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GEOHERITAGE AND GEOPARKS

18

José Brilha*University of Minho, Braga, Portugal***18.1 GEOPARKS: THE DAWN OF AN INNOVATIVE CONCEPT**

For all geoconservationists, the geopark is the striking concept that in less than 20 years has gained a worldwide recognition and has taken geoheritage outside the limited and small world of geoscientists. The original concept of geopark was developed in Europe in the late 1980s. It refers to a territory with a particular geological heritage and a sustainable territorial development strategy (EGN, 2000).

In order to understand the context in which the geopark concept was developed, it is necessary to travel back to the early 1970s, when the world began to be concerned about the protection of natural and cultural assets.

The Man and the Biosphere Programme (MAB) was approved by UNESCO in 1971 as an inter-governmental scientific programme aimed at establishing a scientific basis for the improvement of relationships between people and their environments (Fig. 18.1). One year later, UNESCO adopted the Convention Concerning the Protection of the World Cultural and Natural Heritage aimed at permanently protecting properties with cultural and/or natural assets with 'outstanding universal value' (OUV).

After the first two decades of the implementation of both UNESCO initiatives, the geoscientific community began to realise that geoheritage was under-represented in them (Jones, 2008; UNESCO, 1999). On the one hand, the MAB programme was, and still is, fundamentally based on biodiversity (Bridgewater, 2016), as shown in the current 672 sites dispersed in 120 countries. On the other hand, the World Heritage Convention was, and still is, too restrictive in what concerns the OUV recognition of geological sites. Of the present 1073 properties in 167 countries, 90 properties (8%) were selected on the basis of geoheritage together with other assets, but only 18 (<2%) are in the list exclusively due to the occurrence of geoheritage with OUV (Migoñ, 2018).

In order to overcome this unbalanced international recognition, the geoscientific community proposed in the 1990s two new global actions: the Global Indicative List of Geological Sites (GILGES), later renamed Global Geosites Project (Cowie, 1993; Cowie and Wimbledon, 1994) and the UNESCO Geoparks Programme (Patzak and Eder, 1998; UNESCO, 1999). The latter intended to 'promote a global network of geoparks safeguarding and developing selected areas having significant geological features' (Patzak and Eder, 1998; UNESCO, 1999) and also to support national initiatives for the preservation of important geological sites in line with sustainable development (Erdelen, 2006).

FIGURE 18.1

Timeline with some of the major events concerning the global stage for the development of the geoparks concept and its evolution and dispersion around the world. The establishment in 1988 of the European Working Group on Earth-Science Conservation (later converted into ProGEO – The European Association for the Conservation of the Geological Heritage), was the first international initiative to gather the geoconservation community, which met together in the First International Symposium on the Conservation of the Geological Heritage, held in Digne-les-Bains, France, in 1991.

This first attempt to establish a formal UNESCO Geoparks Programme ended without success in 2001, by decision of the 161st Session of the Executive Board of UNESCO. Despite that drawback, the geopark concept was already being used in several territories. After the establishment of the German Gerolstein District Geopark in 1989 (Bitschene, 2015; Frey, 2012), later renamed Vulkaneifel Geopark, the European Geoparks Network (EGN) was founded in 2000 with three other territories (Réserve Géologique de Haute-Provence, France; the Petrified Forest of Lesbos, Greece; and the Maestrazgo Cultural Park, Spain). According with EGN, geoparks were initially defined as territories with clear boundaries, with sufficient surface area for real territorial economic development and with a certain number of geosites of particular importance in terms of their scientific quality, rarity, aesthetic appeal and educational value. A geopark could also include sites with archaeological, ecological, historical, or cultural interest (McKeever and Zouros, 2005). The EGN has established two agreements with the UNESCO's Division of Earth Sciences (Fig. 18.1): one in 2001 whereby UNESCO gave the network its endorsement and another in 2004 (known as Madonie Declaration) which states that EGN acts as the integration organisation of European geoparks into the Global Geoparks Network (GGN) (Zouros and Valiakos, 2010).

After the establishment of the EGN, new European geoparks progressively integrated this network and together with eight Chinese geoparks, the GGN was constituted in 2004, under the auspices of UNESCO. The increasing number of geoparks accepted in the GGN led to the remarkable number of 127 geoparks in 35 countries in 2017, only 13 years after the foundation of the GGN (for a permanently updated list of all GGN geoparks, check www.unesco.org/new/en/natural-sciences/environment/earth-sciences/).

Finally, the newest development was the definitive approval by UNESCO's General Conference on 17 November 2015 of the International Geoscience and Geoparks Programme and the

foundation of the label 'UNESCO Global Geoparks' (UGGs). The new guidelines clearly state that 'a holistic concept of protection, education and sustainable development' must manage areas with 'geological heritage of international value' represented by 'sites and landscapes of international geological significance' (UNESCO, 2015).

This new international setting has set, for the very first time, a new level of recognition for the geoheritage. This is undoubtedly a new and challenging opportunity to promote geoheritage not only at the international level but also at the national and local levels.

18.2 GEOHERITAGE IN UNESCO GLOBAL GEOPARKS

There is a general lack of studies/statistics about the type of geodiversity/geoheritage occurring in UGGs. To know, for instance, what is the geoheritage with international relevance in UGGs demands a time-consuming search of each of the 127 geoparks' websites and even then the results are absolutely not guaranteed. Ruban (2016) also stresses this lack of compiled information, particularly in what concerns the representativeness of the different geological time units in geoparks. Nevertheless, he concludes that the major time units from the Proterozoic to the Neogene are represented in UGGs more or less equally. This conclusion is in accordance with the fact that, in general, the geodiversity of UGGs is very high. Many geoparks present a diversified set of rocks, tectonic structures and landforms, representing a long geological and geomorphological history.

After the analysis of the main characteristics of all UGGs, there is a general impression that the majority of these geoparks are located in mountain areas. This geomorphological context is somehow consistent with the fact that mountain areas usually allow better exposure of rocks and tectonic structures, together with the presence of landforms and associated landscapes with high aesthetic value. All these geological/geomorphological attributes are certainly very good assets for geoparks.

While not exhaustive, it is possible to get a general picture of what the main types of geoheritage are via UGGs (Table 18.1).

Table 18.1 Noncomprehensive Listing of the Main Types of Geoheritage in UGGs, Based on the Information Available at the UNESCO Website (www.unesco.org/new/en/natural-sciences/environment/earth-sciences/)

Type of Geoheritage	Examples of UNESCO Global Geoparks
Alpine geology/geomorphology	Styrian Eisenwurzen; Carnic Alps; Ore of the Alps (Austria) Karawanken/Karavanke (Austria/Slovenia) Massif des Bauges; Chablais (France) Swabian Alb (Germany) Beigua; Adamello-Brenta; Alpi Apuani (Italy)
Glacial and Ice Age	Tumbler Ridge (Canada) Odsherred (Denmark) Rokua (Finland) Muskauer Faltenbogen/Luk Mużakowa (Germany/Poland) De Hondsrug (The Netherlands)

(Continued)

Table 18.1 Noncomprehensive Listing of the Main Types of Geoheritage in UGGs, Based on the Information Available at the UNESCO Website (www.unesco.org/new/en/natural-sciences/environment/earth-sciences/) *Continued*

Type of Geoheritage	Examples of UNESCO Global Geoparks
Karst	Zhangjiajie; Xingwen; Shilin; Leye Fengshan (China) Psiloritis (Greece) Gunung Sewu (Indonesia) Madonie (Italy)
Landforms	Dong Van Karst Plateau (Vietnam) Huangshan; Lushan; Ningde; Sanqingshan (China) Mixteca Alta (Mexico) Jeju (Republic of Korea) Grutas del Palacio (Uruguay)
Mining	Parco Geominerario della Sardegna; Tuscan Mining Park (Italy) Comarca Minera (Mexico) Idrija (Slovenia) Central Catalonia (Spain)
Palaeontological	Araripe (Brazil) Stonehamer (Canada) Funiushan; Zigong; Tianzhushan; Yanqing (China) Luberon (France) Lesvos Island; Sitia (Greece) Arouca; Naturtejo da Meseta Meridional (Portugal) Hateg (Romania) Sierras Subbéticas (Spain)
Stratigraphical	Haute-Provence (France) Basque Coast (Spain)
Tectonics	Molina & Alto Tajo (Spain) Songshan (China) Vikos (Greece) M'Goun (Morocco) Terras de Cavaleiros (Portugal) North-West Highlands (United Kingdom)
Volcanological	Wudalianchi; Yandangshan; Jinghohu; Leiqiong (China) Vulkaneifel (Germany) Katla; Reykjanes (Iceland) Batur (Indonesia) Unzen Volcanic Area; Toya–Usu; Oki Islands (Japan) Azores (Portugal) El Hierro; Lanzarote and Chinijo Islands (Spain) Kula Volcanic (Turkey)

This brief and noncomprehensive analysis suggests that fossils and volcanoes are the most represented geoheritage elements inside the GGN. Again, this is not surprising as these two types of elements are among the most popular and widely appreciated by the general public, one of the main targets of any geopark. At the European level, there is a concentration of geoparks in the Alpine setting, not only because geology and geomorphology are very well exposed in these mountain areas, but also due to the high aesthetic value of Alpine landscapes, widely recognised worldwide.

18.3 MANAGEMENT OF GEOHERITAGE IN GEOPARKS

Basically, geoparks are territories with a sustainable development strategy based on geological heritage and other natural and cultural assets, through the offer of educational and geotourism actions in order to attract visitors. This means that geoparks play a very important role in the characterisation, conservation and interpretation of geoheritage, which are basic steps for any geoconservation strategy (Brilha, 2015).

18.3.1 CHARACTERISATION OF GEOHERITAGE IN GEOPARKS

Concerning the most fundamental strength of any geopark — its geoheritage — several stages should be implemented in order to prepare a territory to become a geopark (Brilha, 2016):

1. general description of geodiversity with an explanation of the geological and geomorphological setting of the territory;
2. inventory and quantitative assessment of geosites' scientific value and degradation risk;
3. quantitative assessment of educational and touristic potential uses of geosites;
4. inventory of geodiversity sites;
5. quantitative assessment of educational and touristic potential uses of geodiversity sites, together with the degradation risk evaluation.

With the results of these tasks, it is possible to prepare a proper geoconservation action plan that should define priorities for the management of these sites: which ones will be used as educational and/or touristic resources, what kind of infrastructures are needed, which trails can be implemented, etc. (Fig. 18.2). It should be emphasised that for any UGG, not only geosites with international relevance are the ones to be properly managed. In fact, all other sites are also equally important because they support the majority of the educational and touristic actions of geoparks. The results of the above-mentioned tasks will also give all the necessary data required by UNESCO for new UGG applications (UNESCO, 2017), namely: (1) general geological description; (2) listing and description of geological sites; (3) details about their international, national, regional or local value; (4) current status in terms of site protection; (5) data on the management and maintenance of all sites.

FIGURE 18.2

Example of a management measure: due to the fragility and vulnerability of some geosites, in some areas of the Lanzarote and Chinijo Islands UGG (Spain), visitors are not allowed to move freely and to climb cinder cones; in these areas, visitors can only move in local buses with stops at predefined locations (Photograph by J. Brilha).

18.3.2 CONSERVATION OF GEOHERITAGE IN GEOPARKS

The conservation of geoheritage in geoparks is a vital assignment for any manager, simply because without geoheritage there are no geoparks. The maintenance of the integrity of all geosites and geo-diversity sites is a guarantee that the values that were identified and have justified the creation of the geopark in the first place are still present in the geopark, attracting visitors and supporting the sustainable development of the territory.

As geoparks are not a category of protected area, they cannot ensure the legal protection of geoheritage. This means that geoparks must use the national legal setting in order to guarantee a formal protection of, at least, the most important geosites (Fig. 18.3). The results of the quantitative assessment refereed in Section 18.3.1 may help geopark managers to define which geosites must have a statutory protection. Aspiring geoparks must prove that their geosites are legally protected prior to submitting the UGG application (UNESCO, 2015). Sometimes, UGGs include in their boundaries statutory protected areas (many of them already existing before the establishment of the geopark), which ensures the legal protection of geosites.

FIGURE 18.3

On-site notice board clearly stating the statutory protection of a geosite given by the national legislation in the English Riviera UGG (UK) (Photograph by J. Brilha).

FIGURE 18.4

Fossils of giant trilobites are available to experts, schools and general public in an interpretative centre managed by one partner of the Arouca UGG (Portugal). This is an example of *ex situ* conservation and, at the same time, it is also an educational and tourist infrastructure for the geopark (Photograph by J. Brilha).

The conservation of sites in geoparks should follow the same procedures that are recommended for protected areas (Crofts et al., 2015). These authors have compiled threats and pressures that may affect geoheritage, most of them potentially relevant in geoparks, such as: (1) urban development and construction of infrastructures; (2) mining and mineral extraction; (3) changes in land use and management; (4) coastal protection and river management and engineering; (5) recreation and geotourism; (6) climate change; (7) restoration of pits and quarries including landfill; (8) stabilisation of rock faces (e.g., road cuttings) with netting and concrete; (9) irresponsible fossil and mineral collecting and rock coring.

Once the threats affecting each site are clearly identified, it is necessary to study and implement the best solutions to decrease or eliminate the site's risk of degradation. Wimbledon et al. (2004) present guidelines to apply practical conservation actions to geosites.

As recreation and geotourism are important strategies in all geoparks, it is very important to implement studies to calculate the site's carrying capacity (Cifuentes, 1992; Lima et al., 2017; Lobo, 2015; Marion and Leung, 2011) and to establish monitoring routines (Díez-Herrero et al., 2018; García-Cortés et al., 2012; Meyer, 2018). These studies help managers to define the correct

number of visitors that each site can receive, without causing meaningful impacts on the site's integrity. In addition, monitoring actions will help to understand how the site's integrity evolves throughout time.

It is also worth underlining the relevance of *ex situ* geoheritage conservation in geoparks. When it is impossible to conserve geoheritage *in situ*, the removal of fossils, minerals and rocks from the original location, their proper treatment and exhibition in museums and interpretative centres is a very good conservation method (De Wever and Guiraud, 2018) that should be done under the supervision of geopark managers (Fig. 18.4). Although having been removed from the original site, these moveable exemplars still maintain their scientific and educational values, which are major assets for any geopark.

18.3.3 EDUCATION AND INTERPRETATION OF GEOHERITAGE IN GEOPARKS

Education and geotourism, together with geoconservation, form the tripod of any geopark action plan. Although education and geotourism are not exclusively focused on the geopark's geoheritage since these activities must also relate with the other natural and cultural heritage of the territory (Fig. 18.5), it is unquestionable that geosites and geodiversity sites play a central role in supporting formal/informal educational and geotourism activities.

It should be emphasised that not all geoheritage should be used for education and geotourism. Brilha (2016, 2018) details methods to assess the potential for a certain site to be used for educational and tourism uses. For instance, a geosite may have a very high scientific value but its eventual use by young students might raise concerns about their safety, which is a reasonable justification to not include this geosite in the educative programmes of a geopark, at least until the safety issues have been eliminated. When the result of the quantitative assessment of the potential educational and touristic uses of a certain site is high, geopark managers have a sound justification to build new or better facilities to improve the visiting conditions to the respective site, as well as to deliver good educative and interpretation resources.

A site has a high potential for educational use when: (1) its geoheritage is resistant to the eventual destruction caused by students; (2) it can be easily understood by students of different school levels; (3) it can be easily reached by bus or short and easy trails; (4) it provides safe conditions for students, in particular considering the younger ones.

Similarly, one can consider some factors to assess when a site has a high potential for tourist/recreational use: (1) the geoheritage has a remarkable aesthetic relevance; (2) the geological/geomorphological significance can be easily understood by visitors with no geoscientific background; (3) there is a low risk of degradation as a result of human activities; (4) there are good facilities and infrastructures to receive visitors, including those with disabilities.

The educational and tourist/recreation uses of geoheritage require a strong investment by the geopark management structure. The geopark staff should include experts on geosciences education and interpretation, in order to produce solid contents that support the educational and interpretative programmes of the geopark (Brilha, 2009; Buhay and Best, 2015; Cayla and Martin, 2018; Henriques et al., 2012; Macadam, 2018; Newsome and Dowling, 2018; Zouros et al., 2011). It is commonly accepted that, in many countries, the formal education on geosciences in schools is very deficient, resulting in societies with very low awareness for geoscientific topics (Stewart and Nield, 2013; Van Loon, 2008; Vasconcelos, 2016). This general context must be taken into account by

FIGURE 18.5

In the Sobetsu Volcano Memorial Park, visiting the ruins of a hospital that collapsed during the 1977 earthquake is promoted by the Toya–Usu UGG (Japan). Keeping the effects of a natural phenomenon that is inexorably connected to all Japanese people is a way to keep society on alert for the need to be always prepared to face new seismic/volcanic events, a remarkable example of informal education on the Earth's dynamics (Photograph by J. Brilha).

geopark managers because this implies the need for geoparks to have very good educational and interpretation materials and to have trained staff to assist students/teachers and the general public.

18.4 FINAL REMARKS

The geopark and its international recognition by UNESCO as a tool to promote geoheritage in society has been a remarkable move by the geoscientific community in recent years. Being the essence of a geopark, geosites and geodiversity sites need to be well maintained with great responsibility by geopark managers. It is unquestionable that geoheritage inside a geopark must be properly explained to students, visitors and to the local community, so it is understandable that geoparks' action plans dedicate a lot of attention to interpretation and geotourism infrastructures. However, geopark managers must not forget that geoheritage might be fragile and vulnerable, either as a result of visitors' impact or as a consequence of rock weathering and erosion and natural decay in

general. Therefore, aspiring geoparks must prepare a solid application dossier to become a UGG with a strong focus on the characterisation, assessment, and protection of geoheritage, as it is requested by UNESCO. Also, UGG managers must ensure that geoheritage is being properly conserved and with an effective monitoring programme to understand the evolution of sites' integrity throughout time.

The maintenance of geoheritage in the best possible state is the best guarantee to promote geoparks nationally and abroad, attract new visitors and stimulate the sustainable development of the whole territory, the ultimate aim of any geopark.

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