNESCO [6] has pointed out, education is one of the most effective organizations to bring about changes in knowledge, values, behavior, and lifestyles, and should provide stability to the country. Along with education, which is one of the most important organizations for training people to protect geosites, universities can hold significant training courses in this regard. Visiting protected geological sites, besides teaching students, can be very helpful. Also municipalities can change people's behavior and lifestyle in the direction of sustainable use of valuable geological resources by providing public education to citizens such as printing brochures, installing signboards, holding competitions, and direct and indirect training. The tourism organization should also try to prevent the destruction of geological tourism places with numerous advertisements, through radio and television, environmental advertisements, and education to tourists.

However, geoconservation and preservation of geoheritage has been proposed recently [7, 8, 9, 10, 11]. Geoconservation, in line with proper and efficient use of georesources, bears this new social responsibility, and is more focused on the management of preserving geological sectors in which scientifically, educationally, touristically or culturally they have extreme value. This valuable geoheritage is introduced and defined as geosites in geology. In these circumstances, geoconservation becomes important, and it is considered a necessary and developing science in geoscience. That is because, in the framework of this science, interesting geological phenomena will be preserved for future generations.

2. Research Methodology

Geosites and geological diversity that exists in each region should be protected and managed in different ways. This research work was presented based on a general plan by Murray Gray in 2005, which divided the geoconservation goals into eight elements of geological diversity, and addressed its various dimensions. This plan is presented based on rare and common occurrences and phenomena, because it is argued that geological diversity should be respected and protected inside and outside protected areas. This division, along with the author's field investigations, studies of surface geology and geomorphology, examination of the list of phenomena and diversity of geological heritage, examination of previous studies, and finally, finding the areas of education, with the interaction effect of geoconservation as a geological science, has led to the presentation of this research work.

3. Diversity of Geology, Geoheritage, and Protected Areas

People worldwide are becoming increasingly interested in prestigious geological sites characterized by pristine nature and predominant original cultures, and the significance of these heritage sites has been further heightened by the exciting history of the planet. Today, geoheritage sites are making a significant contribution to tourism development in some countries [12].

In geotourism, that its foundation is based on geological diversity, the identification, introduction, and evolution of amazing geological and geomorphological phenomena are addressed, and it is intended to convey scientific concepts of phenomena to tourists, systematic preservation of geoheritage, and achieving sustainable development. Nowadays, in many developed countries, geotourism enjoys a high position in GNP, and it has played an important role in national development. “Geodiversity” can be simply defined as ‘natural range (diversity) of geological features (rocks, minerals, and fossils), geomorphological (dry form, physical processes), and soil features. This definition includes their collections, their interrelationships, properties, interpretations, and systems [2]. In addition, one of the best definitions for geodiversity is provided by Stanley (2000) [13]: ‘geodiversity is a variety of geological environments, phenomena, and processes that make those landscapes, rocks, minerals, fossils, and soils that provide the framework for life on Earth’. Stanley (2000) [13] asserts that geodiversity "also creates a relationship between people, landscapes, and their cultures. This relationship takes place through the interaction of biodiversity with soils, minerals, rocks, fossils, active processes, and the resulting environment". For geoconservation policies, a wider scope and a broader range should be developed. Wilson (1994) [7], defines the preservation of geoheritage as follows: " … maintenance and protection of landforms (surface forms), natural and artificial (man-made) features, rocky places where geological processes can be

seen in active forms". Geoconservation is a new word that can be used to define the arrangements for the protection of geodiversity [8].

Geoheritage is related to its spatial importance (local, regional, national, and international), its use (educational, scientific, recreational), and its protection requirement [14, 9, 10, 11]. The importance of geoheritage protection has previously been recognized by several international organizations such as UNESCO and the International Union of Geological Sciences. In addition, in Europe, the European Association for the Conservation of Geological Heritage (ProGEO) presented a compilation strategy for geoconservation. Despite the recognition of the international community, geologic diversity is still at risk and is under threat; these threats, as they affect biodiversity, influence geodiversity as well [15]. One of the things that can be considered as a risk for geological diversity is the failure to enclose geocides and determine the legal distance to visit them. When visitors can easily access and touch beautiful geological places, they can destroy or threaten these places. Geosites should be demarcated in certain areas and away from the reach of tourists, and visitors can only see them at a certain distance. Also geosites that can be destroyed due to weathering and erosion should be protected and maintained.

The World Conservation Union (IUCN) defines a protected area as "it is an area of land and/or sea that especially is devoted to the protection and maintenance of biodiversity, natural and cultural resources, and is managed and controlled through law or other effective means". So far, the protected areas have been mainly seen and investigated from the perspective of biology; this point is also reflected in the Harley (1996) [16], Nelson and Serafin (1997) [1], and Bibelriether (1998) [17] studies. In a recent book by the IUCN world commission, and from 1996 to 2000, for the World Commission of Protected Areas, there is not a single word about geoheritage [18]. The WCPA short-term action plan and the Program on Protected Areas planned for the period 1999-2002, maintain the policy of ignoring geological issues in conservation policies. During the last WCPA 2000 meeting, six programs were proposed for development between 2001 and 2004; geological concerns were not expressed clearly, although there was room to include them in some programs.

4. Importance of Protecting Geological Phenomena

Places that have interesting shapes and geological and geomorphological processes, in case of the creation of tourism infrastructure, would make geosites. In fact, a place that has a beautiful, interesting, and impressive shape of geological features can be converted to geosites by creating residential facilities and tourist routes and related management [19]. Another term that is used instead of geosite is the German word “geotope” [20]. A geosite is a place on Earth that shows "the process and events, time periods, features, and important issues" of the identity of the planet [21]. Protection of geological heritage is essential because geosites are at risk of several types of threats such as the illegal collection of minerals, fossils, and so on from geosites, visitors’ vandalism, misuse, mining, and inappropriate legislation. The conservation and management of geosites will provide an opportunity to develop scientific research, educate students and the public, and the development of geotourism activities, and generate income for local residents (as in the absence of geosites, sampling and data collection and fieldwork in the field of geoscience would be impossible). Geosites’ proper evaluation is necessary because not all geosites possess characteristics necessary for scientific research, education, and income [22]. The legacy of geology around the world provides attractive scientific and educational resources for us, bearing several billion years of history when continents were displaced, climate changed, sea levels fluctuated, and animals like dinosaurs and mammoths appeared, evolved, and finally disappeared.

Features of geological phenomena around beaches, active and abandoned mines, outcrop sections on the side of the roads and railways, river margins, and bluffs, are highly important in new geological studies. For example, we can mention the beautiful beaches of Bandar-e Moqam, Hormuz Island, Qeshm Island and Chabahar (in Iran), each of which in its own way presents beautiful effects of great geological landscapes (Figures 1 and 2). The presence of geological features is important for scientific study, education, and operation to fill the leisure time in line with scientific tourism.

Figure 1. Beautiful stone outcrops on the coast of Bandar-e Moqam, Hormozgan province.

Figure 2. Beautiful outcrop of the sedimentary layers of Aladaghlar mountains, the route from Zanjan to Mahenshan.

With advancements in the science of geology and geotourism operations, to fill the leisure time, these important locations require protection. The researchers need places to do their studies. Teachers, pupils, and students need places where the geological principles and landscape-altering processes are exposed to their view [19].

Currently, one of the world's remarkable geosites having significant features is Qeshm geopark, which requires extra attention and protection [23]. At present, many beautiful geosites in Qeshm island are on the brink of destruction due to the easy access of visitors. Among them, the Valley of Stars, Chahkuh Strait, and the world's largest salt cave, Namakdan Cave, can be noted (Figures 3, 4, and 5), and they can be saved again by enforcing protection policies. Among the other beautiful geosites of Iran that have been exposed to destruction, we can mention the red soil mine of Hormuz Island, the BadabSoort mineral water spring located in the southeast of Sari, etc. (Figures 6 and 7).

Figure 3. Namakdan salt cave entrance (Photo by author).

Figure 4. Chahkuh valley geosite in Qeshm geopark (Photo by author).

Figure 5. Stars Valley geosite in Qeshm geopark (Photo by author).

Figure 6. Red soil mine of Hormoz Island, which is on the verge of destruction due to the presence of tourists (Photo by author).

Figure 7. BadabSoort travertine spring located in the vicinity of Sari city.

As can be seen in the images above, these valuable geosites are easily accessible to visitors, so footwork, curiosity, sampling, and other activities of individuals, in the long run, could cause irreparable damage to the body of these centers.

5. How a New Scientific Field is Emerged?

The researchers such as Morrell and Thackray (1981) [24], Geison (1984) [25], and Morrell (1990) [26] investigated the occurrence of a particular academic discipline or a specific scientific area from expertise, and found that the process is related essentially to the specialization, skills, and experience in science, and all together, it is a complex process. The main factors that determine specialization in science exist in the emergence of new scientific disciplines including training qualified specialists at high levels of education, implementation of training techniques, along with the formation of research centers, the establishment of associations and scientific and research journals including bonuses for the best performance and the best employees. In the research centers, new employees and trainees are trained by a qualified instructor. The coach should have a well-defined research program, and have the power and corporate funding and he should have access to professional journals. The coach manages graduates to find their proper positions after ending an apprenticeship.

6. Ways to Protect Geodiversity

Many important sites have been and are being damaged or destroyed, particularly in the developing world, but in the developed countries too, through a lack of knowledge about geodiversity and geoheritage. This makes it

important to implement geoconservation measures [27].

Different factors of geological diversity must be protected and managed in different ways. Table 1 is a general and potential schematic offered by Murray Gray in 2004 [2]. This plan is presented based on common and rare occurrences and phenomena because it is argued that the geological diversity and environment, in general, should be respected both inside and outside protected areas.

Table 1. Geoconservation goals for the eight elements of geological diversity.

Group	Event (Occurrence)	Geoconservation management objective
Stone	*Rare*	Maintaining the outcrop and the lower part. Taking samples for the museum.
	Common	Keep exposed and encourage collecting and maintaining responsibly.
Connie	*Rare*	Maintaining the outcrop and the lower part. Taking samples for the museum.
	Common	Keep exposed and encourage collecting and maintaining responsibly.
Fossils	*Rare*	If possible, preserve it in the original place (*in situ*); otherwise, transfer it to the museum.
	Common	Encourage collecting and maintaining responsibly (reliable).
Land forms		Maintain landforms and restoration. Encourage (persuade) for an authentic contour plotting.
Landscapes (sights)		Maintaining a healthy share of topography, rock outcrops, active processes for landscape and its restoration/encourage (persuade) to for an authentic contour plotting.
Processes		Maintain and restore integrity of operation
Soils		Maintain quality, quantity, and function of soil.
Other georesources		Encourage sustainable and valuable use that is used in historical and new texts.

Specifically, building a protected area by legislating protection laws and enforcing the penalties is considered a method, but due to the violation of the law or changes in political attitudes or the investment, this method is not a guaranteed protection. Fines are rarely enough to scare commercial collectors. As seen in pictures 1 to 3, one of the safest methods is supposedly preventing visitors from reaching sensitive areas through fencing or even putting sensitive places inside specialized buildings (Figure 8). Education plays an important role in helping to maintain the geological features (rocks, minerals, fossils, landscapes, etc.) (Figure 9). In terms of education, there are different ways to preserve geological features, which can be mentioned by allocating hours of teaching in schools and universities. Practical training in field trips is also very useful. Printing catalogs, brochures, preparing educational clips, installing guide boards, etc. can be effective in preserving geosites. A part of protection should also be providing adequate documentation about geological attractions of protected areas, progress, further promotion of research as a necessity, and a management plan to protect them, which should be updated regularly. The latter should include a plan to monitor and supervise the geological heritage assets within protected areas, and a program to upgrade and improve for renewal of facilities and repairing the damages.

Figure 8. Fencing for protection of the fossilized trunk of a tree in Yellowstone National Park (Photo by Gary Murray).

Figure 9. Effect of education on better learning geological science and protection of geological phenomena.

Preservation of lifeless nature is summed up in the conservation of geological resources. Part of the problem of geological conservation is achieved by maintaining geosites. Hose (2003) [27] defines lifeless nature conservation (geological conservation) as the retention and conservation of geosites along with its collection of samples, geosite building materials, and documentation of their geological and geomorphological components. Geoconservation aims to protect geosites, as fundamental and important units of the planet's geological heritage [28], and this protection takes place by special methods such as indexing, assessment, conservation, evaluation, and monitoring geosites [29]. These sites can be diagnosed with the use of the distinction principle, that is a place is called a geosite when it is recognized and valued by specialists because of its special properties. This feature would be unique and appropriate for understanding the history of the planet Earth.

From the viewpoint of Pena dos Reis and Henriques (2009) [30], several methods have been used in geoconservation so far; their differences lie in different methods and techniques which are mentioned below:

- Indexing geosites
- Assessment (using qualitative and quantitative ranking systems)
- Protection (use of appropriate legal and physical protection measures)
- Value (using appropriate training techniques and publishing them)
- Monitoring (periodic and non-periodic) on different baselines

These methods lead to a large variety of legal regulations and consequently, non-standard geological heritage protection.

Geosites' indexing and evaluating methods have an important role in the implementation of conservation, evaluation, and monitoring of the geological heritage. These methods are linked to the "basics or fundamentals of geoconservation". Some researchers including Reynard and Panizza (2005) [31], Lima *et al*. (2010) [32], and Pereira and Pereira (2010) [33] studied indexing, evaluating, and selecting methods of geosites based on criteria such as abundance-scarcity, flawlessness, the rate of their application and vulnerability. In choosing geosites, mainly when they are faced with vast territories, indexing, evaluation, and other methods are done according to either choice of locations or a selected geological context. This choice or selection is done comparatively and subjectively, which is always verified and confirmed by scientific data [34, 28]. Taking into account the socio-cultural dimension, the description and identification of geological heritage becomes even more complex [35, 30].

Basic knowledge of geoconservation for other scientists
including paleontologists and mineralogists when the paleontology and mineralogy heritage requires protection, is useful as well; therefore, the definition of the other side of the field is applied geoconservation (Figure 10). Geoconservation's technical applications are relevant to valuable practical data, tools, rules or scientific services offered by geoconservation. Its purpose is the valuation of geological heritage, which is implemented through categories designated to protect natural resources or statements of land use

planning policy such as natural parks, suitable materials for teaching Earth sciences such as books, manuals, and special services with social impressions such as geotourism.

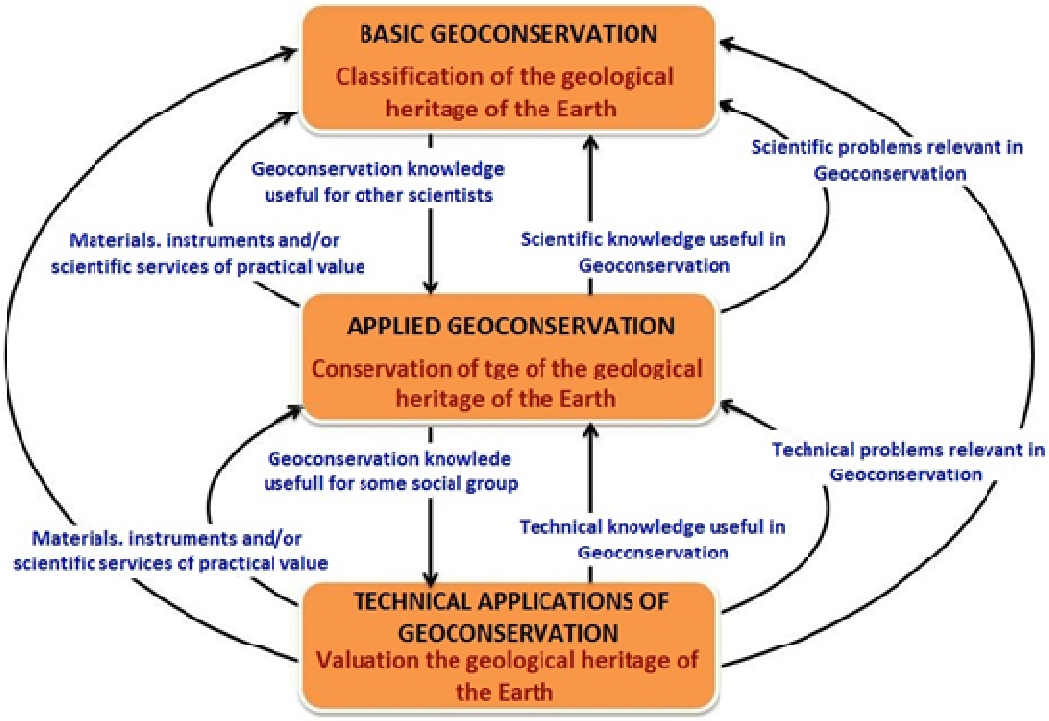

Figure 10. Graph showing the knowledge (awareness), problems, materials, tools or services, among principles of geoconservation, applied conservation, and technical applications of geoconservation (adopting the flowchart set for paleontology by Fernández López, 2000) [36].

7. Public and Social Relations of Geoconservation

In the growing field of geoheritage, geoconservation, geo-education, and geotourism, there is a need to manage sites of geoheritage significance. While there is some great geology in nature available to appreciate for scenic value, education, tourism and research, many locations need to be protected from people and commercialism [37], and some locations need hazard management to protect people (e.g. continuously collapsing cliffs that have potential to be hazardous via rock falls or ….) [38].

Public awareness regarding the protection of nature depends on the context or scientific background of the people. Unfortunately, even in developed countries, many people are exposed to a limited number of scientific and technological subjects. Public understanding of science is a basis for effective implementation of conservation policies. Geoconservation, by providing scientific information with a technical nature, leads to strong relationships with the community. Several major connections that can be named by interfering with the technical applications of geoconservation are:

Planning and legislation for the protection of natural resources: Estimating the value of geological events, which is one of the purposes of geoconservation, determines that geosites are valuable resources, and in line with the protection of scientific values, should be considered important. These geosites are interesting examples of natural heritage, and they need to be protected by natural resources policies and land use planning, as well as adequate legislation [39].

Protecting geosites for improving future research: Selecting should be done based on scientific data and a comprehensive evaluation. Through geoconservation and using new tools and techniques, geosites of high scientific value can be protected, and this would be an ensuring factor in future research. In many countries, key places to the realization of the geological phenomena, which are of national and international value, are destroyed because of the lack of any strategy and policy and the inexistence of geoconservation.

Effect of education on geoconservation: In educational systems, geosites can become an excellent teaching resource only when their geological uses including high-quality images of their geologic outcrops as well as access roads are shown to them. Formal and informal education in geology can be promoted only when in geoconservation planning, conservation, and management of high educational value, geosites become largely included.

Tourism in geologic phenomena: Geotourism, according to Dowling and Newsome, is the "ground" part of geology, and geomorphology and landscape resources and surface forms, layers containing fossils, rocks, and minerals, with emphasis on understanding of processes that created them and is forming these features [40]. Geosite valuation with an aesthetic sense, affects the implementation of geotourism activities [41]. When these activities are the basis of a sustainable development strategy for a certain territory, UNESCO may specify the territory with the geopark term [42, 43]. Geopark, in terminology, refers to a geological park, and in concept, it refers to a geographical area with fixed boundaries that possess one or more special or unique geological phenomena, and remarkable cultural and physical landscape attractions exist in this area as well. This complex should influence the economic development of the region, with programs and special protection measures and have documented management plans [44]. In addition, in a geopark territory, a group of geosites can be found. Frey *et al*. (2006) [45] believe that the concept of geopark consists of the following contexts: geological heritage conservation, transferring the concepts of regional values to the public through tourism, establishing a sustainable economic future, creation of regional geological identity, promoting understanding of geological processes and geological issues, active cooperation with European and international universities and other institutions. The social consequences of this geological heritage primarily take place in national parks, natural resources, and so on, where they are supported by useful and commentary activities including geosites' interpretive panels, brochures, publications, guidebooks, websites, museums, and interpretive centers.

Given the above, we find that the most suitable geosites are considered interesting representatives of natural heritages, which must be safeguarded by natural resources policy protection and land use planning.

It is with the protection of geosites that it is possible to proceed with the global registration of geoparks by providing other conditions. Iran is a country full of geological beauties. There are many places that can be turned into geoparks. Next to the Qeshm Geopark, which is registered in the UNESCO organization, the vast and beautiful Lut desert, which has several beautiful international attractions, is one of the most beautiful attractions that can be turned into an international geopark for tourists to visit. The beautiful island of Hormuz, which consists of various colored soils, with various and beautiful minerals and other interesting geosites, can be a potential geopark. Also Aras geopark is one of the other areas that can become a geopark by providing the necessary infrastructure and conditions.

8. Role of Education and Geoconservation in Sustainable Development

Geological aspects of certain sites can help understand the history of a region and reveal discoveries in regard to the planet. Geodiversity *in situ* is expressed in geosites, with occurrences of geological features of scientific value, and geodiversity sites, places where other values prevail such as education, culture, and tourism. In addition, such locations can generate socioeconomic benefits for the local population through management based on education and geotourism [46].

Nowadays, the maintenance and protection of geosites or geological heritages, given the increasing world population and the consequent growth in demand for natural resources, has become more difficult. Therefore, in such circumstances, managers should have the ability to achieve the coordination and balance between the community's needs and natural resources, and make decisions that are based on professional and scientific studies, and their knowledge of Earth sciences and its valuable heritage.

In this regard, united and uniform training and education must be promoted at large scale, of which the result can be respecting the history of the earth as well as its geological heritage. This important issue of geoconservation is compatible with the general perspectives that underpin the definition of education for sustainable development. To design and implement such an educational system we need that: knowledge and awareness of Earth Sciences become increased, geoconservation to be taken into account and

become seriously pursued, and current and future concerns and consequences of citizens' lives become demonstrated, in which case it can persuade them to adopt the right lifestyle and foster responsible and active citizens [47]. First, we should try to clarify the role of science, especially the earth sciences, in the education of citizens, and the value of geoparks as a tool for the protection and advancement of the public becomes highlighted [48, 49] (Figure 11). Geoparks would be the best option for the implementation of geoconservation goals and effective means of sustainable development, so that countries with diverse geologic features and the world record of their geoparks would be more successful in the absorption of tourists, sustainable development, and the resulting economic incomes.

Figure 11. Geotourists at the Grand Canyon National Park and World Heritage Site, USA [50].

To achieve and propagate this goal, educational programs at all levels including universities should be implemented, which finally enable citizens to face current and future challenges, and enable leaders to make appropriate decisions. In what concerns geoconservation, geological heritage and geosites can deliver cultural services, providing data to develop scientific knowledge and to be used for science communication proposes, in educational and tourist contexts [51, 52]. Among the things that universities can include in their educational programs, we can mention holding scientific conferences and inviting experts and researchers in this field, so that the results of the scientific conference are published in the form of news and reports. Allocating part of the lesson hours to this topic and also scientific visits can be useful.

Geoconservation plans specialized essential services to reduce the risks of destruction of the Earth's heritage, and it is useful knowledge for solving environmental problems associated with the community. Geosites, as the geological heritage of the Earth and the subject of study in conservation, provide important educational resources. These resources may increase learning opportunities and complete the three educational concepts of geoconservation through their mutual interactions as a science of geoscience [5, 29] (Figure 12):

- *Training based on geoconservation* or the underlying (real) knowledge developed by *geoconservation:* means fundamentals of geoconservation and the applied geoconservation;
- *Learning about (concerning) geoconservation* or the metaphysical (unreal), and the philosophical meaning of the term: namely, the knowledge that reflects the organization and procedures involved in the production and verification of knowledge in geoconservation;
- *Training for* geoconservation or a knowledge that explicitly addresses dynamic and responsible citizens, enabling them to participate in discussions about environmental problems that threaten the geological heritage, and take responsible decisions to reduce these problems. For example, the creation of geoparks or protection of monuments heavily depends on the involvement of citizens [53].

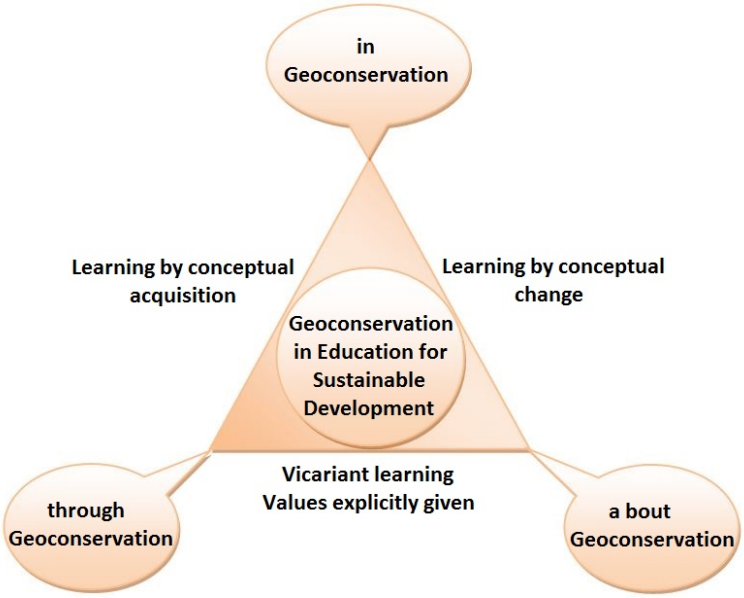

Figure 12. Three areas of education, with the mutual interaction of geoconservation as geological sciences [5, 29].

9. Conclusions

Protection of nature requires providence, long-term policymaking, and a broad perspective. Joining geology to conservation policies at the same level that biology is considered today is urgent. Slow rates of many geological processes lead to the false impression that the earth's resources are inexhaustible and unchangeable. Geologists know this is not true and many unique landscapes and outcrops are already destroyed forever because of inappropriate and improper management. The problem is that most geologists have not been taught to communicate and exchange information with non-archaeologists and tourists. Geology, often because of its terminology, is unknown and incomprehensible, and geological processes also need millions of years and this period is incomprehensible. An example of the difficulties that geology faces in communicating with a large number of viewers is the limited number of television shows devoted to geological documentaries, on the contrary, numerous TV shows on wildlife are aired throughout the world.

In summary, efforts should be made in this important subject by increasing public awareness about geology, and the emergence and development of new disciplines or areas of scientific expertise including geoconservation. To formalize geoconservation, some conditions are to be met including:

- Assigning a particular organizational context conducive to investment and hiring new personnel.
- Installation of educational billboards to protect geosites by tourism organization and municipalities around beautiful geological places.
- Establishing research centers and professional training in the conservation of natural resources in academic environments.
- Dedicating part of the teaching hours in schools and universities to the important discussion of the need to protect geological diversity
- Creating wide awareness at the community level through radio and television and showing clips and educational films to the general public in order to create a culture for the protection of geosites.
- Commissioning and support of scholarly journals and professional societies.
- Writing specialized articles in the field of geoconservation and specification of boundaries of this new discipline.
- Preparation of brochures and catalogs to introduce the beautiful geological places to tourists and the ways of taking care of them better.

In geoconservation, some objectives related to geological heritage might be distinguished from each other: indexing and assessment, protection,

and valuation (evaluation). Protection and evaluation objectives have progressed and are currently progressing by organizations and geologists through submitting technical and consultative reports that support the formal protection of geosites and their general understanding. However, the objectives of indexing and assessment, which rely on more theoretical approaches, require more improvements and greater consensus, and this cannot ~~to~~ be made possible without studying geoconservation as a geological science with deep and explicit social correlations.

Today, despite fierce resistance from some academic communities regarding new scientific disciplines, a group of people interested in geoconservation have become professionals and geoconservation has been proposed as a new body of scientific knowledge. We hope this article helps in showing the importance of geoconservation and respecting God's blessings on Earth, and we look forward to the day when all the people are diligent in conserving the valuable heritage of the Earth.

References

[1]. Nelson, J.G., & Serafin, R. (Eds.) (1997). National Parks Protected Areas: Keystones to Conservation and Sustainable Development. First edition. NATO ASI Series (40), *Ser. G, Ecological Sciences*, Springer-Verlage. Berline Heidelberg, 285 p.

[2]. Gray, M. (2004). Geodiversity: Valuing and Conserving Abiotic Nature. *John Wiley and Sons-Chichester*, UK.

[3]. Leenaers, H., & Schalke, H. (2004) Planet Earth in our hands. In: Nield T, Derbyshire E (Eds.) Earth Sciences for Society. *Earth Sciences for Society Foundation*, Leiden.

[4]. Sinding-Larsen, R., Hovland, M., Shield, D., & Gleditsch, N. (2006). Resources issues towards sustainable use. In: Nield T, Derbyshire E (Ed.) Earth Sciences for Society, *Earth Sciences for Society Foundation*, Leiden.

[5]. Henriques, M.H. (2008). "Ano Internacional do Planeta Terra e Educação para a Sustentabilidade". In: Vieira R *et al*. (Ed.) Ciência-Tecnologia- Sociedade no Ensino das Ciências—Educação Científica e Desenvolvimento Sustentável, *Universidade de Aveiro*, pp. 110–116.

[6]. UNESCO (2005) UNESCO and Sustainable Development. UNESCO, http://unesdoc.unesco.org/images/0013/001393/139369e.pdf. Accessed 9 October 2010.

[7]. Wilson, C. (Ed.) (1994). Earth Heritage Consrevation. Milton Keynes, UK: *The Open University*, 272 p.

[8]. Sharples, C. (1998). Concepts and Principles of Geoconservation. Tasmania, Australia: Parks and Wildlife Service, Department of Environment and land Management, 86 p.

[9]. Barettino, D., Vallejo, M., & Gallego, E. (Eds.) (1999). Towards the Balanced Management and Conservation of the Geological Heritage in the New Millenium. Madrid, Spain. *Sociedad Geologica de Espana*, 459 p.

[10]. Barettino, D., Wimbledon, W.A.P., & Gallego, E. (Eds.) (2000). Geological Heritage: its Conservation and Madrid, Spain. *Instituto Tecnologico Geominero de Espana*, 212 p.

[11]. Osborne, R.A.L. (2000). Geodiversity: 'green' geology in action. *Proceedings of the Linnean Society of New South Wales,* 122, 149-173.

[12]. Yahya Sheibani, V., & Zamanian, E. (2023). Geodiversity and Geological Treasure of Tabas UNESCO Global Geopark for Geotourism Development, New UGGp from Iran. *Geoheritage*, 15.

[13]. Stanley, M. (2000). Geodiversity. *Earth Heritage,* 14, 15-18.

[14]. Zagorchev, I., & Nakov, R. (Eds.) (1998). Geological Heritage of Europe. Geological Balcanica special 28, parts 3-4. Sofia, *Bulgarian Academy of Sciences*, 182 p.

[15]. Weighell, T. (2000). National and international strategies for the integration of geological and nature conservation. *Abstracts of the 31st International Geological Congress* (Rio de Janeiro).

[16]. Harley, M.J. (1996). Involving a wider in conserving their geological heritage: a major challenge and recipe for success. In: Geoscience Education and Traininng in Schools and Universities, for Industry and Public Awareness, ed. D.A.V. Stow and G.J.H. McCall, pp. 725-730. Rotterdam, the Netherlands, A.A. Balkema.

[17]. Bibelriether, H. (1998). Natural heritage conservation in Europe: a review. In: Parks for Life 97, Proceedings of the IUCN/WCPA European Regional Working Session on Protecting Europe's Natural Heritage (Ed.) H. Synge, pp. 33-35 (Cambridge, UK: The German Federal Agency for Nature Conservation, Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, Federal Republic of Germany and IUCN, Cambridge).

[18]. IUCN (2000). Protected areas – Benefits beyond boundaries – WCPA Action [www document]. URL http:wcpa.iucn.org/pubs/pdfs/WCPAInAction.pdf.

[19]. Haj Aliloo, B., & Nekooi Sadri, B. (2011). Geotourism (Geology). *Payam Noor University Press,* Tehran, pp. 28-147.

[20]. Sturm, B. (1994). The geotope concept: geological nature conservation by town and country planning, Geological and Landscape Conservation, In: D. O'Halloran, C. Green, M. Harley *et al*. (Eds.), *Geological Society*, 27-31.

[21]. Wimbledon, W.A.P. (1998). An European geosite inventory: GEOSITE —an International Union of Geological Sciences initiative to conserve our geological heritage. In: Duran JJ, Vallejo M (Eds.) Comunicaciones de la IV Reunion Nacional del Patrimonio Geológico, Miraflores de la Sierra (Madrid). *Soc Geol España*, Madrid, pp. 15–18.

[22]. Brilha, J. (2012). Geoconservation, modern and advanced knowledge of geology and geotourism. *Journal of Earth Sciences and Mining* (Special Geoheritage), Tehran, *Geological survey of Iran publication*, Iran, pp. 20-19.

[23]. Yazdi, A. (2013) Qeshm Island of Iran, Natural Academy of Geotourism Development, *Journal of Basic and Applied Scientific Research* 3(2s), 405-411.

[24]. Morrell, J.B., & Thackray, A. (1981). Gentlemen of Science; Early Years of the British Association for the Advancement of Science. *Oxford University Press,* Oxford.

[25]. Geison, G.L. (Ed.) (1984). Professions and the French State, 1700–1900. *University of Pennsylvania Press*, Philadelphia.

[26]. Morrell, J.B. (1990). Professionalisation. In: Olby RC *et al*. (Eds.) Companion to the History of Modern Science. Routledge, London/New York, pp. 980–989.

[27]. Prosser, C.D., Diaz-Martinez, E., & Larwood, J.G. (2018). The conservation of geosites: Principles and practice, Reynard E., Brilha J. (Eds.), Geoheritage: Assessment, protection, and management, *Elsevier*, Amsterdam, pp. 193-212.

[28]. Henriques, M.H. (2010). O Ano Internacional do Planeta Terra e a Educação para a Geoconservação. In: Cotelo Neiva JM, Ribeiro A, Mendes Victor L, Noronha F, Magalhães Ramalho M (edn) Livro Branco da Geologia de Portugal. *Assoc Portuguesa de Geólogos and Soc Geol Portugal*, Lisboa, II (IV), pp. 465–474.

[29]. Brilha, J. (2005). Património Geológico e Geoconservação. A conservação da natureza na sua vertente geológica. *Palimage*, Braga.

[30]. Pena dos Reis, R., & Henriques, M.H. (2009) Approaching an integrated qualification and evaluation system of the geological heritage, *Geoheritage* 1(1), 1-10. DOI:10.1007/s12371-009-0002-0.

[31]. Reynard, E., & Panizza, M. (2005). Geomorphosites: definition, assessment and mapping. An introduction, Géomorphologie: Relief, processus, environnement 3:177-180. https://doi.org/10.4000/geomorphologie.337.

[32]. Lima, F.F., Brilha, J., & Salamuni, E. (2010). Inventorying geological heritage in large territories: a methodological proposal applied to Brazil, *Geoheritage* 2, 91–99. DOI:10.1007/s12371-010-0014-9.

[33]. Pereira, P., & Pereira, D. (2010) Methodological guidelines for geomorphosite assessment, Géomorphologie: relief, processus, environnement, 2, 215–222. https://doi.org/10.4000/geomorphologie.7942.

[34]. Satkunas, J., Mikulenas, V., Lazauskiene, J., Raudsep, R., That, K., Markots, A., & Lacis, A. (2004). Towards a geosites framework in Northern Europe—a first attempt in the Baltic States. In: Parkes MA (Ed.).

[35]. Henriques, M.H. (2004). Jurassic heritage of Portugal—state of the art and open problems. *Riv Ital Paleontol Stratigr*, 110(1):389–392. https://doi.org/10.13130/2039-4942/6317.

[36]. Fernández López, S. (2000). Temas de Tafonomía. Departamento de Paleontología, Univ. Complut. Madrid (Project: Evolutionary taphonomy).

[37]. Brocx, M., & Semeniuk, V. (2019). The '8Gs'—a blueprint for geoheritage, geoconservation, geo-education and geotourism. *Australian Journal of Earth Sciences*, 66, 803–821.

[38]. Stavi, I,, Rachmilevitch, S., & Yizhaq, H. (2019). Geodiversity effects on soil quality and geo-ecosystem functioning in drylands. *Catena*, 176, 372–380.

[39]. Brilha, J. (2002). Geoconservation and protected areas. *Environ Conserv* 29(3), 273–276.

[40]. Dowling, R.K., & Newsome, D. (2006). Geotourism, *oxford*, Burlington (Elsevier Butter worth-Heinemann), pp. 1-2. 10.1016/B978-0-7506-6215-4.50021-X.

[41]. Hose, T.A. (2008). Towards a history of geotourism: definitions, antecedents and the future, In: Burek, C and Prosser, CD (Ed.) The history of geoconservation. *The Geological Society*, London, Special Publication, 300, 37–60 pp. https://doi.org/10.1144/SP300.5.

[42]. Eder, W. (1999). "UNESCO GEOPARKS" A new initiative for protection and sustainable development of the Earth´s heritage. N Jb Geol Palaont Abh 214(1/2):353-358. https://doi.org/10.1127/NJGPA%2F214%2F1999%2F353

[43]. Eder, W., & Patzak, M. (2004). Geoparks—geological attractions: a tool for public education, recreation and sustainable development. *Episodes*,

27(3), 162-164. http://dx.doi.org/10.18814/epiiugs/2004/v27i3/001.

[44]. Amrikazemi, A. (2006). A look towards overall concept of Geopark, Geotourism and geology heritage and Iran position in this field. Proceedings of twenty-sixth meeting of Earth Science, *Geological survey of Iran*, Tehran.

[45]. Frey, M.L., Schafer, K., Buchel, G., & Patzak, M. (2006). Geoparks – a regional, European and global policy, Geotourism, Chapter Six, *Elsevier*, Oxford, pp. 95-117.

[46]. Albani, R., Leite Mansur, K., de Souza Carvalho, I., & Francisco Sá dos Santos, W. (2020). Quantitative evaluation of the geosites and geodiversity sites of João Dourado Municipality (Bahia-Brazil). *Geoheritage*, 12, 46. https://doi.org/10.1007/s12371-020-00468-1.

[47]. Pedrosa, M.A., & Moreno, M.SM. (2007). Ensino Superior, Protecção Ambiental e Desenvolvimento Sustentável. In: Vasquez CV at al. (org) *I Congreso Internacional de Educación Ambiental dos Países Lusófonos e Galícia*, 6, Educación Ambiental e. Universidade.http://www.ceida.org/CD_CONGRESO_lus/documentacion_ea/comunicacions/EA_e_Universidade/Pedrosa_Arminda.html Accessed 9 October 2010.

[48]. Eder, W., & Mulder, E. (2008). Paris Declaration. International Year of Planet Earth (Declaration presented at the Global Launch Event of the International Year of Planet Earth (IYPE), UNESCO, Paris, 12-13 February 2008). http://yearofplanetearth.org/index.html. Accessed 19 October 2010

[49]. Henriques, M.H., Guimarães, F.A., SÁ, A.A, Silva, E., & Brilha, J. (2010). The International Year of Planet Earth in Portugal: past activities and further developments. *Episodes*, 33(1), 33–37. http://hdl.handle.net/1822/11737.

[50]. Gray, M. (2019). Geodiversity, geoheritage and geoconservation for society, 7, 226-236.

[51]. Pereira, D.I. (2017). Raising awareness of geodiversity services in Terras de Cavaleiros UNESCO Global Geopark. In: Lima E, Nunes JC, Meirinho P, and Machado M (Eds.) *Abstracts Book of 14th European Geoparks Conference*, Azores, Portugal, 87.

[52]. Pereira, D.I,, Brilha, J., Gray, M., & Pereira, P. (2018). Promoting geodiversity in the sustainable management of nature. In: Proceedings of the 8th International Conference on UGGps: Geoparks and Sustainable Development. Adamello Brenta UNESCO Global Geopark, Madonna di Campiglio, 22.

[53]. Gray, M., & Gordon, J. (2008). Geodiversity and the sustainable development of the regions. *Eur Geol* 25, 28–30.

ژئوکانزرویشن: علمی نوظهور برای حفاظت از میراث زمین‌شناسی

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ارسال ۲۰۲۳/۰۸/۰۲، پذیرش ۲۰۲۳/۰۹/۲۵

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چکیده:

ژئوسایت‌ها و داشته‌های آنها، اعم از کانی‌ها، فسیل‌ها و ... بیانگر تاریخ آن منطقه بوده و در فهم ما از سیر تکاملی زمین، فعالیت‌های آتشفشانی، تحرکات صفحه‌ای، و مشخصات محیط‌های مختلف کمک شایانی می‌کند. اینها بخشی از اطلاعات حیاتی مربوط به ۴۵۰۰ میلیون سال حیات زمین را تشکیل میدهد ومیراث بین المللی مشترک‌مان است. مهمترین هدف ژئوکانزرویشن، حفاظت از ژئوسایت‌ها، به عنوان واحدهای اصلی میراث زمین‌شناسی، می‌باشد و این اصل از طریق بکارگیری روش‌های خاص، از قبیلِ لیست کردن پدیده‌های زمین‌شناسی، ارزیابی، محافظت، ارزش‌گذاری و برآورد میزان اهمیت هر یک از ژئوسایت‌ها، و دیده‌بانی (یا نظارت بر این پدیده‌ها) تأمین می‌گردد. در این نوشتار، ژئوکانزرویشن، به عنوان یکی از شاخه‌های تخصصی و ضروری علم زمین‌شناسی معرفی شده است که هم‌اکنون درحال تکوین می‌باشد. بنابراین اصول ژئوکانزرویشن ارائه و به ارتباط آن با سایر علوم زمین پرداخته می‌شود. همچنین می‌توان از طریق ترویج آموزش-های علمی و فرهنگی مرتبط با توسعه‌ی پایدار، (در رابطه با علوم زمین) این آگاهی را به شهروندان داد که عدم حفاظت از منابع طبیعی، باعث کاهش منابع زمین‌شناسی و از سویی تهدیدی جدی برای میراث زمین‌شناسیِ کره‌ی زمین است. این مهم با در اختیار قرار دادن اطلاعات و آموزش مهارت‌هایی که از طریق آنها بتوان تصمیمات آینده‌نگر و درست‌تری گرفته شود امکان پذیر است.

کلمات کلیدی: حفاظت از زمین، علوم زمین، پدیده جدید، حفاظت، میراث زمین شناسی، ژئوسایت.