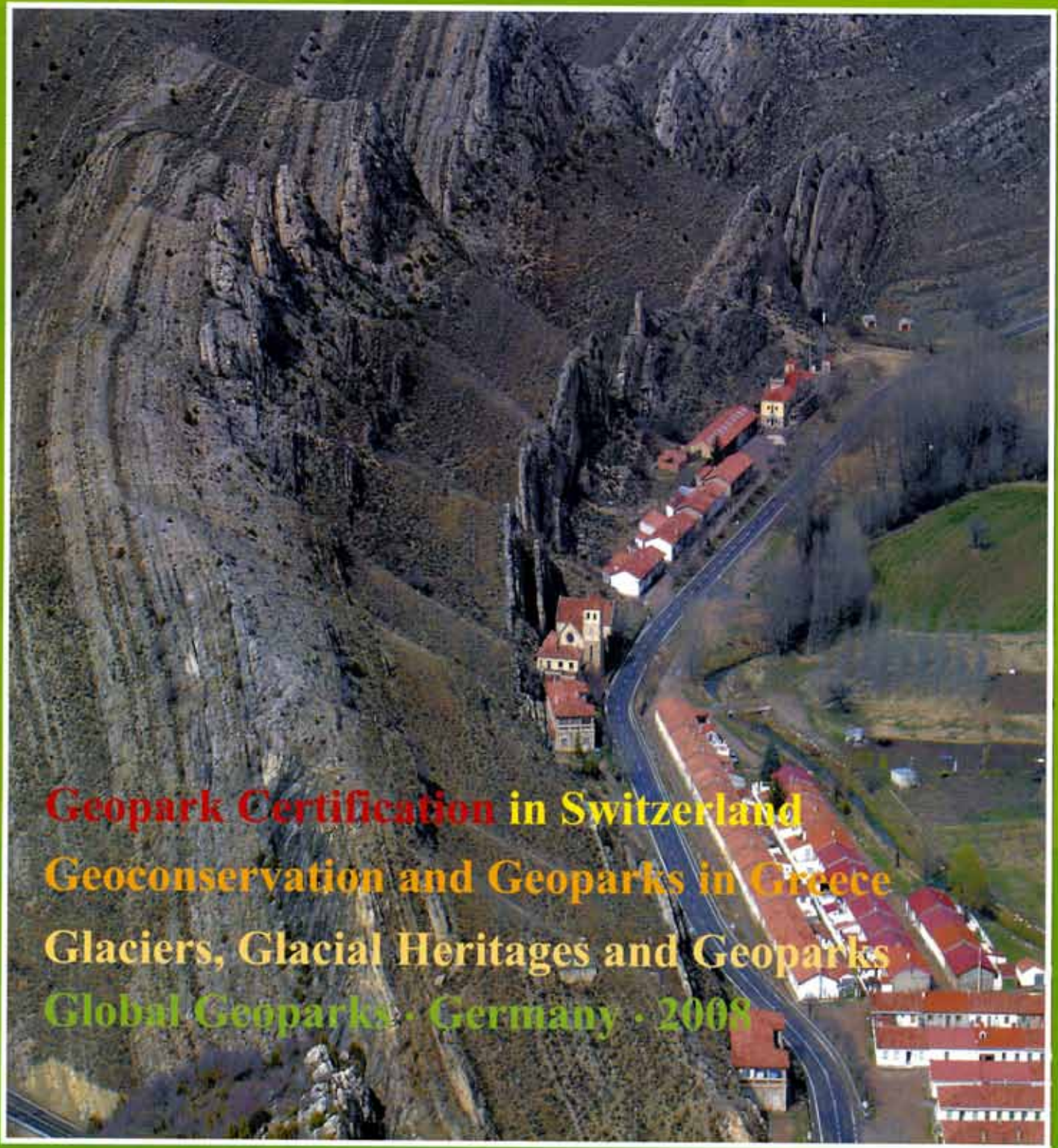
World Geoparks

newsletter

Office of the World Geoparks Network

No. 4



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Geoconservation and Geoparks in Greece

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Introduction

Greece is one of the most geologically active regions on earth due to its intense geotectonic activity and can be characterized as an area very rich in geodiversity as its geological structure clearly displays remnants of numerous geological phenomena and processes .Significant geological, geomorphological, and palaeontological sites comprise volcanoes, narrow valleys and gorges, caves and other karstic structures, rare rocks and minerals, thermal springs and geothermal fields, major fossil sites, large faults and other tectonic structures, ore mines, stone quarries and spectacular landscapes. Geo-sites having a monumental character can be defined as natural monuments. Aside from their scientific and educational importance, these sites are areas of surprisingly aesthetic and natural beauty. Some of these, including caves, springs and fossils, inspired the ancient Greeks to create many stories in Greek mythology, where as others, such as ore deposits or stone quarries, are associated with great moments in Greek history and culture.

Although national legislation protects several geosites-geotopes (Meteora, Samaria and Vikos gorges, Diros and Petralona caves, Mount Olympus, Mount Athos, Lesvos Petrified Forest, and Lavrion ancient mines) through various designations such as national parks, natural monuments and protected archaeological sites, there is no official inventory of protected geosites-geotopes in Greece. In 1985 the Petrified forest of Lesvos, was declared a protected natural monument (Presidential Degree 433/1985) and became the first site in Greece protected mainly for its geological value.

In 1986 a new Environmental Protection Law was adopted, which also protects abiotic components of Nature. However, the necessary application process is so complicated that no other geological monument has been declared as protected.

The first attempt at compiling an inventory of protected geosites-geotopes was made by the Greek Institute of Geology and Mining Research (IGME), and a list of 50 geosites was subsequently submitted to the Ministry of Culture, but without further result. Following international initiatives (Martini 1993, O'Halloran et al. 1994) several efforts have been made for the protection and promotion of important geosites in Greece (Zouros 1998, 2001, Fassoulas 1998, 2000, Bornovas 1999).

In 2001, ProGEO members established a working group (WG1) to implement the Geosites Project, an initiative of the International Union of Geological Sciences (IUGS) in South Eastern Europe. The project established common criteria for a new national geosites inventory that ultimately led to the presentation of a new geosite list for South Eastern Europe (Theodosiou-Drandaki et al. 2003).

Geological monuments in the Aegean area

In 1998 the Natural History Museum of the Lesvos Petrified Forest, in collaboration with the Departments of Geology of the Universities of Athens and Thessaloniki, the Department of Geography of the University of the Aegean and the Natural History Museum of Crete began a new effort to select and assess geological monuments in the broad Aegean area, through a project financed by the Ministry of the Aegean. The result was the creation of an Atlas of the geological monuments of the Aegean (Velitzelos et al., 2003, Zouros et al., 2004). The atlas includes a list of significant geosites that demonstrate the geological wealth of the Aegean area and draw a comparison among different landscapes of the Aegean islands linked by analogous geological histories.

A comparable inventory based on the main scientific bibliography, as well as cartographic analysis, remote sensing, ground survey and mapping resulted in 317 of the most significant geosites being selected and categorized. Subsequently, a scientific value was assigned to each of those geosites through an evaluation process based on the following criteria:

1.Scientific and educational value (integrity, rarity, representativeness and exemplarity);

2. Natural beauty and aesthetic value;

3. Cultural interest;

4. Geodiversity;

5. Potential threats and protection needs (legal protection, vulnerability);

6. Potential for use (recognizability, geographical distribution, accessibility and potential for generating economic activities)

According to the importance of the geosite, they were classified into five groups: I) International, II) European, III) National, IV) Regional and V) Local. Table 1 presents the most important monumental geosites in the Aegean area. Sites of local interest are not shown.

Geosite protection and management in Geoparks

During the last decade several European countries established initiatives aimed at the protection, promotion and rational management of geosites through the creation of geoparks. The Geopark concept was developed in strong cooperation with UNESCO (Eder and Patzak 2004), which recommended that "the potential of geoparks is to be used as a basis for enhancing the promotion of geological heritage in order to

educate the public at large in geological sciences and in environmental matters; ensure sustainable development (geotourism); and protect endangered geological heritage sites for future generations" (UNESCO 2004).

Founded in 1994, the Petrified Forest of Lesvos is the first Greek geopark and is managed by the Natural History museum of the Lesvos Petrified Forest.

In June 2000, four European geoparks, including the Petrified Forest of Lesvos, created the European Geoparks Network. Its main objective was to cooperate in protecting the geological heritage of their territories and promoting sustainable development through geotourism (Zouros et al., 2003, Zouros 2004 a, b).

In 2001, the second Greek geopark was established in the Psiloritis area of Central Crete. In 2005, the European Geoparks Network, operated with the support of UNESCO, expanded to include 25 territories across ten European countries. Since February 2004, UNESCO established the Global Network of Geoparks, which includes both Greek geoparks.

Several other areas in Greece containing significant geosites have the potential to become geoparks (Santorini and Nisiros volcanoes, Vikos Gorge - Zagoria area, Aggitis karst system, etc) and some are preparing their applications to become members of the European Geoparks Network.

The Lesvos Petrified Forest Geopark

The island of Lesvos is located in the NE of the Aegean Sea and covers an area of 1630 km^2. Neogene volcanic rocks dominate the central and western part of the island. Lesvos is part of a belt of late-Oligocene-to-middle Miocene calc-alcaline to shoshonitic volcanism of the northern and central Aegean Sea and western Anatolia. In the central part of the island there is a series of volcanic centres. The main volcanic sequence consists of andesite lavas, dacite lavas, basalts, ignimbrites and a thick pyroclastic sequence that is associated with the development of the Lesvos Petrified Forest. Hundreds of standing and lying fossilised tree trunks appear among volcanic rocks on the western part of the island. A palaeobotanical study shows the floral composition of the Lower Miocene forest was dominated by higher plant group angiosperms and gymnosperms (conifers), and had a low proportion of pteridophytes (ferns) (Suss and

TABLE 1 : Geosites of the Aegean area, Greece

TYPE OF GEOSITE	I / II International / European	III National	IV Regional
Structural	Olympos tectonic window	Ampelakia contact, Kerketeas tectonic window, Syros ultramafics, Agios Pavlos Crete, Gonies sequence	Thassos folds Telendos
Stratigraphic		Chios carboniferous-permian seq., Andros seq., Syros seq.,Naxos seq., Kos seq., Istmos seq., Epidauros seq.,	Oinouses sediments, Ios plutonics, Gavdos sequence
Palaeonto-logical	Lesvos Petr. Forest, Pikermi f. s. Petralona cave	Axios f. sites, Mygdonia f. s., Evros petr. Forest, Sesclo fs, Antissa deinothere fs, Limnos fs, Vatera fs, Chios fs, Samos fs, Eboea – Kerasia fs, Aliveri fs. Eboea Kymi fs, Vraona fs, Santorini fs, Tilos fs, Nisyros fs, Epidauros fs, Lakonia fs, Rethymno fs	Emvolo f. s., Nikiti f. s. Sarantaporo fs, Psara fs, Kithira fs, Delos fs, Mykonos Chtapodia fs, Rodos fs, Karpathos fs, Kasos fs
Mineralogical Petrographical	Kassandra mines Lavrion mines	Serifos, Aliveri quarries Mantoudi mines, Olympiada mines, Scouries Chalkidica, Thassos, Milos volcanics, Naxos smirida mines Sifnos mines, Milos mines,	
Geomorpho-logical	Meteora Mt Olympos Samaria Gorge	Kimolos, Andros – Korthi, Tinos, Mikonos, Ierapetra rockforms	Nymfopetres, Sithonia Kithira Paleochora gorge Paros -Kolympithres
Morphotecto-nics	Sperchios fault zone	Xanthi F scarp, Athos FZ, Anchialos F, St. Efstratios F, Delfoi F, Atalanti F., Platees F., Amorgos F., Plakias F	Pithagorion F Lesvos - Geras F

TYPE OF GEOSITE	I / II International / European	III National	IV Regional
Volcanic	Santorini cald. Nisyros volc.	Lesvos volc., Milos volcanos, Kimolos, Glaronisia, Sousaki vol.	Microthives, Psathoura, Oxilithos, Aigina, Kalogeroi, Antiparos, Patmos
- Karstic - Caves	Aggitis carstic system Alistrati caves Diros caves Psiloritis carstic structures	Petralona cave Antiparos cave Maronia cave, Kopais, Peania cave, Panos cave, Vouliagmeni doline– cave Kithnos cave, St.John cave -Heraclia Naxos, Folegandros cave, Omalos dolines, Sfendoni c., Lasithi	Kilkis c, Kavala St Hellen c, Chios caves, Samos caves Keratea cave, Salamina c., Kithira c., Serifos c., Naxos c., Kalymnos caves, Kastelorizo c., Methana c., Kapsia c.
Fluvial	Evros delta, Nestos delta, Aliakmon delta	Axios f. sites, Mygdonia f. s., Evros petr. Forest, Sesclo fs, Antissa deinothere fs, Limnos fs, Vatera fs, Chios fs, Samos fs, Eboea – Kerasia fs, Aliveri fs. Eboea Kymi fs, Vraona fs, Santorini fs, Tilos fs, Nisyros fs, Epidauros fs, Lakonia fs, Rethymno fs	Aggitis gorge, Nestos gorge Tempi gorge, Sperchios delta Zakros gorge
Coastal		Milos – kleftiko, Milos-Sarakiniko, Kimolos, Falasarna, Mpalos, Elafonisi Gavdos	
Hydro-geological		Lesvos geothermal fields – hot springs Aidipsos hot springs Almiros spring	Ikaria h. springs
Ancient mines and quarries Tech. constructions.	Lavrion mines Penteli quarries Efpalinion	Kavala mines, Thasos mines, Karistos quarries, Thasos quarries, Serifos mines Paros lichnite quarries, Milos opsidian quarries, Milos catacomb, Lavirinth	Petrota quarry, Naxos quarries Lesvos - Moria quarries
Geo-mythological Geo-archaeological	Athens Akropolis Mt. Athos Ideon andron cave	Akrokorinthos Patmos cave Monemvasia Giouchtas Crete Diktaion antron	

Velitzelos 1993, 1994, Velitzelos and Zouros 1997, 1998, 2000).

The Lesvos Petrified Forest Geopark covers an area of 15,000 ha. It has become a major tourist attraction as well as an ideal location for environmental education. The park features programmes for students, who are among the thousands of visitors the park attracts each year. Aside from the Museum, the Geopark is developing five visiting parks, each one presenting a different aspect of the Petrified Forest, an information centre and as a series of trails linking the major geological features of the area.

Psiloritis Natural Park

Psiloritis Natural Park is located on the Island of Crete, in the southern Aegean Sea. It has an area of 1159 Km^2, with 157 settlements and towns and a population of about 42,234 inhabitants (population density 36.4 inh/Km^2).

The Park area includes the Psiloritis mountains and its northern coastal zone, and combines the unique natural environment and its fascinating geology (part of the area participates in the Nature 2000 network) with the history and customs of the local civilization.

Crete is a young continental part that was formed 20 million years ago as an accretionary wedge due to the convergence of the African and European plates. Compressional tectonics emplaced a series of different rock sequences (nappes), originated initially at the area of central Aegean over the sedimentary rocks of the European foreland (Bonneau 1984). Further deformation resulted in the creation of deep basins and valleys as well as high mountainous areas with summits reaching 2,5 kms (Fassoulas 1999, 2001). Plate convergence is still active in this landscape and the surface is still sculptured by intense tectonic and atmospheric processes.

Within the territory of the Geopark, the whole nappe pile of Crete and the majority of the rock types of the island are presented in excellent outcrops and sections. It is an area of high scientific value where every year researchers from foreign universities come for basic scientific research and education. In the geopark, all types of small and regional geological structures are visible: large faults with excellent and imposing fault surfaces, fossil sites, caves, impressive gorges and moun-

Standing Petrified Tree

tainous plateaus that host many endemic species of the island, unique fold associations and geomorphologic structures. For thousands of years, these structures have inspired the culture, traditions and customs of the inhabitants (Fassoulas 2004).

As a member of the European Geoparks Network, the Psiloritis Natural Park is developing several subparks, each one featuring a major geological feature of the area. Psiloritis Karstik Landscape deals with high mountain morphology and landscapes including high plateaus, caves (such as the Idaion Andron cave where Zeus grew up) and culturally significant sites. The Talea Ori Stratigraphic Sequence features many rock types, weathering structures, folds (as the Vossakos fold succession) and fossils (as the Permian corals) that illustrate a 200-million-year journey through the early geological history of the island. The Basin to Range Park shows the transition from high mountains to low lands and from natural environment to human civilization. The planned SpeleoPark in the Psiloritis Mountains will specifically present the main aspects of speleology and will support several types of educational activities. Many other geotops located within the geopark are considered as individual sites that present the main features of the geological history of the island.

In Psiloritis area mythology, nature and tradition combine to beautifully present an environment of gods and humans. It is the nest of the real Cretan spirit.

Conclusion

Geoparks seem to be the most effective tool for the recognition of geomorphological and geological heritage by local authorities, inhabitants and visitors, and for geosite protection and management. Geoparks promote the establishment of geotourism, which is very effective as a means to create important links between geoconservation and sustainable local development. By combining different geosites and promoting them together – along with the ecological and cultural elements within their territories – geoparks could undoubtedly offer numerous benefits for the development of alternative forms of tourism.

Geoparks also help the local community to explore new fields and perspectives which can lead to sustainable development of their territories through a variety of geotouristic activities and the promotion of local products.

All these issues can be developed and implemented in a structured and responsible manner.

In Greece, geoparks help the public to understand the diversity and richness of the geological heritage and the complex processes which created the unique Aegean landscapes. Geoparks also help the public to build greater social awareness of the value of the natural environment and the need for its protection.