ΑΞΙΟΛΟΓΗΣΗ ΚΑΙ ΔΙΑΧΕΙΡΙΣΗ ΓΕΩΤΟΠΩΝ

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Περίληψη

Η Ελλάδα λόγω της πολύπλοκης γεωλογικής δομής και τις ποικιλίας των γεωμορφολογικών διεργασιών που επηρεάζουν και διαμορφώνουν το ανάγλυφο της ξηράς χαρακτηρίζεται από ιδιαίτερα υψηλή γεωποικιλότητα και ιδιαιτέρα στις προστατευταίες περιοχές, φιλοξενεί αξιόλογους γεωτόπους.

Ο όρος γεώτοπος (geosite/geotope) δημιουργήθηκε ακολουθώντας έναν αντίστοιχο ορισμό της βιολογίας και περιγράφει μια τοποθεσία με μοναδική και εξέχουσα εμφάνιση γεωλογικού ή γεωμορφολογικού ενδιαφέροντος, σε σχέση με το περιβάλλον της. Άλλοι επιστήμονες θέλοντας να δώσουν μεγαλύτερη έμφαση στην γεωμορφολογικές διεργασίες χρησιμοποίησαν τον όρο γεωμορφολογικές θέσεις (geomorphosites). Ως γεώτοπος (geosite/geotope η/και geomorphosite) χαρακτηρίζεται μια θέση στην οποία εμφανίζονται σημαντικές γεωλογικές δομές, χαρακτηριστικές ή σπάνιες μεταλλοφόρες εμφανίσεις, σπάνιες ορυκτολογικές παραγενέσεις και πετρολογικές εμφανίσεις, ιδιαίτερες ιζηματογενείς δομές, σπάνια ή χαρακτηριστικά απολιθώματα, στρωματότυποι, χαρακτηριστικές τεκτονικές δομές, θέσεις σύγχρονων γεωμορφολογικών και γεωλογικών διεργασιών, γεωμορφές, ιδιαίτεροι γεωμορφολογικοί σχηματισμοί και τοπία ιδιαιτέρου φυσικού κάλους.

Σε αντίθεση με την αυτονόητη αξία τους για το φυσικό περιβάλλον και παρά τη σχετική πρόβλεψη του Ν.1650/86, οι γεωτόποι δεν κατάφεραν να αποτελούν αντικείμενο αυτόνομης προστασίας και διαχείρισης αλλά προστατεύονται μέχρι σήμερα χάρη στην αρχαιολογική ή τη δασική νομοθεσία για την προστασία οικοτόπων ή τοπίων ιδιαιτέρου φυσικού κάλλους.

Στην εργασία αυτή προτείνεται μια μεθοδολογία αξιολόγησης η οποία εφαρμόζεται σε γεωτόπους ευρύτερης σημασίας (γεωλογικά – γεωμορφολογικά μνημεία) που βρίσκονται εντός προστατευμένων περιοχών με σκοπό να συμβάλει στην προστασία και την αποτελεσματική διαχείριση τους. Η προτεινόμενη μεθοδολογία αξιολόγησης περιλαμβάνει έξι κατηγορίες κριτηρίων 1)επιστημονική και εκπαιδευτική αξία, 2) γεωποικιλότητα, 3) βιολογική και αισθητική αξία, 4) πολιτιστική αξία, 5) απειλές και ανάγκες προστασίας 6) δυναμικό για την αξιοποίηση τους.

Η εφαρμογη της μεθοδολογίας γίνεται σε 14 σημαντικές θέσεις γεωτόπων που περιλαμβανονται σε προστατευόμενες περιοχές.

Η διαδικασία αξιολόγησης των γεωτόπων αποτελεί προϋπόθεση για τον σχεδιασμό και την εφαρμογή ενός σχεδίου διαχείρισης της γεωποικιλότητας μιας περιοχής (geodiversity action plan) το οποίο θα περιλαμβάνει δράσεις που αφορούν στην προστασία, ανάδειξη, προβολή και πρόσφορη αξιοποίηση της φυσικής κληρονομιάς της περιοχής.

GEOSITE ASSESSMENT AND MANAGEMENT

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Abstract

Greece is characterized by a complex geological setting and evolution and was subjected to a variety of geological and geomorphological processes, resulted in a high geodiversity. As a result a large number of spectacular landscapes and geosites are present in the country's protected areas.

In spite of their intrinsic value for the natural environment the protection of geosites in Greece is related mainly to the conservation of habitats and ecosystems or with the protection of cultural sites. Thus geosites failed to gain attention autonomously, as elements of value for conservation and management.

The aim of this paper is to present a methodology for assessing geosites lying in protected areas which will contribute to the appropriate management of the sites.

The evaluation process includes six criteria: 1) scientific and educational value; 2) geodiversity; 3) ecological and aesthetic value; 4) cultural value; 5) potential threats and protection needs; and 6) potential for use.

In this study 14 geosites of different size and categories were selected, classified and assessed using the above mentioned methodology.

The results can be used be the managing authority of each site to establish a geodiversity action plan and encourage geoconservation and sustainable local development.

1. Introduction

The term Geosite is used by IUGS in 90's to describe first-class importance to global geology sites, outstanding examples representing major stages of Earth history, significant ongoing geological processes in the development of landforms (Gray 2004). The term geotope in German literature was proposed (Strum 1994) as a loan-term from Biology. A Geotope is the geological component of the abiotic matrix present in an ecotope.

The term geomorphosite is proposed to describe landforms presenting a particular importance for the comprehension of Earth history, spatially delimited and scientifically clearly distinguishable from their surroundings (Grandgirard 1997, Reynard 2005).

During the last decade several synonyms have been used: geomorphological assets (Panizza & Piacente 1993), geomorphological sites (Hooke 1994), geomorphological geotopes (Grandgirard 1997), sites of geomorphological interest (Rivas et al. 1997). According to the broad definition proposed by Panizza (2001) geomorphosites are geomorphological landforms that have acquired a scientific, cultural/historical, aesthetic and/or social/economic value due to human perception or exploitation. According to a more restrictive definition a geomorphosite is defined as a part of Earth surface of particular importance for the knowledge of Earth, climate and life history (Reynard 2004). They can be single geomorphological objects or wider landscapes (Reynard and Panizza 2005).

Every geomorphosite is located within a particular landscape. Current landforms are the result of three evolutions, the history of rocks, the history of tectonic deformation and the

history of landforms (Reynard 2005).

The Geopark concept was developed mainly in Europe in cooperation with UNESCO. Geoparks are nationally protected areas which include a number of internationally important geological heritage sites (geosites and geomorphosites) on any scale, or a mosaic of geological entities of special scientific importance, rarity or beauty. These features are representative of the region's geological history and the events and processes that formed it. Geoparks have well-defined limits and comprise large enough surface area for it to serve local economic and cultural development (Eder and Patzak 2004, Zouros 2004).

Until recently, no international convention specifically on geological heritage existed. Taking into account the importance of common goals for advancing geological heritage activities, educating the public on the environment, and promoting regional sustainable development, the United Nations Educational, Scientific and Cultural Organization (UNESCO) decided to establish the Global Geoparks Network of National Geoparks in February 2004 providing UNESCO's support to and co-operation with National Geopark initiatives.

This initiative of UNESCO to support Geoparks responds to the need for an international framework to enhance the value of the Earth's heritage, it's landscapes and geological formations, which are key witnesses to the history of life. Geology and landscape have profoundly influenced society, civilization, and the cultural diversity of our planet (UNESCO 2006).

2. Geosites in Greek protected areas

Greece with its complex geological and geomorphological setting and evolution, the great variety in climatic conditions and the numerous islands and convoluted coastline presents a great diversity of natural scenery. The abiotic diversity and the "mosaic" of micro-climatic types, is reflected in the presence of a highly diverse flora and fauna and a great variety of ecosystems.

Greece is primarily a mountainous country, with seventy per cent of its territory covered by mountains (42 summits over 2000m) and a very long coastline, with a plethora of peninsulas, gulfs and islands.

The Hellenic orogen is a composite one, consisting of three orogenic belts (Mountrakis 2005). The first one is the Cimmerian internal belt, in pre-Late Jurassic times as the result of the northward drift of Cimmerian continental fragments from Godwana towards Eurasia. Rodope mountain range is the most prominent feature. The second one is the Alpine orogenic belt, created during Cretaceus-Tertiary times after the Neotethyan subduction beneath the Cimmerian-Eurasian plate and the collision of the Apulia to the great plate. Pindos mountain range is the main feature of this belt. The third one is the Mesogean orogenic belt along External Hellenic arc, due to the Mesogean-African underplate beneath the unique Alpine-Eurasian plate in Miocene-Pliocene times and the exhumation of the Cretan-Southern Peloponnesus tectonic windows (Figure 1). During Alpine and Mesogean orogenic processes in Tertiary a SW migration of successive compressional and extentional tectonic events took place, producing nape stacking and extentional exhumation of underplate rocks. During Pliocene to recent times the extensional processes continued in the broader Aegean area producing normal and strike-slip faults.

The complex geological and geomorphological setting and evolution of the Hellenides resulted to the presence of a high geodiversity. A large number of spectacular geosites are present in the country's protected areas (Figure 2). Some of the most important geosites such us the Meteora, the Olympus mountain, the Samaria gorge in Crete, the Lavrion ancient mines included in the Sounion NP, the Petrified forest of Lesvos, the Vicos and Aoos gorges in Epirus, the Diros caves in Peloponnesus, the Santorini volcanic caldera, the Prespes lakes in West Macedonia, the Falakron Mountain – Aggitis karstic system in Easter

Macedonia, the Northern Pindos Mountain chain, the Tempi valley and Pinios river delta, the Psiloritis Mountain in Crete, the Milos island etc are well-known, legally protected and established tourist attractions with thousands of visitors each year.

Although the intrinsic value of geosites and geomorphosites for the natural environment is broadly accepted, their recognition in Greece is related mainly to the conservation of habitats and ecosystems or with the protection of cultural sites. Geosites and geomorphosites failed to gain attention autonomously within the protected areas as elements of value for conservation and management.

The need for conservation and appropriate management of the reach geodiversity in the protected areas and especially to those including geomorphosites and geosites of outstanding importance and value, led to the establishment of the first Greek Geoparks, the Lesvos Petrified Forest geopark in 2000 and the Psiloritis geopark in Crete in 2001 (Zouros 2004).

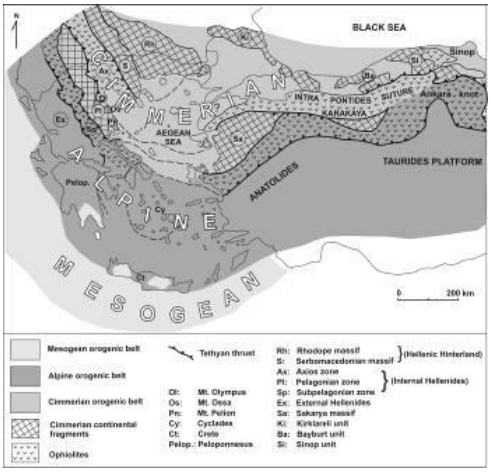

Figure 1. Structural sketch-map showing the three orogenic belts of the Hellenic Orogen and their extension to the Minor Asia region. Cimmerian continental fragments and ophiolitic sutures after Mountrakis 1986 and 2005.

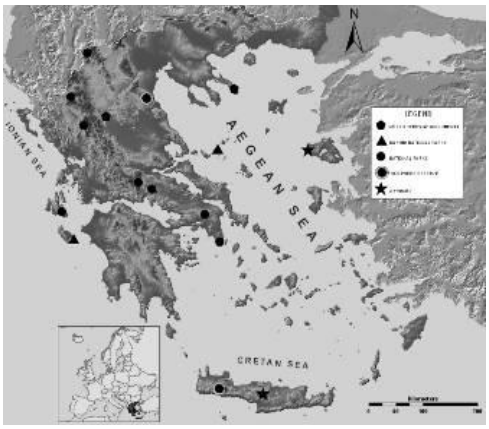

Figure 2 – W.H. Sites, Biosphere reserves, National parks and other protected areas in Greece.

3. Geosoite / Geomorphosite assessment methodology

Assessment methodologies have been recently established using quite similar criteria (Grandgirard 1997, Reynard 2004, 2005, Coratza & Giusti 2005, Bruschi & Cendrero 2005, Serrano & Gonzalez-Trueba 2005, Pralong 2005).

The methodology applied to assess geosites / geomorphosites in Greek protected areas uses a series of six criteria. For each criterion several indicators are adopted: 1) scientific and educational value : integrity, rarity, representativeness, and exemplarity; 2) geodiversity; 3) ecological and natural aesthetic value; 4) cultural value; 5) potential threats and protection needs : legal protection, vulnerability; and 6) potential for use : recognizability, geographical distribution, accessibility, and potential for generating economic activities (Zouros et al. 2004a, Zouros 2005, Zouros 2007).

For each criterion or indicator a ranking from 0 to 10 or in some cases from 0 to 5 is been used. The incorporation of criterion 1 in the evaluation process was performed by assigning a numerical value (within a range 40-0) based on the integrity (10-0), rarity (10-0), representativeness (10-0), and exemplarity (10-0) of each site.

A numerical value (10-0) was assigned to criterion 2 based on the number of distinguished geological and geomorphological phenomena that appear in each site.

Criterion 3 was incorporated by assigning a maximum (10) or minimum value (0) based on the site characterization by international designation or by national or regional legislation (WHS- Natural World heritage site or MAB-Biosphere reserve, National park or National natural monument, Natural park, Regional park, Locally protected site)

Criterion 4 was incorporated by assigning a maximum (10) or minimum value (0) based on the site characterization by international designation or by national or regional legislation (WHS- Cultural World heritage site, National cultural monument, Cultural landscape or landscape of outstanding aesthetic beauty, Regionally protected site, Locally protected site).

A numerical value (5-0) was assigned for each one of the two indicators which compose the criterion 5. The level of legal protection was taken into account by assigning a value from 5 to 0 (international designation, national park or monument, protected by national legislation, regional protection, poor protection, no protection) Similarly the presence and the magnitude of potential threats were taken into account by assigning a value from 5 to 0 (uncontrollable risk, strong pressure, moderate risk, controlled risk, poor risk, no risk).

A numerical value (5-0) was assigned for each one of the four indicators which compose the criterion 6, recognizability (international, national, regional, local, known only by scientific community, unknown), geographical distribution (numerical value expresses the percentage of the space occupied by the geomorphosites in comparison with the total surface of the protected area), accessibility (by a road of regional or national importance, by local road, by unsurfaced road, by foot path, with permission only, no access) and potential for generating economic activities (more than 75.000 visitors, more than 50.000 visitors, more than 20.000 visitors, more than 5.000 visitors, less than 5.000 visitors, no visitors).

The quality of geomorphosite is expressed by the total number of credits ranking from 0 -100.

The results of the assessment of selected geosites / geomorphosites are shown in Table 1. The evaluation of the above mentioned six criteria allows comparing the importance of each attribute in the assessment of the sites. Assessment of the 14 first class geosites/geomorphosites, led to their classification according to their intrinsic value, their ecological and cultural value as well as management value. All examples can be considered as geomorphological landscapes (Reynard 2005) rather than single

geosites/geomorphosites.

Regarding the final assessment, the percentage of high-scoring geosites is outstanding, showing excellent scoring for scientific and educational value, ecological and cultural value, as well as management value.

The same methodology can be used to evaluate each single geosites/geomorphosites present within the national protected areas in Greece, thus representing a useful management tool.

In Geoparks the recognition of the values of the earth heritage sites is part of an holistic concept of protection, education and sustainable development. Assessment methodology can help the Geopark management by quantifying values of geomorphosites, to take into account the whole geographical setting of the region.

4. Conclusions

Geosites have the potential to gain recognition as natural and tourist resources with serious economic effects, especially for those located in protected areas. The proposed methodology for geosite / geomorphosite assessment applied in Greek National parks showed that the examined geosites / geomorphosites fulfil the criteria to be characterized as great attractions in terms of scientific and educational value, aesthetic appeal and potential for use.

The same methodology can be applied in Geoparks for the classification and characterization of single geosites / geomorphosites. Using the results the managing authority of each protected area to establish a geodiversity action plan and include activities aiming the monitoring and safeguarding of the geosites, the valorisation of local identities linked to their presence, the creation of the necessary touristic infrastructure, the development of new local products and services, encourage local economic growth and creation of new opportunities for employment.

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TABLE 1

Results of selected geosite assessment in Greek protected areas

	Name	Meteora	Lavrion ancient mines	Olympus Mnt.	Samaria gorge	Lesvos petrified forest	Vicos - Aoos gorges	Diros cave	Santorini caldera	Prespes lakes	Psiloritis karstic features	Falakro Mnt. - Aggitis kartic sys.	North Pindos Mnt.	Tempi - Pinios Delta	Milos volcanics
	Status	CM	NP / CM Natura	NP /Natura	NP / Natura	NM / G Natura	NP / Natura	CM	LAB / Natura	NP / Natura	CM / G / Natura	CM / Natura	NP / Natura	NM / Natura	Natura
1	**scientific & educational value**														
1.1	integrity	10	9	10	10	8	10	10	8	8	8	8	8	8	8
1.2	rarity	9	9	7	9	9	7	7	8	6	6	6	6	6	6
1.3	representativeness	9	8	7	8	9	7	7	8	6	6	6	5	6	6
1.4	exemplarity	9	8	8	8	7	6	6	9	5	6	6	5	6	6
2	**geodiversity**	4	6	9	6	7	6	3	5	4	5	4	7	5	3
3	**ecological & aesthetic value**	10	8	10	10	8	8	6	6	9	7	7	8	8	7
4	**cultural value**	10	8	8	6	6	6	8	6	8	8	8	6	8	8
5	**potential threats & protection needs**														
5.1	legal protection	5	4	4	4	4	4	4	3	4	3	3	4	4	3
5.2	vulnerability	3	4	4	3	4	3	4	5	4	4	3	3	4	5
6	**potential for use**														
6.1	recognizability	5	3	4	4	3	3	3	4	3	3	3	2	3	3
6.2	geographical distribution	4	2	2	2	3	2	5	4	3	3	1	3	3	3
6.3	accessibility	5	5	2	5	5	5	5	5	5	5	5	3	5	3
6.4	economic potential	5	3	3	5	5	5	5	5	5	5	3	3	5	5
	TOTAL	88	77	78	80	78	72	73	76	70	70	63	63	71	66

NP=National Park, NM = National Natural Monument, G= Geopark, CM = Cultural Monument, LAB = Landscape of Outstanding Beauty