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FROM GEOMORPHOSITE EVALUATION TO GEOTOURISM INTERPRETATION. CASE STUDY: THE SPHINX OF ROMANIA'S SOUTHERN CARPATHIANS

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Abstract: Geomorphosites are commonly regarded as landforms that are mainly defined by their scientific value. Prior to assuming the existence of a "*geomorphosite*", however, the scientific value of landforms must be determined. The study comprises three major steps. The first of them implies the identification and classification of the intrinsic geo(morpho)logical characteristics of landforms, some of which are readily identifiable and quantifiable by tourists and scientists alike, whereas others are noticeable and deducible only by scientists. The second step employs a numerical methodology for assessing the scientific value of landforms which, once ascertained, also acquires a significant educational importance for geotourism. The third step and final goal is the development of a logical scheme for the scientific interpretation of a geomorphosite's origin and evolution and its brief application on the most representative of the erosional landforms on the Bucegi plateau of Romania's Southern Carpathians – the Sphinx.

Key words: geomorphosites, landforms, intrinsic characteristics, geotourism, interpretation, the Sphinx, Southern Carpathians

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INTRODUCTION TO THE STUDY OF GEOMORPHOSITES. A BRIEF HISTORY OF RESEARCH

Large-scale tourism practices around the world determine a progressive overflowing and degradation of natural areas. One of the early measures undertaken in order to limit the negative impact of mass tourism was the establishment of protected natural areas and natural monuments, and the foundation of national parks and reserves. However, most theoretical and operational frameworks were almost exclusively suited for the protection of biodiversity, and it is only recently that the importance of the main component of landscapes – geodiversity – has been acknowledged (Kiernan, 2001; Sharples, 2002; Gray, 2004). The evaluation of geodiversity in its many aspects in order to ensure its proper conservation, management and reasonable tourism exploitation proved itself to be a major subject of interest for researchers within the last decade.

In certain European countries – particularly Italy, Spain and Switzerland (Reynard, 2004) – concern about this issue started in the early 1990s. A new terminology emerged – hence a variety of specific terms generally regarded as synonyms, among which

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geomorphological geotope, geomorphological site and eventually *geomorphosite* (Reynard, 2005). A subsequent stage consisted of the drawing up and implementation of an assessment methodology based on several criteria according to different purposes such as environmental impact studies, land planning and lately geotourism practices (Reynard, 2008). Some of the methods have been proposed in the shape of either a numerical evaluation (Bruschi & Cendrero, 2005; Pralong, 2005; Zouros, 2007) or an inventory card (Reynard, 2006; Cocean, 2011a), while others comprise both stages within a single process (Serrano & González-Trueba, 2005; Pereira & Pereira, 2010).

In Romania, the first study dedicated to geomorphosites focused on the Apuseni Mountains in Romania's Western Carpathians – an area whose many instances of natural and cultural scenery, although remarkably rich and diverse, are still little explored (Ilieş & Josan, 2007).

THE NATURE OF GEOMORPHOSITES

According to M. Panizza, a geomorphosite represents "*a landform to which a value can be attributed*" (Panizza, 2001, p.4) – a very brief definition that allowed a wide range of values to be associated to geomorphosites, from scientific and ecological, to aesthetic, cultural and economical. The definition was later clarified by E. Reynard who separated the central – scientific – value from the additional ones (Reynard, 2005). Therefore if a landform does not acquire a scientific value it cannot become a geomorphosite since "[...] *les géomorphosites étant définis en premier lieu pour leur rôle visant à comprendre le fonctionnement et l'histoire de la Terre*" (Idem, p.187).

Geomorphosites may be regarded as complex units (Figure 1), yet a detailed research is compulsory prior to assuming a geomorphosite's existence and considering it as a geotourism resource. This process implies the identification and classification of the inherent characteristics of a particular landform – the ones existing regardless of human will and action – as well as their score-based evaluation. Together, these steps lead to the assessment of the scientific value – the essential criterion a landform must meet in order to become a "*geomorphosite*". This however is not a self-existing property since it emerges from the intrinsic characteristics of a landform. A close attempt in establishing the intrinsic characteristics was provided by Cocean G. who separated the structural values from the functional values of a geomorphosite (Cocean, 2011a, b).

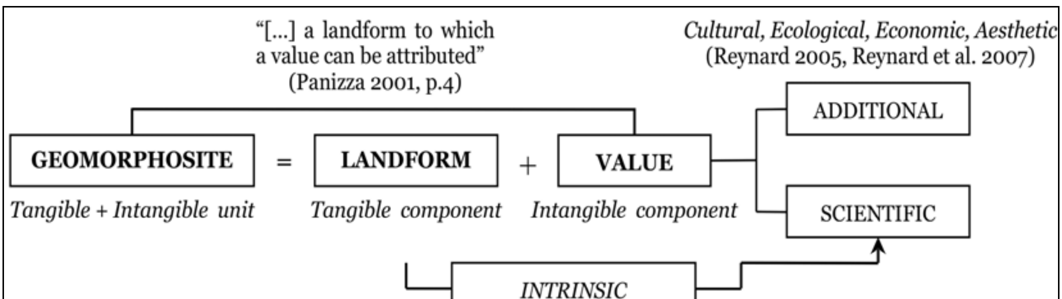


Figure 1. Geomorphosites are complex units consisting of two major components: a landform (as a tangible element) and a scientific value (as an intangible element)

Nevertheless, in more recent studies there is a growing tendency to associate geomorphosites with (geo)tourism (Panizza & Piacente, 2008; Reynard, 2008). Ielenicz M. notices that "*geomorphosites*" comprise only certain landforms or geomorphological processes, namely the ones displaying specific features that are exploitable for the purpose of tourism or that make them attractive as tourist destinations (Ielenicz, 2009).

OBJECTIVITY OF RESEARCH. QUESTIONING THE "*SCIENTIFIC VALUE*"

A paramount issue arising from the evaluation process and mentioned by many authors (Grandgirard, 1999; Bruschi & Cendrero, 2005; Pereira et al., 2007; Rodrigues & Fonseca, 2010) is the objectivity of research. Each of the three steps dealing with the intrinsic characteristics of landforms implies a certain degree of subjectivity (Figure 2). The lowest degree corresponds to the identification of these attributes (the first step) as human intervention is mainly reduced to observation. Higher degrees of subjectivity are gradually implied in the classification and evaluation (second and third steps) as these stages are purpose-directed and involve analysis and appreciation.

Regardless of its nature, an evaluation process is always prone to subjectivity as a researcher "*is intimately involved in scientific research*" (Ratner, 2002, chap.1). Bias is almost impossible to avoid as it often interferes with the analysis, yet full objectivity may not be achieved without implicitly withdrawing interest for the context and purpose of the research. Nevertheless the degree of subjectivity can be limited or even decreased at a general level by providing reasonable arguments or explanations (Grandgirard, 1999; Cocean, 2011a, b) and in particular circumstances, when a comparative analysis of genetically identical landforms is implied, by attaching charts or images in order to illustrate similarities and differences (Pralong, 2005). Reasoning – broadly regarded as evidence and arguments – eventually represents "*a move one party makes in a dialog to offer premises that may be acceptable to another party who doubts the conclusion of the argument*" (Walton, 2009, p.1).

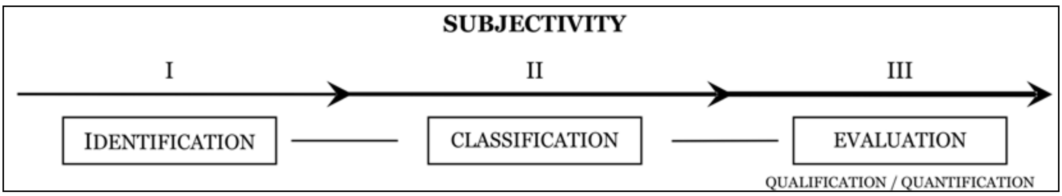


Figure 2. Degree of subjectivity involved in the different stages of the research dealing with the intrinsic characteristics of landforms

Although awareness has been raised regarding the important role of human perception in the assessment process, the very use of the word "*value*" is a first step towards subjectivity, since it implies an individual's perception rather than an objective reality. "*Values*" are inherently human attributes. However, in the different stages of geomorphosite assessment they are gradually detached from their original subjective meaning, being widely used either to determine or comprise random non-human attributes that belong to landforms, or to define their relevance. In a study that is not directly concerned with the human nature or perception but instead with the characteristics of abiotic nature, a phrase such as "*scientific value*" may prove to a certain extent questionable and premature. Landforms possess valuable information that, once decoded, provides them with a scientific importance in terms of understanding and reconstructing the geological and paleogeographical evolution of the regions they belong to (Henriques et al., 2011). This importance is a pre-existent global attribute which only becomes a "*value*" when it is acknowledged and appraised and when efforts are carried out in order to ensure its proper interpretation, preservation and perpetuation.[1] Once the scientific importance becomes a "*value*", it becomes an implicit and equally important educational value for geotourism.

IDENTIFYING AND CLASSIFYING THE INTRINSIC CHARACTERISTICS OF LANDFORMS

Landforms have intrinsic characteristics which are self-evolving but may be irreversibly modified and even lost because of human actions. "*This architecture* (i.e. geodiversity as the variety of forms and processes within the abiotic nature) *has taken thousands of millions of years to evolve, yet can be destroyed or altered within days*" (Gray, 2004, p.68). The study consists of three major steps, the first of which implies the proper identification and classification of the intrinsic characteristics of landforms (Table 1). Three of them – degree of preservation, uniqueness and representativeness are recurring criteria in almost all stages dealing with the scientific assessment, while the others usually differ with the scope of the research. A wider yet similar classification may also consider the intrinsic ecological characteristics, referring to local flora and fauna encountered within or close to landforms.

Table 1. The intrinsic geo(morpho)logical characteristics of landforms

GEO(MORPHO)LOGICAL CHARACTERISTICS		
(1) ***PRIMARY*** *characteristics*	Surface	(1a) ***Outer*** *characteristics*
	Height/Depth/Breadth	
	Degree of preservation	
	Colour contrast	
	External agents and processes	(1b) ***Inner*** *characteristics*
	Dynamics	
	Auxiliary or integrated geomorphological elements	
	Auxiliary or integrated geological elements	
(2) ***DERIVED*** *characteristics*	Uniqueness	
	Representativeness	

The intrinsic characteristics of landforms are depicted by various authors and different methods (Grandgirard, 1999; Wimbledon et al., 2000; Coratza & Giusti, 2005; Serrano & González-Trueba, 2005; Pralong, 2005; Zouros, 2007; Reynard et al., 2007; Joyce, 2008; Pereira & Pereira, 2010; Cocean, 2011a, b; Coratza et al., 2012). They can be divided into two main categories: (1) Primary characteristics and (2) Derived characteristics. The first of them is further divided into two subcategories: (1a) Outer characteristics and (1b) Inner characteristics respectively, with the former subcategory reflecting the latter.

The Outer characteristics comprise the *surface*, *height/depth/breadth*, *degree of preservation/integrity* and *chromatic*.[2] They refer to the physiognomy and appearance of landforms and are easily observed and quantified by anyone, including laymen in the fields of Earth sciences like geology or geomorphology. They are not self-standing characteristics but generally reflect the Inner characteristics.

The Inner characteristics comprise the *external agents and processes*, *dynamics*, *auxiliary or integrated geomorphological elements* and *auxiliary or integrated*

[1] All geodiversity elements – from minerals and fossils to landforms and even geolandscapes – bear a theoretical scientific importance in re-creating stages of the geological evolution of the Earth. This importance may or may not be considered, emphasized and later capitalized on in different purposes, including geotourism.
[2] Details regarding this subcategory are displayed in Table 2

geological elements.[3] These properties, which are less obvious, refer mainly to the evolutionary changes in geological time and can only be observed and/or deduced by well-trained researchers in the fields of geology and geomorphology.

The presence of fossils or trace fossils especially of marine origin in mountain regions is a proof of the major climate modifications that occurred in geological time. Even though fossils are generally embedded in rocks or sediments, they may nevertheless be considered as a separate (palaeo) ecological feature.[4]

The derived characteristics comprise the *uniqueness* and *representativeness*.[5] They can hardly be considered self-standing characteristics, since a landform is neither unique nor representative *per se* but due to certain attributes it possesses. As a consequence, they fully depend on the Outer and Inner characteristics and become inherent attributes only when human reasoning – more than perception – is involved. *Uniqueness* refers to a landform's genesis, structure and evolution, whereas *representativeness* refers to a landform's physiognomy and attractiveness (Figure 3). Both of them are equally important since their meaning is to quantify the landforms' educational relevance for geotourism interpretation.

The *surface*, *height/depth/breadth* and *degree of preservation* are directly shaped by the *external agents and processes*. The *chromatic* reflects the nature of the geological materials that influence the force and intensity of action of the external agents. The *auxiliary or integrated geo(morpho)logical elements* often provide additional information regarding the formation of a geomorphosite while the presence of (trace) fossils provides clues regarding the paleoclimatic evolution of the environment. The *uniqueness* refers to the Inner characteristics while the *representativeness* refers to the Outer characteristics.

Some of the intrinsic characteristics, however, are sometimes referred to as determinants for establishing the additional values of geomorphosites, yet this may diminish or alter both their scientific and educational relevance.[6] Although designed for the purpose of geotourism, the present study dismisses any additional values since it is not a holistic approach that is assumed, but a restricted, scientific one.

ASSESSING THE SCIENTIFIC VALUE – FROM "*LANDFORMS*" TO "*GEOMORPHOSITES*"

The second step of the study comprises the assessment of the scientific value of landforms. In order to achieve this, the intrinsic characteristics must undergo an assessment process. Although it has been argued that not only the criteria but the methods themselves are invariably dependent on the scope of the research (Grandgirard, 1999; Reynard et al., 2007), the natural characteristics of the study area play an equally important role since they may require either the insertion of new criteria or the overall adaptation of an existing method, especially if the region is significantly different from the one the method has been originally developed for. Both the Alps and the (Southern) Carpathians share the same geological age, yet the general elevation and the climatic conditions are responsible for ascribing different geomorphological characteristics, the most important of which is related to the evidence of Pleistocene glaciers. While they are still well represented in the Alps, they did not persist in the Carpathians.

Nonetheless, two studies have been carried out so far in order to assess the geomorphosites within the Bucegi Mountains of Romania's Southern Carpathians by employing

[3] Details regarding this subcategory are displayed in Table 2

[4] Although paleontology lies on the border between geology and biology, the relation between fossils and rocks may have stood for its being commonly regarded as a field of geology.

[5] Details regarding this subcategory are displayed in Table 2

[6] In some assessment methods and studies, *surface* and *height* feature as criteria for determining the Scenic/Aesthetic value of a geomorphosite (Pralong, 2005, Cocean, 2011a).

J.-P. Pralong's assessment method. The first of them aims to provide a basis for further suggesting protection measurements and promoting tourism (Comănescu & Dobre, 2009). The second one engages both specialists and tourists in the evaluation process, with the final results revealing divergent opinions between the two categories (Comănescu & Nedelea, 2010).

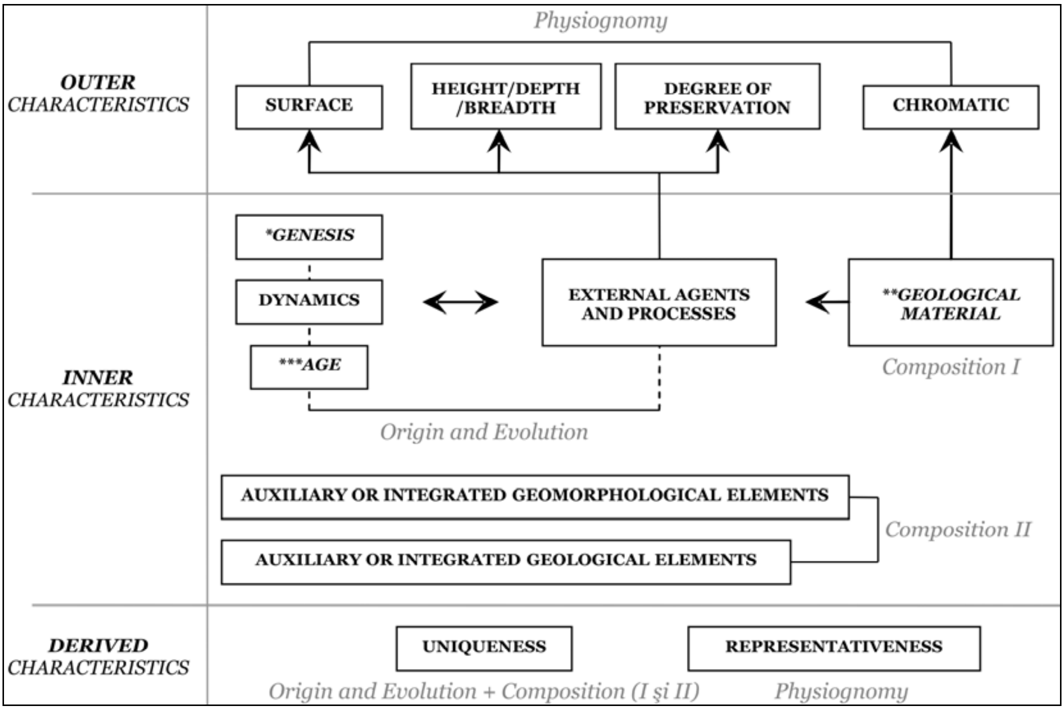


Figure 3. Scheme illustrating a model approach for the interpretation of the scientific value of a geomorphosite

As the scientific value is a prerequisite for the existence of a geomorphosite, all evaluation methods, regardless of their purpose, contain criteria for its assessment (e.g. Grandgirard, 1999 – in a study serving as a general framework for developing evaluation methods; Bruschi & Cendrero, 2005 – in a study aiming at the protection and sustainable development of geomorphosites; Coratza & Giusti, 2005 – in a study designed for territorial planning, environmental studies and protection of natural heritage; Pralong, 2005 – in a study that has as its main purpose the assessment of the tourist potential and use of geomorphosites; Serrano & González-Trueba, 2005 – in a study directed towards the proper use and management of geomorphosites encompassed within protected areas; Reynard et al., 2007 – in a study concerned with the assessment of the overall global value of geomorphosites; Cocean, 2011a, b – in a study focusing on a regional ranking of geomorphosites).

However, "*different national geomorphological contexts and objectives have not allowed the development of universal guidelines*" (Pereira & Pereira, 2010, pp.216-217). Since none of the existing methods consider all the intrinsic characteristics of landforms which would be relevant in creating a scheme for the scientific interpretation of the origin and evolution of a geomorphosite, the method employed in this study is a compilation.

The assessment criteria correspond to the ten intrinsic characteristics introduced in the previous chapter as a direct consequence of both the particular geographical character of the study area and the purpose of the research (Table 2).

Table 2. The intrinsic characteristics of landforms as assessment criteria in determining their scientific value and "*geomorphosite*" status

		0	**0.25**	**0.50**	**0.75**	**1**
OUTER (VISIBLE) **CHARACTERISTICS**						
Geo1	Surface	tiny	small	moderate	large	huge
Note: The overall surface of the landform is expressed either in m^2 or in km^2. As the case may be, for various genetically identical landforms (e.g. erosion-shaped rocks, caves, waterfalls), charts or comparative scales should be provided as arguments for the given score.						
References in literature: Pralong, 2005						
Geo2	Height (can also be Depth or Breadth)	tiny	small	moderate	large	huge
Note: The *height* is only considered for positive landforms (upstanding topographic forms) and it is not the absolute elevation that is evaluated, but the relative elevation (height above a ground reference level). The *depth* is considered for negative landforms (low-lying topographic forms, including lakes) and the *breadth* for underground hollows (caves). All three are expressed in m^2. As the case may be, for various genetically identical geomorphosites, charts or comparative scales should be provided as arguments for the given score.						
References in literature: Pralong, 2005; Cocean, 2011ab						
Geo3	Degree of preservation	deteriorated to a great extent	-	deteriorated to a small extent	-	intact
Note: It refers to the integrity of the landform as a result of only natural causes (the degree of exposure to the external agents). A relatively intact structure is more attractive and can be more successfully used for an educational purpose.						
References in literature: Grandgirard, 1999; Bruschi & Cendrero, 2005; Coratza & Giusti, 2005; Pralong, 2005; Reynard et al., 2007; Zouros, 2007; Cocean, 2011ab; Coratza et al., 2012						
Geo4	Chromatic	low contrast	-	medium contrast	-	high contrast
Note: It refers to the colour contrast between the landform and the surrounding environment, hence determining its visibility. A low contrast is generated by slightly different colours or hues (e.g. a mountain summit within a ridge, a torrential gully within a mountain face). A medium contrast is the result of the association of closely related though vivid colours (e.g. a vegetation-covered ledge within a bare mountain face, an erosion-shaped rock within a plateau area). A high contrast is given by the occurrence of a striking colour – usually white (e.g. a limestone cliff emerging from a biotic environment, a waterfall seen from afar).						
References in literature: Pralong, 2005; Cocean, 2011ab						
		0	**0.25**	**0.50**	**0.75**	**1**
INNER (LESS VISIBLE) **CHARACTERISTICS**						
Geo5	External agents and processes	1	-	2	-	≥3
Note: They continuously shape the landform. As the number of agents increases, the complexity and educational potential of landforms also increase.						
References in literature: Serrano & González-Trueba, 2005						
Geo6	Dynamics	fast-evolving	-	noticeable	-	deducible
Note: It is not only the landform's dynamics that is considered, but also the dynamics of its integrated geo(morpho)logical elements (if any). However, the latter are considered only if their dynamics reflects within the landform's general evolution and influences its overall configuration. A landslide or a torrential gully may be regarded as having a fast dynamics, if their annual evolution ascribes significant modifications. Noticeable dynamics implies major differences that can be revealed through comparisons between photos taken in the course of several years. The deducible dynamics occurs in geological time and is mostly a matter of deduction.						
References in literature: Serrano & González-Trueba, 2005; Cocean, 2011ab						
Geo7	Auxiliary or integrated geomorphological elements	nonexistent	-	hardly identifiable	-	readily identifiable
Note: They refer to both simple and complex geomorphosites and include a wide range of geomorphological elements (e.g. landslides, glacial moraines, erosional landforms) situated within or close to a geomorphosite, which could be successfully used with an educational purpose.						
References in literature: Bruschi & Cendrero, 2005; Cocean, 2011ab						
Geo8	Auxiliary or integrated geological elements	nonexistent or insignificant	-	hardly identifiable	-	readily identifiable
Note: They refer to occurences of alien rocks within a geomorphosite (e.g. limestone / conglomerate / granite, etc. comprised in a structure which is mainly composed of sandstone). Instances of fossilized plants and animals or traces of such organisms within a geomorphosite or its surrounding area should also be considered.						
References in literature: Cocean, 2011ab						

		0	0.25	0.50	0.75	1
DERIVED CHARACTERISTICS						
Geo9	Uniqueness	common occurrence	-	rare occurrence	-	unique occurrence
Note: It refers to the origin and composition (geological material) of a landform as relevant in reconstructing a particular stage in the evolution of the study area. Structure shall not be confused with shape(!)						
References in literature: Grandgirard, 1999; Bruschi & Cendrero, 2005; Coratza & Giusti, 2005; Pralong, 2005; Reynard et al., 2007; Zouros, 2007; Joyce, 2008; Cocean, 2011ab; Coratza et al., 2012						
Geo10	Representativeness	insignificant	low	moderate	high	very high
Note: It refers to the shape of a landform as a major source of attractiveness among tourists. As the case may be, for various genetically identical landforms, geographical location and accessibility may also be considered. A unique landform in terms of composition will always receive the highest score for representativeness.						
References in literature: Grandgirard, 1999; Wimbledon et al., 2000; Bruschi & Cendrero, 2005; Pralong, 2005; Reynard et al., 2007; Zouros, 2007; Joyce, 2008; Cocean, 2011ab; Coratza et al., 2012						

Each score is given by quarter points on a 0 to 1 scale (with 0 corresponding to the lowest variable and 1 to the highest) while the final scientific value is expressed as an overall sum score. Apart from criteria and scores, additional information is provided in order to minimize inaccuracy and inconsistency as a result of misinterpretation. References to other methods are also indicated, although in different contexts the meaning of the same criterion may vary.

The scientific value is calculated as the sum score of the ten criteria, according to the following formula:

ScV = Geo1+Geo2+Geo3+Geo4+Geo5+Geo6+Geo7+Geo8+Geo9+Geo10, with a maximum achievable score of 10.

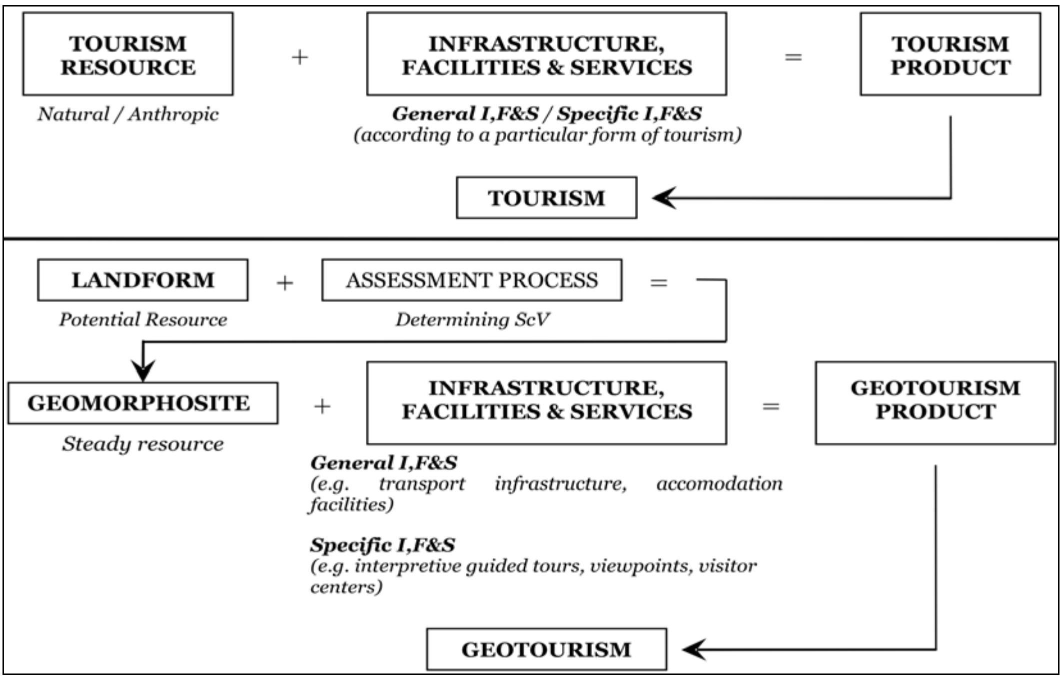


Figure 4. Tourism products are an inherent condition for the existence of any form of tourism

Far from being a goal in itself, the evaluation of the geomorphosites' scientific value is merely an intermediate step (Bruschi & Cendrero, 2005) in achieving the reasonable exploitation and conservation of geomorphosites as independent geotourism products (Figure 4). Landforms are potential resources for geotourism which, following the assessment of their scientific value, become steady resources or "*geomorphosites*". As an adequate management framework is implemented (hereby including good quality infrastructure, general and specific services and facilities), geomorphosites become authentic geotourism products.

Of all nature-based forms of tourism, geotourism is the only one that is concerned with the protection of the abiotic nature while at the same time it equally seeks to involve tourists in leisure and educational activities. Geotourism "*involves visitation to geosites for the purposes of passive recreation, engaging a sense of wonder, appreciation and learning*" (Newsome & Dowling, 2006, pp.3-4). Consequently it promotes an open approach towards geodiversity conservation, in the sense that areas bearing a scientific importance are not preserved exclusively by means of isolation, but by encouraging constant yet controlled tourist access while providing tools for an interactive interpretation of the Earth's history. "*With appropriate interpretation, any landscape, rock outcrop or landform can be made as exciting as spectacular displays of wildflowers and concentrations of wild animals*" (Idem, p.14). Although geotourism itself may be regarded as a tool for "*geodiversity conservation*", its more restricted approach focusing on the scientific value of geo(morpho)sites can nevertheless be broadened when dealing with additional values (Reynard, 2005; Reynard et al., 2007) or with geoheritage elements of outstanding cultural value (see Hose, 2005 approach on geoheritage).

INTERPRETING GEOMORPHOSITES – DECODING THE LANGUAGE OF LANDFORMS

The last step of the study aims to create a logical scheme to provide a model approach for the interpretation of the evolution of geomorphosites. While engaging in geotourism activities, specially trained guides explain the formation of landscapes in general and of geomorphosites in particular. In order to facilitate and enhance the tourist experience, the interpretation process should start from what is commonly visible for both the guide and the tourists, namely the Outer characteristics (*surface*, *height/depth/breadth*, *degree of preservation* and *chromatic*). Based on their careful observation, the Inner characteristics as well as the relations that establish between the two categories will be gradually revealed and explained. In a complex interpretive process, the Derived characteristics are essential reference parameters that help the guide decide what aspects must be emphasized.

In order to properly understand and interpret the evolution of a geomorphosite, three additional attributes of landforms should be considered, namely the *genesis*, *geological material* and *age*. Although they do not feature as self-standing criteria within the assessment method, they are essential for the interpretation process. The *genesis* refers to a landform's origin (e.g. glacial, periglacial, erosional, karst) and represents the premise for further explaining its formation. The *geological material* refers to the landform's composition which ensures a certain degree of resistance to the external agents and the processes they generate. The *age* refers to the approximate geological period when a geomorphosite was formed and can sometimes be correlated with the age of other genetically identical geomorphosites.

The *genesis*, *geological material* and *age* of landforms vary in response to the complexity and evolution of both tectonics and environmental conditions that occurred in geological time and are of major importance in understanding the current structure and shape of landforms. However it may prove hard and unrealistic to argue that a landform is of greater importance than another simply because it dates from an earlier period or because it has a different origin or composition (Grandgirard, 1999). Consequently, these three inherent attributes, although essential for the interpretive process, are hardly quantifiable and were not integrated within the assessment method as valid individual criteria.

THE BUCEGI MOUNTAINS OF ROMANIA'S SOUTHERN CARPATHIANS – A SHORT INTRODUCTION

The Bucegi Mountains are located at the easternmost edge of Romania's Southern Carpathians and are almost entirely encompassed within an IUCN[7] category V protected area, namely the Bucegi Natural Park. Their overall geological configuration is influenced by the suspended syncline – a concave folded structure with both limbs dipping towards a central valley – thus creating a trough bordered to the west and east by steep escarpments. The eastern flank of this syncline displays a wide and relatively flat surface commonly referred to as "*the Bucegi plateau*". As a result of wind and water erosion as well as thermal variations, distinctive erosional micro-landforms lie scattered across it.

With ever-growing numbers of tourists especially during summer time, the area is currently regarded as Romania's top mountain destination. During the last years, however, tourism activities and intensive overgrazing concentrated particularly within the Bucegi plateau generated negative impacts on the environment; among them littering, intense soil erosion, deforestation and general landscape degradation (Werren, 2007, Mihai et al., 2009). Consequently it is necessary that awareness should be raised regarding landforms' vulnerability and interpretation should be adopted as an educational tool. Interpretation helps tourists "*gain a better understanding of the natural environment* […] *thereby enhancing their experience*" (Chin et al., 2000, p.31), while education "*also has an important role in terms of communicating the reasons behind management actions* […]" (Idem, p.31) within a natural protected area.

CASE STUDY: THE SPHINX

The method was applied on ten erosional micro-landforms scattered across a tiny area in the north-central sector of the Bucegi plateau, relatively close to Babele chalet (Figure 5.a.). Their comparative analysis played a key-role in testing the eligibility and relevance of the intrinsic characteristics as valid criteria in the assessment method.

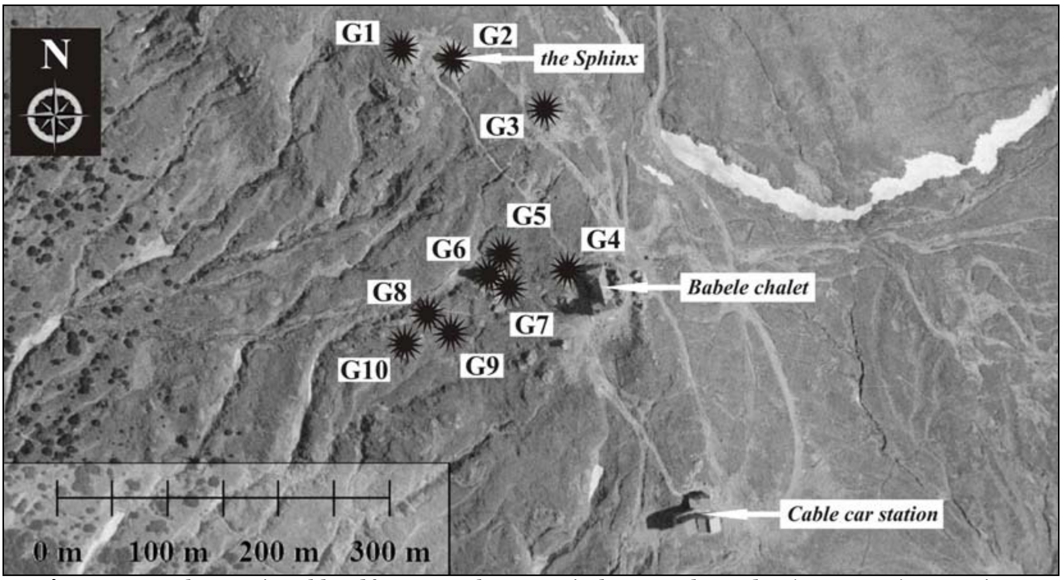


Figure 5.a. The erosional landforms on the Bucegi Plateau. The codes (G1 to G10) were given according to their local distribution from north to south and from east to west.
(Source: satellite image from Global Mapper v13.00, with subsequent annotations by the author)

[7] International Union for Conservation of Nature

Given the many instances of such landforms with common origin, in order to avoid a random selection, the geographical location on the one hand and the physiognomy on the other were considered.

The comparative analysis also confirmed the hypothesis according to which any of the micro-landforms possesses an equally important scientific value and can thus constitute the object of a scientific interpretation, regardless its degree of attractiveness among tourists. The ten micro-landforms can be divided in three major groups: G1-G4 comprises four individual geomorphosites, located north of Babele chalet. The unusual physiognomy of especially G2 (the Sphinx) and G4 (“*Babele*”=“*The Old Ladies*”) accounts for high numbers of tourists every day. G5-G7 comprises a group of three landforms scattered westward of the Babele chalet on the smooth slope descending towards Ialomiţa valley. Their less striking physiognomy determines a lower degree of attractiveness. G8-G10 comprises a group of three landforms located further away from the previous ones. They were especially selected because of their relative remoteness and ordinary shapes. Although tourists may regard them as unattractive they have the same scientific relevance as the others (Figure 5.b.).

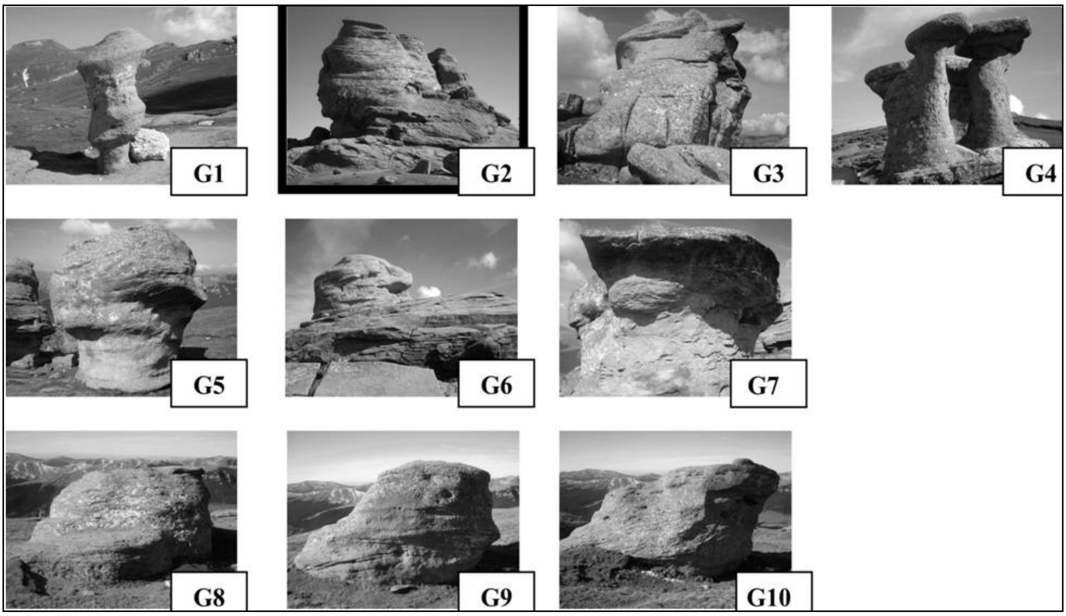


Figure 5.b. The ten micro-landforms can be divided in three major groups (G1-G4; G5-G7; G8-G10) according to their degree of attractiveness and proximity to the Babele chalet

The derived characteristics – *uniqueness* and *representativeness* – bear significant relevance in the evaluation since they provide a general overview on the results of the comparative analysis. On the one hand, as far as *uniqueness* is concerned, landforms acquired no score. Although this may decrease the overall scientific value, hence revealing their common origin and composition, it does not alter, in any way, the importance of any of the other characteristics. On the other hand, in terms of *representativeness*, the landforms acquired different values. In the first group (G1-G4), G2 and G4 both received the maximum score of 1, while G1 and G3, as well as the entire geomorphosites in the second group (G5-G7) received the average score of 0.5. The last group (G8-G10) earned no points. Following the comparative evaluation, the Sphinx – a geomorphological landmark of Romania’s (Southern) Carpathians and a major tourist attraction in the Bucegi Mountains – proved to be the most representative. If two or more landforms in the study area share a common origin, a comparative analysis should be performed not only to properly estimate the first two criteria (*Surface* and *Height/Depth/Breadth*) but also to obtain a deeper insight on the differences occurring among identical geomorphosites. This will allow further comparisons between larger areas comprising genetically distinct geomorphosites.

Table 3. Assessment of the scientific value of the Sphinx, based on the evaluation of its intrinsic geo(morpho)logical characteristics

		0	0.25	0.50	0.75	1
OUTER (VISIBLE) **CHARACTERISTICS**						
Geo1	Surface	tiny	small	moderate	large	**huge**
Note: Of all the erosional micro-landforms, the Sphinx has the greatest surface (100 m^2). A comparative scale is attached in **APPENDICES Figure 1**						
Geo2	Height	tiny	small	moderate	large	**huge**
Note: Of all the erosional micro-landforms, the Sphinx has the greatest height (□10 m). The whole structure was considered, from bottom to top. A comparative scale is attached in **APPENDICES Figure 2**						
Geo3	Degree of preservation	deteriorated to a great extent	-	**deteriorated to a small extent**	-	intact
Note: The overall structure is slightly deteriorated due to the cumulated actions of the external agents.						
Geo4	Chromatic	low contrast	-	**medium contrast**	-	high contrast
Note: The Sphinx creates a moderate colour contrast with its surrounding environment. However, this may vary according to the time of day, the intensity or amount of sunlight and the season which also influence to a great extent the overall chromatic of the alpine vegetation. The general colour of the structure itself is the result of alternating layers of sandstone and conglomerate with hues that vary from light and dark brown to grey, white and black.						
		0	**0.25**	**0.50**	**0.75**	**1**
INNER (LESS VISIBLE) **CHARACTERISTICS**						
Geo5	External agents and processes	1	-	2	-	**≥3**
Note: The Sphinx is the result of three active external agents: *water* resulting from rain and snowmelt (determining the main processes of sheet and rill erosion), *wind* (generating processes of deflation and abrasion) and *thermal amplitudes* (determining successive freeze-thaw processes).						
Geo6	Dynamics	fast-evolving	-	noticeable	-	**deducible**
Note: Overall dynamics is slow and may only be deduced. However, repetitive freeze-thaw processes generate hollows and fissures whose constant evolution is noticeable.						
Geo7	Auxiliary or integrated geomorphological elements	nonexistent	-	hardly identifiable	-	**readily identifiable**
Note: A close examination of the structure reveals hollows and fissures especially concentrated along the natural stratification of sandstone layers. Around the base of the Sphinx permeable and cemented sand deposits are clearly visible.						
Geo8	Auxiliary or integrated geological elements	**nonexistent or insignificant**	-	hardly identifiable	-	readily identifiable
Note: -						
		0	**0.25**	**0.50**	**0.75**	**1**
DERIVED CHARACTERISTICS						
Geo9	Uniqueness	**common occurrence**	-	rare occurrence	-	unique occurrence
Note: In terms of origin (erosional landform) and geological material (sandstone and conglomerate), the Sphinx is a common presence within the north-central sector of the Bucegi plateau.						
Geo10	Representativene ss	insignificant	low	moderate	high	**very high**
Note: The Sphinx stands out through its unusual anthropomorphized shape, greatly resembling a human profile. This provides it with a great educational relevance.						

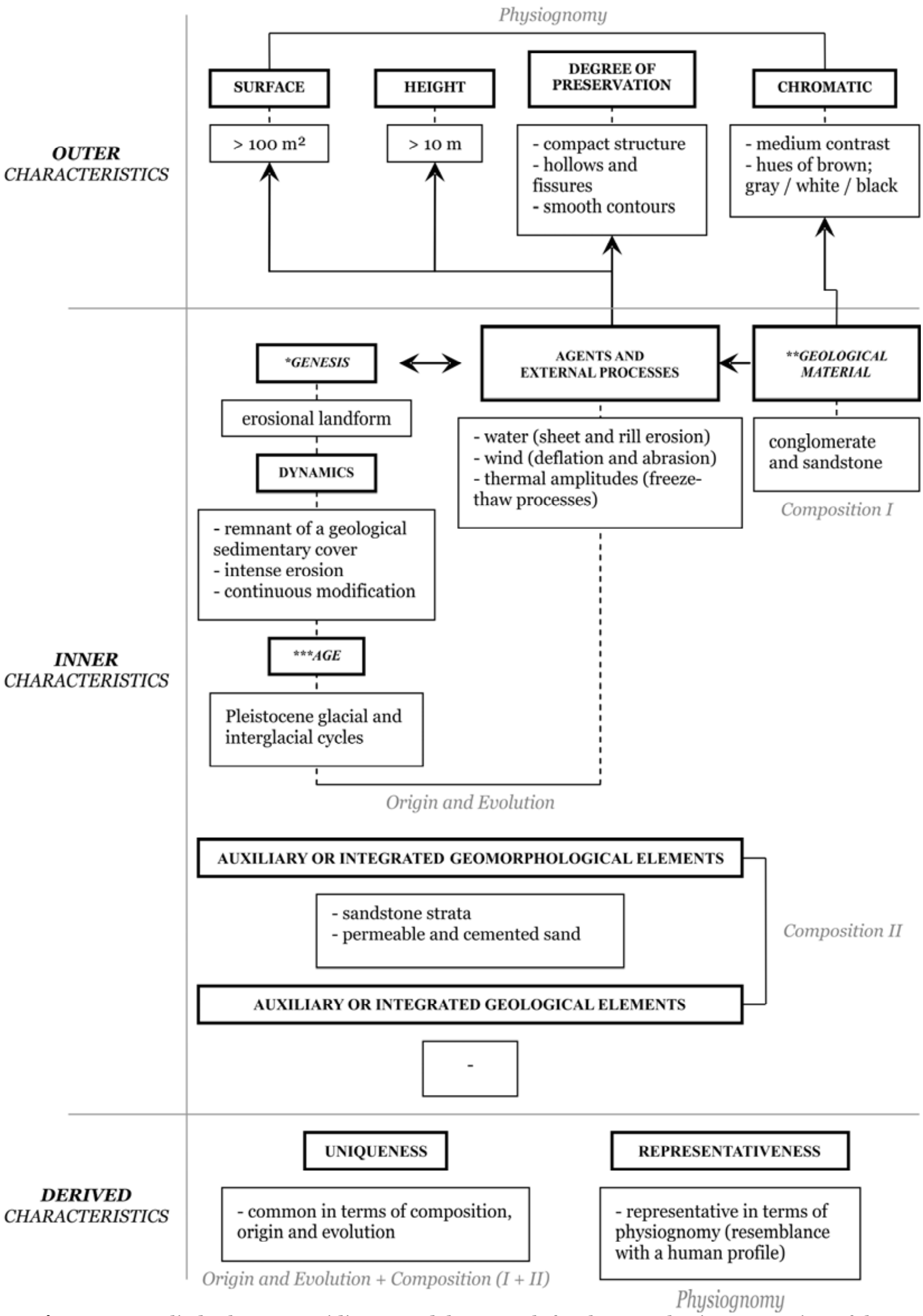


Figure 6. Applied scheme providing a model approach for the complex interpretation of the scientific value of an erosional micro-landform (the Sphinx)

ScV (Sphinx) = Geo1+Geo2+Geo3+Geo4+Geo5+Geo6+Geo7+Geo8+Geo9+Geo10 = 1+1+0.5+0.5+ 1+1+1+0+0+1 = 7

Following the assessment of the scientific value of the Sphinx, an interpretation scheme was created (Figure 6).

INTERPRETING THE ORIGIN AND EVOLUTION OF THE SPHINX

GENESIS (Premise for the interpretation) The Sphinx is a remnant of an old and compact sedimentary layer that expanded across the north-central sector of the Bucegi plateau. This structure has been gradually eroded in geological time, resulting in isolated patches with different sizes and shapes.

Outer characteristics

SURFACE and HEIGHT The Sphinx is the largest (>100 m^2) and the highest (>10 m) of all similar geomorphosites from the Bucegi plateau.

DEGREE OF PRESERVATION and CHROMATIC It appears as an overall compact and massive structure, with hues generally varying from yellow to brown, but also white and black. According to the season and the weather conditions the contrast with the surrounding environment is obvious yet not striking.

Inner characteristics

GEOLOGICAL MATERIAL The Sphinx is made of sandstone and conglomerate. While sandstone is the result of sand grains being cemented together into rock, conglomerate is created when gravel and other clasts larger than sand grains are cemented together into a solid mass. According to the amount of silica or calcite they contain, cements may be more or less resistant, thus increasing or limiting the action of the external agents. The chromatic of the geomorphosite reflects the natural colour of the geological materials.

Figure 7.a. (left) Fissures and hollows occur as rock particles are being carried away by wind and water erosion; Figure 7.b. (right) Freeze-thaw processes lead to their subsequent expansion.

EXTERNAL AGENTS AND PROCESSES The Sphinx is the result of the cumulated action of three main agents: water, wind and thermal amplitudes. During rainfalls, water and wind have the greatest impact on its surface. Rock fragments are ejected, then carried away and finally deposited. In time, heavy rainfall may cause severe damage on the structure since water flowing down the steep slopes sometimes concentrates along narrow gullies corresponding to layer stratifications, generating fissures and tiny hollows (Figure 7.a). When temperatures fall below 0°C, water filling these gaps turns into ice which expands putting huge pressures on the rock walls – approx. 2,000-6,000 kg/cm² (Posea et al., 1976, p.114). This process allows fissures to enlarge (Figure 7.b.). In the case of conglomerate, selective erosion loosens the cohesion of rock fragments according to their resistance and degree of cementation.

DYNAMICS and *AGE* The evolution of the Sphinx is a long and complex process that has been lasting for tens and hundreds of thousands of years. The Earth's climate suffered major changes with most of them occurring in the Pleistocene (cca 1,800,000 – 11,700 BC), a geological stage dominated by glacial and interglacial cycles, during which continental glaciers expanded and retreated. During the warmer interglacial periods, the processes generated by external agents reached their maximum intensity.[8]

SURFACE, HEIGHT and DEGREE OF PRESERVATION are determined by the evolution and intensity of the processes generated by the external agents. As time elapses, the Sphinx gradually decreases in surface and height. Although the overall dynamics of the structure goes unnoticed, at a component level, modifications are noticeable.

AUXILIARY OR INTEGRATED GEOMORPHOLOGICAL ELEMENTS Apart from gaps accounting for different erosion rates, cemented and permeable sands surrounding the Sphinx are mainly deposited at the base of its northern and western faces (Figure 8). The sandstone layers are predominantly horizontal. Unconsolidated sand in response to the long-lasting erosion of the Sphinx also reveals the cyclic process of sand grains. Once they are carried away by water and wind, they are laid at the base of the structure where in time they recement together into sandstone.

AUXILIARY OR INTEGRATED GEOLOGICAL ELEMENTS No significant alien rocks or traces of fossils are found.

Figure 8. Randomly-oriented consolidated and partially unconsolidated sands at the base of the western face of the Sphinx

[8] According to V. Micalevich-Velcea, the Sphinx is a periglacial structure. Out of the two subsequent stages that occurred – the fossil and the present periglacial – the former, correlated with an interglacial stage, had a decisive role in the formation of the erosional landforms which are nowadays encountered throughout the Bucegi plateau (Micalevich-Velcea, 1961, pp.93-94)

Derived characteristics

UNIQUENESS In terms of genesis, composition and evolution, the Sphinx is definitely not a unique presence on the Bucegi plateau, but one of many leftovers of a compact layer that has been worn away by erosion.

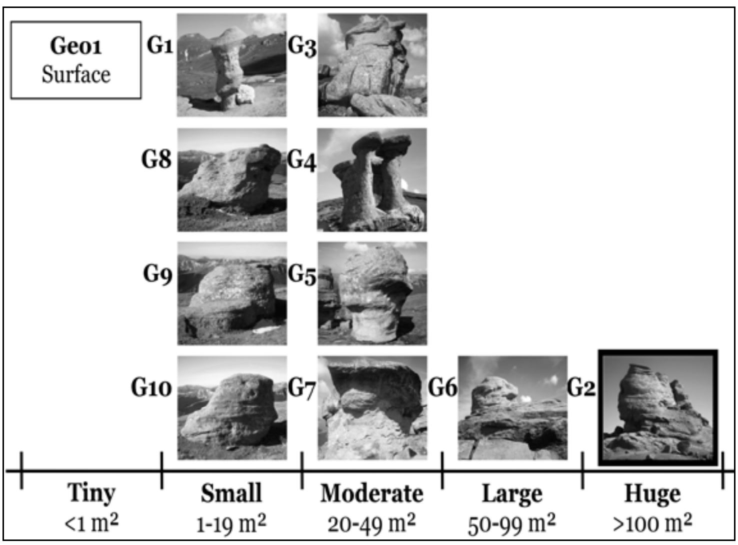
REPRESENTATIVENESS Located less than five minutes away from the Babele chalet, the Sphinx displays remarkable and well-individualized anthropomorphic features that influence to a great extent its attractiveness among tourists. This also increases its educational value for geotourism.

CONCLUSION

Geodiversity elements around the world are relevant to understanding and reconstructing specific stages in the geological evolution of the Earth. Among them, geomorphosites are complex entities consisting of two major components: a landform and a scientific value. They are, at the same time, an inherent condition for the practice of geotourism.

The assessment of a geomorphosite's scientific value and its further interpretation require a three-step research study. The first step implies the identification and classification of the intrinsic attributes of landforms, comprising both Outer and Inner characteristics which may be easily observed or only deduced. The second step consists of an evaluation process employing an assessment method, according to which the attributes of landforms acquire a score. Subjective bias is common during any assessment process, regardless of the object of the analysis, and may severely alter the final results. In order to minimize its impact, detailed arguments and explanations must be provided according to field observations. As the case may be, comparative analyses of genetically identical landforms should also be performed since they provide a deep perspective on the morphology and evolution of similar geomorphosites and also enable the possibility to expand and diversify further studies. Once ascertained, the scientific value of geomorphosites becomes an educational value. The last step, which also marks the transition from the geomorphosite evaluation to the geotourism interpretation, consists of the elaboration of a scheme providing a model approach for the interpretation of the scientific value. A proper management framework ensuring access, services and facilities is a major prerequisite in order to acquire a final geotourism product.

APPENDICES



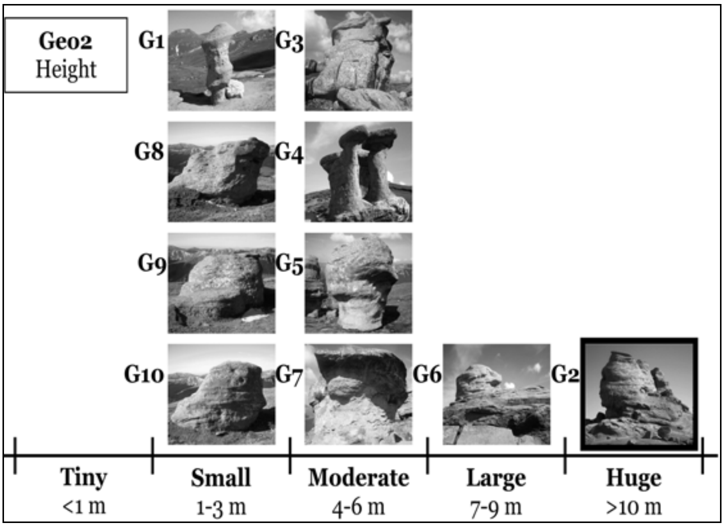


Figure 1. and **Figure 2.** Comparative scale for the surface / height evaluation of the Sphinx. Nine other genetically identical geomorphosites were considered

The erosional landforms scattered across the Bucegi plateau share a common origin, age and composition. Regardless of their attractiveness among tourists, they bear an equally important scientific relevance in reconstructing a recent stage of the geological history of the Bucegi Mountains and its environment conditions. The Sphinx, however, is the most representative of all similar geomorphosites. Due to both its complex morphology and anthropomorphic features, it acquired the highest scientific value (7) and was thus considered as the most appropriate example to support the interpretive process.

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