



PROCEEDINGS



Maria Luísa Rodrigues
Maria Elisabete Freire
(editors)

PROCEEDINGS

of the

INTERNATIONAL CONFERENCE ON GEOHERITAGE AND GEOTOURISM

2010

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At the end of the Proceedings, it is presented a full list of all the authors.

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INTRODUCTION

Geotourism is a developing branch both of fundamental and applied research and rather significant to planning and management at local, regional and national levels. It is strongly connected to land geodiversity and geoheritage, embracing also the tangible or intangible cultural values of local communities.

A large number of studies on geotourism and geoheritage already exist. Nevertheless, most of them are framed by other designations such as ecotourism, nature tourism, geoconservation, geoparks, geotopes, geosites, geomorphosites, natural heritage, protected areas, or natural monuments.

The idea to set this meeting has started, in 2007, at the Workshop *Geomorphosites, Geoparks and Geotourism* organized by the Natural History Museum of the Lesvos Petrified Forest and directed by Nickolas Zouros. A formal meeting, chaired by Emmanuel Reynard, has taken place at Oslo (Norway) during the International Geological Congress (2008) and then the International Conference on Geoheritage and Geotourism (ICGG2010) to be held in Lisbon was announced in Paris at the Geomorphosites 2009 meeting and in Melbourne (Australia), at the International Geomorphological Congress (2009). In these two meetings the Lisbon conference was announced to be held from 29th May to 1st June 2010, but a clash of other scientific events made us to postpone it to the present date: 14-17 October 2010.

We hope that all those who have been engaged on geodiversity, geoheritage, geotourism or cultural heritage research, aiming at contributing to the sustainable development of specific areas, find in this conference an opportunity to present and exchange their knowledge, experiences and visions. The Conference will provide a forum to discuss and give evidence to a set of themes which were considered of particular relevance in the frame of the contribution of Geodiversity and Geoheritage for Tourism and Sustainable Development:

- A – Geoheritage, environmental policies and land planning;
- B – Geoheritage vulnerability and geoconservation;
- C – Coastal and shoreline geotourism, recreation and management;
- D – Geotourism products and evaluation of users needs;
- E – Geotourism in Geoparks;
- F – Geoheritage and geotourism information technologies and mapping.

This conference is organized by the Portuguese Association of Geotourism (**APGeotur: Associação Portuguesa de Geoturismo**), that was created by a group of researchers that have been active on the study of Geoheritage and Geotourism but also others, professionally not involved on that, but altogether have in common the concern on the preservation, promotion, education and divulge of our natural heritage. This conference has also got the collaboration of the Geodiversity, Geotourism and Geomorphologic Heritage Research Group (GEOPAGE) of the TERRiTUR (Tourism, Culture and Space cluster), from the Geographic Studies Centre of the Lisbon University (CEG-UL) and of the Institute of Geography and Spatial Planning of the University of Lisbon (IGOT-UL).

Furthermore, the conference has received the patronage of the University of Lisbon, of the “Geomorphosites” Working Group of the International Association of Geomorphologists (IAG) and of the European Geoparks Network (EGN).

The conference venue is held at the Rectory of the University of Lisbon. One hundred researchers from Brazil, Canada, France, India, Iran, Italy, México, Norway, Poland, Portugal, Romania, Spain, Taiwan and Tunisia, have contributed with more than 40 oral and poster presentations.

And, the last but not the least, as this is the year of the Biodiversity, we aim that with this Conference to have made a small contribution to make it too the year of the Geodiversity.

The editors

GEOHERITAGE VULNERABILITY AND GEOCONSERVATION IN NORTHWESTERN INDIAN HIMALAYAS OF HIMACHAL PRADESH AND LADAKH

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The present paper highlights the urgent need to declare important geological and paleontological sites as geoheritage site, so that important geological and paleontological data is conserved and preserved for our future generation.

Till this date geological sites in Himalayas have not been preserved and anthropogenic activities mainly related to provide better infrastructure in the name of widening of roads or constructing buildings, has led to loss of valuable geological data. Important geological sections and sites are almost studied along the roads sections and since no laws for protection and preservation of these sites is in place, these sites are known or unknown and destroyed to fulfill the infrastructural needs and greed of the growing population.

Many fossil sites were destroyed due to mining in Barog. However one such site of fossil tree trunk, discovered by the author in 1989 at Jagjitnagar in Himachal from Kasauli Formation, approx. 20 million years old, was however preserved and conserved due to the action of the locals, the owner of the land and the local authority and was declared as a geoheritage site. Without the community participation and the will of the owner the entire fossil tree trunk could have been destroyed by the labors of the wall construction. Efforts are also made to declare the entire Solan district as a Geopark and conserve the valuable fossils discovered from time to time. This will help the conservation of the fossils on

one hand and on the other will help to boost geotourism in the area thereby providing opportunities of employment and more revenues in the hill state.

Similarly an important geological site in Leh, Ladakh near Spituk, is famous for Gompa Miti (meaning mud) from which gompas or religious Buddhist places are made. But today it is being used by everybody and the entire deposits are on the verge of extinction. These deposits represent palaeoglacial lakes and have good records of climate signatures since the last Ice Age. If this site is not declared Geoheritage site and strict laws are not made, the entire information about climate change easily available will be lost. There is a urgent need to take up the matter of geoheritage and geoparks with respective governments, to form local bodies and to take actions for preservation of this valuable geological data which is always on the verge of facing extinction due to natural or anthropogenic activities.

Keywords: geoheritage, geoconservation, fossil trunks, palaeoglacial lakes, geopark.

THE “ROUTE OF THE FOSSILS” (SANTA MARIA ISLAND, AZORES)

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Santa Maria Island is the only island that has marine fossils in the volcanic archipelago of the Azores. These fossils are known since the 19th century but have recently received new attention due to the establishment of a local team of biologists/palaeontologists, based in the University of the Azores.

Since 1999, a series of international workshops named “*Palaeontology in Atlantic Islands*” have studied the late-Miocene early-Pliocene and the Pleistocene fossiliferous deposits of the island. The stratigraphy and age-dating of the outcrops was done; the systematic of different marine fossil groups (molluscs, echinoderms, brachiopods, crustaceans, sharks, cetaceans, fishes, algae, bryozoans and ostracods) was improved, with new species described; the taphonomy and the palaeoecology of the most representative outcrops is being done; and the palaeobiogeographical relationships of the fossil Azorean communities was established. All of the above mentioned studies contributed for a better understanding of the processes and patterns of dispersal and colonization by marine organisms that have lived in the oceanic islands of the Azores.

The results of these studies were published and related scientific communications were also done during the two editions of the “*Atlantic Islands Neogene*” International Congresses (in 2006 and 2008). The Regional Government of the Azores has taken advantages on these results for the

coastal environmental policies, allowing protecting all of the outcrops at Santa Maria Island (POOC Santa Maria, 2006).

More recently, a series of books directed for a broader audience were printed, e.g., “*O Império dos Fósseis*” (2009) and “*Os fósseis de Santa Maria*” (2010).

At the same time, a proposal was presented by the MPB-team to the local government of the Azores, aiming the implementation of pedestrian and maritime tours in Santa Maria Island, included in “*The Route of the Fossils*”. These tours are described in this presentation, with a special emphasis on the coastal and shoreline geotourism, as many of these outcrops are only accessible by boat.

Considerations are also done in relation to the problems that the scientific collections (which are necessary to study the outcrops) may pose to the environmental policies.

Keywords: Azores, fossils, environmental policies, coastal geotourism, “*The Route of the Fossils*”.

GEOCONSERVATION OF BRAZILIAN'S GEOHERITAGE IN SÃO PAULO STATE, AND HOW TO MAKE IT AVAILABLE TO GEOTOURISM AND GEOPARKS: PRELIMINARY RESULTS

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The Sao Paulo State geological patrimony is characterized by geosites and geotopes of uncommon pedagogical contents for environmental education and geological as so as beautiful rareness for touristic appreciation generally, and geotouristic, privately. An inventory of this patrimony will be done, and in order to protect it, standards of management will be established. One of the existing strategies is geotourism.

This research includes the State of Sao Paulo's territory, more particularly the places where geological elements are in evidence and in the touristic resorts when they are geologically interesting. Resources and touristic attractions that give witness of the past or the history of the origins and evolution of the Earth are made available, in order to promote geotourism. And it is the '*sine qua non*' condition to save the geological past, and to make it visible for the present and next generations.

The preliminary results indicated twenty-two geosites with geological's characteristic that enable to suggest five geoparks: Ribeira de Iguape, Paraíba do Sul, Tietê and Paranapanema, and Basaltics *Cuestas* in Peripheral Depression. These contain five geological monuments recognized by Brazilian Geological and Paleobiological Sites Commission (SIGEP), networked for

UNESCO. Increase some geosites still more for to enrich geoheritage in São Paulo State still don't recognize by study field's institutions, of effort unpublished works, so as to will add social value among of job's generation and to increase income for the receiving community of tourists.

For example, the Devil Mount, small point of Paranapanema riverside, a hillocks left by erosion into Parana Basin or Caiua Basin. In Paranapanema Medium Valley occurs basaltic mines how open air museum that evocate volcanic lavas and originated soils hers, from agriculture cultivation by large fertility. In Tertiary formation to concur the archaeological sites of past civilizations that inhabited fluvial raised shore lines, Indian peoples, huntsmen and collector. A relevant contribution to sustainable development in all the territorial unities; the Brazilian's São Paulo State, for example, is of geoheritage conservation and its contributions to geotourism about geoparks.

Keywords: geoconservation, geodiversity, geotourism, geoparks, Brazilian São Paulo State.

VOLCANIC LANDFORMS OF THE LAST ERUPTION, ON APRIL TO MAY 1995, WITHIN THE NATURAL PARK OF FOGO ISLAND, CAPE VERDE

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Fogo Island represents the only active volcano of Cape Verde archipelago, brought up by a within-plate mantle plume from the central Atlantic underneath the island. The most important heritages of that activity are the conical aspect of the island, a 29 km² caldera on its top, at 1600m, and the main volcanic cone rising up 1100m above the caldera floor, where the last event has occurred on June 1799.

The most visible impacts on the landscape that have occurred on the Island, during the 26 known eruptions, was the results from the volcanic products expelled. It has produced a great number of volcanic cones and large extensions of lava flows and ashes covers. The lava flows from eleven magmatic events that have been occurring since 1664, have covered the eastern slope of the island and the bottom of the wide summit caldera, opened eastwards, the Chã das Caldeiras. The Chã is a volcanic depression where a great number of volcanic cones and vents where those eruptions were generated, namely the last two (1951 and 1995).

During April to May 1995 eruption, of Hawaiian / Strombolian style, the expelled materials have covered about 6 km² within the caldera, forming two major landforms, a volcanic cone, resulting from the accumulation of bombs, ashes and lavas, and 4 km long lava flows. The *aa* lava type, from the first stage of the eruption, has covered a larger area and has built thicker and more irregular landforms than the effusive *pahoehoe* lava type, from the last stage. Associated

to this eruption a number of minor landforms were formed, such as depressions related to the several eruptive craters, a 3 km elongated depression, which it was primed by a fracture, where the eruption first hours has taken place, multiple bomb impact craters and long fractures at the cone top, to which was associated fumaroles' emissions and the formation of vaporized colourful eruptive products.

The new major landforms, namely the cone and the lavas, as well as the ephemeral minor landforms and the eruptive products of the last volcanic episode are the more relevant touristic attractions of the Fogo natural park. All these geomorphosites demands an urgent scientific assessment and a detailed mapping in order to preserve the most recent active volcanic geomorphosite of the Cape Verde archipelago, and to mitigate its vulnerability to the human destruction, such as by taking some "souvenirs".

Keywords: Volcanic landforms, active geomorphosite, landscape conservation, Fogo Island, Cape Verde.

QUATERNARY FLUVIAL DYNAMIC HERITAGES IN THE RIBEIRA SECA BASIN, SANTIAGO ISLAND, CAPE VERDE

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Ribeira Seca, at the eastern and more humid façade of Santiago Island, is the larger river basin. In terms of geological aspect this basin is identified by a thick detritus unit of basaltic origin, type *lahar*, from the Miocene; this is covered by a basaltic complex, formed by a thick piling up of pillow-lavas, and thin bed of sub-aerial lava mantles and pyroclasts succession, from the Pliocene. The most representative geomorphological heritages from quaternary fluvial dynamic in this basin are three levels of fluvial and marine terraces and calcareous waterfall travertine.

The fluvial terraces are the more common heritage landforms from the quaternary river valleys network. The top level is found in small and disperses alluvial accumulations of very weathered pebbles. The medium terrace is more uniform and occupies a larger area, mostly at the medium and lower streams sectors of the three main valleys of the basin; and the lower are scattered the two most important tributary streams.

Downstream, at the vestibular area of the main valley, there are three marine terraces levels. At the medium sector the marine deposit gives place laterally to a fluvial deposit, according to its pebble imbrications. Based on this aspect and to the altimetry similarity between these fluvio-marine deposits and the marine terraces, whose palaeofaunal chronology was established in the Island (Lecointre, 1963), the medium terrace may be Tyrrhenian age, the highest one Tyrrhenian I or Sicilian age and the lowest Ouljian age.

The waterfall travertine was recorded by the first time in Cape Verde at Santa Helena valley (Costa, 2002), a tributary stream of the right bank of the basin. These external carbonated rocks are common in dry tropical climates, frequently related to chalk regions, but they may appear in magmatic areas, under more humid climatic conditions with a distinct dry season. This damp period was registered locally during the Holocene, after the valley formation at the maximum Quaternary regression.

All the fluvial landforms and quaternary sedimentary sequences were studied and detailed mapped, and all the main geomorphosites were signed up. However, a more solid scientific assessment is required, namely to define the climatic mechanisms on its genesis and to establish an absolute chronology of the deposits related to the main landforms. A strong commitment is need to set a number of events and to publicize the results in order to preserve this heritage which represents the quaternary streams network definition.

Keywords: Fluvial terraces, waterfall travertine, geomorphosites conservation, Santiago Island, Cape Verde archipelago.

KARSTIC GEOHERITAGE OF CENTRAL PORTUGAL

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Karstic areas of Central Portugal (e.g. the Sicó Massif) offer outstanding scientific, aesthetic and cultural values that make the carbonate massifs, and related surrounding areas, very important in terms of geoheritage conservation.

Despite its relative small size, the Sicó Massif has beautiful landscapes and other geological elements that bear high ecotourism potential. Weathering and erosion on the carbonate rocks have produced unique and *sui generis* landforms as karren fields, closed depressions, fluviokarst canyons, rock-shelters, caves and karst springs. The massif hosts some caves and rock-shelters (locally called “Buracas”) with important sediment’s infilling and the traces of a prehistoric occupation with a very high scientific, cultural and pedagogic importance.

The karst and fluvial processes on the massif justify the underground water circulation, the distribution of the soils and the surface biogeography. At the same time, the spatial distributions of both superficial and underground archaeological vestiges were highly conditioned by that processes, such as for a rich and diversified agro-pastoral tradition. This geological, geomorphological and archaeological heritage deserving to be studied, divulged, preserved and valued from the point of view of the local development.

Substantially, in Central Portugal, the karst landscape represents an important part of our national heritage from the point of view of both natural beauty of our

landscapes and the relationship between man and his environment. This study has been carried out to show examples of this natural and cultural geoheritage, at the same time that it is preceded to its spatiotemporal and thematic hierarchy. In the second instance were also considering interpretative circuits able to value the karstic features and to integrate it in more appropriate ecotourism strategies. Finally, we intend to insert these studies in appropriate programs that improve local management practices in order to protect these karstic geoheritage values across land tenures and land uses.

Keywords: Geoheritage, cave, rock-shelter, fluviokarst canyon, Geoarchaeology, local development.

THE ELECTION OF A NATIONAL NORWEGIAN GEOLOGICAL MONUMENT: A TOOL FOR RAISING AWARENESS OF GEOLOGICAL HERITAGE

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The Geological Society of Norway, the Geological Survey of Norway and GeoPublishing have together formed an initiative to celebrate the geological diversity of Norway. The public are invited to elect a National geological monument. Prior to the election, everybody has been encouraged to nominate candidates. A jury will pick 10 candidates from the nominees. The 10 chosen nominees will be designated as geological national heritage. The candidates will be presented and promoted by the Norwegian Broadcasting Corporation and the Norwegian Tourist Association. The candidates are also thoroughly presented and promoted on a joint website, and the public will be invited to vote for their favourite candidate on the website. The winner will then be presented on national television on October 18th.

Norwegians are obsessed with outdoor activities in the natural environment. Tourists, who visit Norway, also hold nature as the main attraction of the country. However, the geological aspect of the natural history is often not appreciated. The aim of the project is to teach residents, pupils and tourists about the geological influence on the Norwegian natural environment, while learning more of the stories the rocks and particular landscapes can tell.

Some phenomena are unique to Norway, while others are more globally widespread. Nevertheless they all tell their little part of the story of the origin of

Norway. Some geological attractions, such as World Heritage areas and geoparks are appreciated internationally. Other local attractions can serve as good examples of geological processes and phenomena suitable for field education in school. Other geological attractions can also be primary spectacular, meaning that they generate attention and interest. No matter what status the attractions have, they can act as worthy candidates in the awarding process and as a potential national monument.

The nomination process has been running during 2010. So far, the process has mobilised local communities all around the country, and our aspiration is that the voting process will raise local and national awareness too. In 2008, a similar nomination took place. Norwegians voted for Larvikite as their national rock, in close competition with 9 other commendable candidates. The public interest in the various candidates and their influence on society was significant. We hope for a similar effect in the election of a national geological monument. The lecture will present the candidates and the preliminary results.

Keywords: Geotourism products, awareness, natural monuments.

COASTAL AND MARINE GEOMORPHOLOGICAL MAP, GEOSITES AND GEODIVERSITY OF SAN PIETRO ISLAND (SW SARDINIA)

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Geologically the San Pietro Island is composed almost entirely by volcanic rocks, with minor outcrops of Quaternary alluvial, aeolian and coastal deposits. In spite of its small size, the island boasts a wealth of geodiversity, with the occurrence of a variety of effusive magmatic rocks formed during the Oligo-Miocene volcanic cycle. During this cycle numerous units were emplaced as well as various, easily distinguishable, types of volcanic rocks (rhyolite, rhyolitic ignimbrite, comendite, retinite, diaspore, etc.) and tuff (tuff, pyroclastite, cinerite, etc.), sometimes with spectacular domes, manganese bearing mineralizations, emission centres, lava flow surface structures, convolute flow structures and spectacular cliffs with columnar fracturing.

Detailed field surveys and laboratory investigations, conducted using aerial photographs, orthophotographs and satellite images, allowed to examine and classify those landforms attributable to geomorphological processes associated with water, weathering, wind and coastal dynamics. The geomorphological study enabled to identify a variety of volcanic and coastal erosion landforms (cliffs, ria-like bays, and coastal caves) some of unique geomorphological landscape and scenic interest.

The marine environment was geologically-geomorphologically interpreted chiefly by examining the *Side Scan Sonar* data, supplemented with direct observations during underwater surveys. For the pericoastal areas (0-15 m deep), photograms and recently acquired satellite imagery were analysed. Side

scan sonograms together with direct underwater observations were used to determine lithology of submerged rock outcrops, to reconstruct boundaries between different rock types, to detect evidence of tectonic lines, to determine the evolution of coastal and underwater relief forms, to identify the main sedimentary facies and evidence of sea level stand (palaeo shore line).

An underwater geological-geomorphological survey was conducted to determine diaclasses direction, extent and nature of rock outcrops, boundaries, distribution of biocenoses and dispersion of different mobile sediment facies, height and direction of erosion ridges, depth of erosion gullies or the direction of seafloor sedimentary structures (*ripples, megaripples and hydraulic dunes*).

Data from land and sea surveys were interpreted in CAD and GIS environments, while final rendering was obtained using vector graphics software. The thematic map compiled, which also indicates and classifies geosites and geomorphosites, is a document of significant interest for evaluating coastal tourism potential, for planning geotourism itineraries in the island's interior and along the coastal perimeter and submerged coastal zone, for promoting tourist demand and also for environmental management and assessment of the coastal landscape, as well as for the prevention of pollution and climate change related to environmental hazards.

Keywords: Coastal and marine geomorphology, geosites, geodiversity, San Pietro Island, SW Sardinia.

GEOMORPHOSITES, VOLCANISM AND GEOTOURISM: THE EXAMPLE OF CINDER CONES OF CANARY ISLANDS (SPAIN)

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The Canarian Archipelago (Spain) are seven islands located on the mid Atlantic Ocean. These islands are characterized by a high volcanological complexity extending over the past twenty million years and a varied geomorphological evolution.

Monogenetic volcanoes are the most frequent eruptive structure in the Canary Islands (more than one thousand) and they group forming different volcanic fields. Young basaltic monogenetic cinder cones are characterized by pyroclastic cones, fall deposits and lava fields. The scoria cones are formed by the accumulation of normal (proximal) to inverse (distal) graded welded and/or non-welded volcanoclastic deposits with symmetrical, fluidal and irregular shapes and different sizes (lapilli, bombs, blocks, scoria, spatter, ash, etc.), xenoliths and intercalated lava flows.

The aim of this paper is to illustrate the volcanic geomorphologic heritage of three monogenetic mafic volcanoes based on the geomorphological and geomorphosite maps: Pico Partido cinder cone (Lanzarote Island), Orchilla scoria cone (El Hierro Island) and Fasnía volcanoes (Tenerife Island). These multiple volcanoes were born out of spectacular eruptions and they created a paradise in volcanic forms: cones, craters, volcanic tubes, channels of lava, hornitos, spatter, lava fields (pahoehoe, aa, blocks and balls), lava lakes, pyroclastic deposits (bombs, lapilli, ash and scorias), etc. The methodology is

based on field observations, topographical and geological maps and interpretation of aerial photos.

The rich variety of volcanic forms constitutes the geomorphological heritage of these cinder cones. In the study area different geomorphosites with an intrinsic or scientific high value are recognized, but also with cultural and economic value. The scientific value focuses on the volcanic geomorphology, for this reason the cinder cones are natural protected areas.

Volcanism can play an important role in human communities. The volcanic forms constitute a component of the cultural heritage of a territory (historical monuments, works of art, spiritual places, etc.). In our case, the cinder cones studied represent an important value for the population of the surroundings, because the Fasnía and Pico Partido are historical eruptions dating from the 1705 and 1730-1736 eruptions. These volcanoes modified the previous natural and rural landscapes and the villages. On the Orchilla lava flows the meridian zero was located, for this reason the volcanic landscape was the most occidental of Europe.

In the volcanic regions people visit volcanoes for a variety of reasons, for example the fascination of being close to the power of nature. The major economic resource of the volcanoes is tourism. In this sense, the economic value from monogenetic volcanoes is related to geotourism.

The tourists that visit the natural protected areas should practise a sustainable and responsible tourism, and a good way for it are the geo-hiking maps. This kind of maps will only emphasise on the landscape elements that the tourist can recognise and observe.

Keywords: Volcanic geomorphology, geoheritage, geotourism, geomorphosite, geomorphological map, geohiking maps, cinder cones.

GEOLOGICAL, GEOMORPHOLOGICAL AND CULTURAL SIGNIFICANCE OF A LOWER JURASSIC GRANITIC-SANDSTONE OUTCROP IN THE MONTEJUNTO MASSIF, PORTUGAL

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The importance of establishing the connection between Geoheritage and Cultural heritage, as a mean to achieve conservation of Geosites, is a concept that is growing within the scientific community as it brings new insights on how to interpret the world that surrounds us. This communication outlines the scientific importance and cultural significance of a granitic outcrop in the protected area of the Montejunto massif, as it represents a unique heritage in the context of the Estremadura region.

The Montejunto massif is characterized by a NE-SW fault-bounded asymmetric anticline where middle to upper Jurassic sediments outcrop. Compact oolitic and coral limestones, marls and clays mostly constitute the lithology. Intense tectonic activity together with karstification processes over the Cenozoic period created a great variety of tectonic and karst landforms: fault scarps, dissolution fractures, dolines and uvalas, caves, small canyons and dry valleys.

Within the lower Jurassic unit it is possible to find a granitic-sandstone intercalation with conglomeratic beds (10m thick), outcropping throughout the south-eastern flank of the Montejunto's anticline. Five south dipping granitic-sandstone structural ridges reaching 3m in height form the Penedo dos Ovos geomorphosite. Micro and mesoscale meteorization forms are visible on the top and along the sides of the ridges and can be divided in two major genetic

groups: tafoni and flared slope (endogenetic forms developed due to the layers resistance differences); pits, pans and armchair shaped hollows (exogenetic forms developed under soil cover). The presence of such lithology in the vicinity of a limestone massif represents high geological heritage, connected to the paleogeographical evolution of the Lusitanian basin, and high geomorphological heritage, as it contains unique meteorization forms within the protected area.

In order to understand its connection to cultural heritage one must travel to the beginning of the nineteenth-century, to a time where agriculture played a crucial role in the region. As a mean of taking advantage of wind power to grind cereals, local inhabitants erected windmills along major elevations, particularly throughout the south-eastern sector of the massif. At that time, possibly due to the proximity of resources and toughness of the rock, granite-sandstone was used as a base for the grinding system.

During the twentieth century, mostly due to the abandonment of agriculture, these constructions became more and more degraded, existing only as storytellers of the past. Hopefully, during the last 10 years, a great number of windmills have been reconstructed as people recognise these landmarks as an important part of the Estremadura's culture and history. Nevertheless, during the processes of reconstruction, the use of granite-sandstone rock was neglected, substituting them by limestone collected in local quarries. The original stones can only be found inside abandoned mills or scattered throughout the fields.

The presence of granite lithology and landforms in the proximity of a limestone massif represents for itself high geological and geomorphological value. By associating cultural knowledge and practices to this Jurassic outcrop, we are capable of picking the pieces of the past, interpret the landscape with the eyes of our ancestors and give continuity to a story that began 150 thousand million years ago.

Keywords: geoheritage, granitic forms, cultural heritage.

COASTAL GEOMORPHOLOGICAL GEOSITES: THE HOLOCENE HERITAGE WITHIN ALMADA MUNICIPALITY (PORTUGAL)

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Lisbon Metropolitan Area (LMA) is a region with a very precious natural heritage, in particular, associated to the natural coastal dynamics. In its territory of about 2957km² there are erosion but also depositional landforms, such as two estuaries, an important river bank and coastline, altogether of more than 300km long, some dune fields and cliffs. Some of them are even included on the list of the Portuguese protected areas.

Among the municipalities within LMA, Almada might be the one with a richer, more diversified and still preserved natural geoheritage. There is a long fossil cliff, the Costa da Caparica Fossil Cliff Protected Landscape, which is an important landmark defining almost Almada limits, at the northern and western sides, representing a vestige of an Holocene sea level, higher than the present.

At the bottom of this fossil cliff, covering most of the coastal plain, towards the sea, and at the top of it, there is an important dune field that some centuries ago has lengthened, on a continuous, for more than 30km along the coast. Later, at the beginning of the seventeen century, by king's decision, most of these dunes were forested to control the free circulation of sand and to protect the rich agricultural inland.

Today, this dune field is already cut into two distinctive areas by the city of Costa da Caparica and on its southern section, at the top of the fossil cliff, is the National Forest of Medos (an old word for small natural or man-made accumulation).

Along this last quarter of a century, with a faster and a better mobility, a urbanization sprawl has grew at LMA and, in particular, within Almada's district; and thus, some of the vestiges of Almada heritage of its coastal geomorphology has already lost or in danger by wrong costal management policies and practices that, sometimes, were ruled not for the common but for the particular benefit.

So far, in Portugal, the geological and geomorphological aspect of the landscape has not yet been considered as an important asset that it can be used too as the threshold for a sustainable local development. Additionally, geoheritage is seen as less vulnerable than the biological, the ecological or the cultural ones; and thus, the classification as protected areas were based mainly on these aspects. Altogether, these may be the reason why geoheritage and therefore also geotourism are still unknown among public and local governments.

So, a strategic planning of geoconservation is demanded and needed to be reinforced. It urges to undertake a detailed assessment of these geoheritage areas to set up effective policies and tools for geoconservation. It should be drawn a geoheritage mapping and guide for educational purposes but also for tourists that are concerned and interested on this field.

Keywords: Coastal geomorphology heritage, geotourism, geoconservation policies.

GEOMORPHOLOGICAL HERITAGE ASSESSMENT USING GIS ANALYSIS FOR GEOTOURISM DEVELOPMENT IN MACIN MOUNTAINS, DOBRUDJA, ROMANIA

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Macin Mountains, the most obvious witness of the Hercynic orogenesis from our country, unfolds in the form of parallel ridges, NW-SE oriented, in the south-east of Romania, respectively in the north-western part of Dobrudja, in Tulcea County.

They are characterized by an amazing geodiversity being composed from magmatic (especially granite), metamorphic (crystalline schists) and sedimentary (limestone, conglomerates, sandstones) rocks exondated during the last 300 million years. Despite this lithological variety, in 2000, when the Macin Mountains were declared National Park, just its biodiversity values (flora and fauna) were considered.

The geomorphology of the area is closely linked with the diversity induced by structure, lithology and tectonic, as well as with the different external agents that shaped the landscape troughout time.

Although of a relatively low altitude (467 m the highest peak) and a predominantly hilly appearance, Macin Mountains present, especially in the granite areas, a great variety of forms represented by ruiniform relief, pyramidal peaks, block fields, etc.

A wide variety of weird rock forms: fangs, tors, balls, gigant “eggs”, etc, were created through the rocks disintegration processes, still active in the area.

Our studies approach a topical issue and follow the assessment of geomorphological heritage of the Macin Mountains for the geotourism development in the area.

In order to analyze geomorphologic features of this area and to create a digital geotourism map we created a GIS database comprising topographic map sheets (at a scale of 1:25 000), digital ortophotos (at a scale of 1:5000) and satellite images. Using these datasets the main geomorphologic features were extracted. Also the landform elements (shoulder, backslope, footslope, toeslope, summit, peak), primary and secondary topographic attributes were extracted from DEM through GIS analysis methods.

As a result of this study we combined the most representative elements of the topography and realized a digital geotourism map of the area which can improve a better perception over the geological-geomorphological features of the surrounding landscape.

Keywords: geomorphological heritage, GIS analysis, geotourism, Macin Mountains.

STATIC AND DYNAMIC MAPPING OF GEOSITES

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The aim of this work is presenting two different ways for publishing and communicating information about geosites: static and dynamic maps.

Three different maps are presented and compared:

- geotourist and interpretive map of Tanaro Valley (North-West Italy);
- Web-GIS tool based on MapServer concerning the inventory of geosites in Piemonte Region (North-West Italy);
- Web-mapping tool based on GoogleMaps showing the swiss geosites of national significance.

Geosites maps may be classified in three categories according to their objective:

- Inventory maps to localize sites and compare attributes;
- Geotourist maps to inform public about tourist facilities and communicate geoscientific information;
- Interpretive maps to visually transfer geoscientific knowledge between specialists and public.

Inventory maps are used as synthesis tools showing localization and sometimes few attributes specific of the sites. The authors carried out a web-mapping project based on the swiss inventory of geosites of national significance. Compared with the static map, this project exemplifies the interests of a dynamic and interactive map. While keeping the objectives of a basic inventory

map, it becomes also a query tool, allowing spatial and thematic request. Dynamically based on a database, the Web-map is thereby no more just a storage tool, but an exploration and publication tool.

Geotourist maps aim to inform the users on specific aspects (geological and geomorphological) of a territory. An example of this kind of map has been designed by Ghiraldi L.: "it is a bird's-eye view map with two sides". In the front there is geotourist information, while the back is more interpretive, and explains the landscape's evolution using a series of drawings supported by synthetic text explanations. This example shows that a static map can also meet several objectives and illustrates the importance of focusing on one and only theme.

Last kind of map is based on Web-GIS application, developed using open source software such as: MapServer (www.mapserver.org) and P.Mapper (www.pmapper.net). It offers the same functionalities of the Web-mapping tool based on GoogleMaps, but with some disadvantage: it requires stability and maintenance of the server, it needs internet connection with high bandwidth and it necessitates a little familiarity with GIS applications.

In conclusion the use of dynamic tools allows the users to select the content according to his interests and competences. Hyperlinks allow adding a large numbers of information, including multimedia support, giving the opportunity to the users to build his own knowledge of a theme.

Keywords: Web-mapping, GoogleMaps, geosites, geotourism.

ARCHAEOSEISMOLOGY AND THE ARCHAEOLOGICAL CASE OF MONTE MOLIÃO, LAGOS (ALGARVE, PORTUGAL)

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It is known that the Southern part of the continental Portuguese territory has more seismic risk than any other Portuguese areas, followed by the Tagus valley mouth. That's why, throughout history, the southern areas of Portugal have suffered several seismic destruction events.

However, archaeological evidences of seismic events are not always very clear. Some of the possible proofs that might be related to seismic events in archaeological structures and stratigraphical sequences may, in fact, be created by other kinds of destruction agents. Therefore we present an introduction to this Geoarchaeological branch responsible for the approach of Neotectonics in Archaeological studies, the Archaeoseismology.

Archaeoseismology is a new geoarchaeological science that interprets direct and indirect evidences of seismic deformations in archaeological sites. In this presentation we refer the state of art of this new discipline and we also present a specific archaeoseismological case in Portugal, the Monte Molião in Lagos, Algarve. Through the observed deformations of some old man-made structures, together with archeological data, we could relate a possible destruction due to the already known 63 b.C. seismic event.

One of the roman walls in Monte Molião shows a noticeable destruction that reflects a strong external agent of deformation. Combined with archaeological information that points to an abandonment of the site from early first century b.C. till early first century a.D., the clear destruction evidences indicates a

probable seismic case of destruction between the roman republican period and the roman imperial age.

This study, not only focuses the first archaeoseismological case in the Portuguese territory, but also enriches the Monte Molião hill with a new geoarchaeological investigation. The watershed that already contained the Monte Molião archaeological site has now a new reason to be considered one of the places with more geoarchaeo-turistic potential in all southwestern Portugal.

Keywords: Archaeoseismology; Archaeology; Seismicity; Monte Molião.

PROPOSAL OF VOLCANIC GEOMORPHOSITES ITINERARIES ON LAS CAÑADAS DEL TEIDE NATIONAL PARK (TENERIFE, SPAIN)

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Sun and beach tourism is the most relevant economic sector in the Canary Islands (Spain). Hiking tourism, which combines other activities with the appreciation of volcanic landscapes, is today one of the main economic activities of sustainable tourism in several Canarias enclaves.

Tenerife is the largest island of the Canarias Archipelago and is characterised by a complex volcanic history. The construction of a basaltic shield and a phonolitic composite volcano represent the main features in the volcanic evolution of the island. Both volcanic complexes are still active, the first through two main rift zones and the second through the Teide-Pico Viejo central complex. The island of Tenerife is dominated by Las Cañadas del Teide National Park (LCTNP). This area is a volcanic paradise rich in spectacular forms: stratovolcanoes, calderas, cinder cones, craters, pahoehoe, aa, block and balls lavas, etc. The LCTNP receives more than 2.8 million tourists per year (2008) and it has 21 main paths and 14 secondary ones.

The aim of this paper is to propose a different geomorphosite itinerary in the LCTNP, using for it the main net of paths. These itineraries are based on geomorphological and geomorphosite resources. The methodology relies on different aspects such as bibliographical research, aerial photos, topographical

and geological maps and field survey. The geomorphological characters of LCTNP were obtained out of the project Volcanic Seismicity at Teide Volcano: recent volcanism (CGL2004-05744-CO4-02) funded by the Spanish Ministry of Education and Science. The geomorphosite landforms are obtained from geomorphological maps with a triple evaluation (scientific, cultural, socioeconomic and scenic values).

Three itineraries that represent the geodiversity and singularity of the national park are attempted. The first itinerary is developed on the path of Siete Cañadas (16.6 kms. and low difficulty). The main landforms and geomorphosites are the wall of Las Cañadas caldera, talus, floodplains, cinder cones and lava fields. The second route is developed on the path of Teide-Pico Viejo-Carretera Tfe 38 (9.3 kms. and extreme difficulty). The geomorphological elements and geosites are stratovolcanoes, Pico Viejo crater, historical eruptions, volcanic domes and pyroclastic and lava fields. The third itinerary is developed on the Volcán Fasnía (7.2 kms and low difficulty). The main volcanic forms and geomorphosites are the basaltic monogenetic volcanic field and historic eruptions.

Keywords: volcanic geomorphology, geoheritage, geotourism, geomorphosite, geomorphological map, Las Cañadas del Teide National Park, Tenerife.

WHEN THE PROMOTION OF THE GEOHERITAGE HELPS GEOSCIENCES AND VICE VERSA: THE CONCEPT OF HYBRID RESEARCH APPLIED TO THE GEOHERITAGE OF THE BAUGES MASSIF (FRENCH PREALPS)

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The works on the promotion of geoheritage were considered for a long time as minor and secondary towards the major subjects of research in geosciences. The current development of the topic of geoheritage, in answer to a significant social demand, requires the establishment of a specific and recognized research.

To do it, we propose the concept of "hybrid research" serving and associating at the same time the expectations of the fundamental geosciences and those of the promoters of the geotourism and the "geoeducation" (as a component of the Sustainable Development).

This concept results in tools and methodologies conceived in this double optics, which we call "monitors". Such tools are in the course of experiment in the Regional Natural Park of the Bauges Massif (French Prealps) which is candidate to the label of European Geopark. Two examples of "monitors" experimented in the Bauges Massif are presented here, more particularly: "GeoVision" and the "Educational Dye-Tracing".

- GeoVision consists in developing a station of measure and visualization of the processes relative to the extern geodynamics. The aim is to increase the knowledge of these phenomena while making them visible to the general public, within the framework of territories concerned to the

geotourism and to the environment education. This station is a development of the process Hymage-TIP: an optical sensor connected with a treatment of images specific software, initially finalized for hydrometric applications. A model of station GeoVision is in development for the measure and the visualization of the phenomena of the Prerouge Spring floods, one of the main Bauges massif's karstic emergences.

- In the same order, took place in June 2010 an "educational dye-tracing" in a karstic mountain of the Bauges massif heart, in association with the cavers and the pupils of the local middle school, within the framework of their courses of Earth sciences and environment education. The pupils were able to participate actively in the experiment and to realize in which point their springs were vulnerable, especially those which are fresh water catchments.

So, tools and experiments of type "monitors" should allow reconciling the expectations of the fundamental research and those of the applied research in the promotion of the geoheritage. In the end this one will tend to be more recognized as a substantial topic of research and a full outlet for the today Geosciences.

Keywords: hybrid research, geoheritage, geotourism, geoeducation, monitors, Bauges.

THE GEO-TOURIST MAP OF BAILE FELIX-1, MAI-BETFIA SECTOR, BIHOR COUNTY, ROMANIA

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The paper exemplifies the criteria and methodology used for setting up the geo-tourist map of the area Baile Felix–1, Mai balneoclimateric resorts, from Bihor County, Romania, located at the contact between Tasadului Hills (structurally speaking they further continue the Padurea Craiului Mountains from the Western Apuseni Mountains) and the Western Romanian Plain.

This space has been distinguished itself through the presence of the thermal waters that have already been known from the 19th century (the artesian well was drilled in 1885 and has the largest flow capacity in Romania), being successfully used for curative purposes.

The cartographic materials printed by the Military Topography Department, the topographic and cadastral plans, at the scales of 1:5 000 and 1:10 000, the ortophotoplans having 0.5 m resolution and the ASTER scenes used for GIS applications by overlaying technologies. These materials, together with the field investigations, represent the base for the layers elaboration with lithological information (e.g. terraces and meadows deposits), geomorphologic data (river geomorphostructures, sheet erosion, gravity, etc.) and tourist information (e.g. the main roads network, parking and public food places, hotels, board and lodgings, wood churches, camping areas, etc.).

Through the combination, synthesis and generalization of these information it had resulted the study area geo-tourist map. In its design was used the factor

analysis; the mapping and the used symbols were choose to facilitate the map manipulation and its understanding for the tourists.

The mentioned geo-tourist map will be located in several major points in the resorts, contributing in this way to a better promotion and tourist valorization of this area.

Keywords: Geo-tourist map, balneoclimateric resort, board and tourist pensions.

VULNERABILITY OF TOURISTIC GEOMORPHOSITES IN TRANSYLVANIAN SALIFEROUS AREAS (ROMANIA)

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Our study focuses on the impact analysis of contemporary geomorphological processes on tourism activities in the diapiric regions of Transylvania. The aim is to identify geomorphosites vulnerable to manifestations of contemporary geomorphological processes and to appreciate, in qualitative terms, the feedback offered by the local and regional human communities.

The methodology implies identifying the causes and effects of geomorphological processes that induce territory's vulnerability and restrict tourist activities. The graphic support used includes topographical maps at a 1:50 000 scale, aerophotographs and orthophotographs. They facilitated the identification of vulnerable areas, and on site investigation provided an opportunity to spot isolated events and feedback offered by local communities to hazards and risks.

In this papaer we associate the instability specific to geomorphological systems of the diapire folds with their vulnerability and susceptibility to generate geomorphological processes with a destructive potential.

Potential vulnerability of a destructive process, will express geomorphological risk frequency, referred to casualties and material destruction represented by roads, municipal and industrial infrastructures, and practice of tourism specific infrastructures.

Anthropogenic interference in saliferous territories, through european programs of rehabilitation, modernization and development of rural land, confirms the new destination of transylvanian saliferous, namely the recovery and leisure tourism, sports tourism, cultural tourism, religious tourism with climatic and spa tourism. Geomorphological landscapes have received new functions in the correlation context of resources of saliferous substrate with hydro-atmospheric transylvanian and biotic cover (forest, steppe, agriculture).

Inhabited areas' vulnerability to contemporary geomorphological processes is reflected in the agricultural and forestry suitability index. Our methodological approach has led to the identification of opportunities offered by the diapiric geomorphological landscape in the creation of complementary or alternative tourism activities, to ensure permanent activities. Forms of sport and recreational tourism, ethnographic and folklore tourism, cultural religious tourism, scientific tourism are associated to balneary and spa tourism. Territory's geodeclivity, fragmentation, slope exposure and tectonic stability are attributes that lead to diversification of the tourist offer. CERG methodology, allowed the establishment of a hierarchy for territory's vulnerability depending on the types of processes, and the identification of tourist development opportunities. The study was made for the diapir anticlines Dej-Sic-Cojocna, Jabenita-Teaca-Sărățel-Blăjeni, Sovata-Praid-Ocland and Ocna Sibiului and proved poor appreciation of the tourist value attributed to the resources offered by the Transylvanian diapiric regions.

Keywords: vulnerability, geomorphosite, diapiric areas, Transylvania.

GEOLOGICAL HERITAGE RESOURCES AROUND THE PLAN DE AYUTLA REGION, NORTHEASTERN CHIAPAS, MEXICO

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The state of Chiapas in southeastern Mexico has a various and rich natural and cultural heritage. An important part of this richness corresponds to the biological and archaeological heritage but the geoheritage resources are almost unknown. Therefore, a border area in the northeastern part of the *Montes Azules Biosphere Reserve*, which is located within the Lacandon jungle, was selected to conduct geomorphological and geoarchaeological studies.

The aim of the studies is to know the rock formations, stratigraphic and geological structures, and landform genesis, in order to understand the processes that gave shape to the physical and environmental foundation in the region. Preliminary results indicate that a very important karst system developed in folded carbonate rock beds of Cretaceous and Tertiary ages. Cave forming process have opened joints and bedding planes allowing the evolution of a groundwater environment. The karst nature of the landscape has been obliterated by more recent surface geomorphological process: fluvio-alluvial sedimentation, soil formations, and collapsed materials. Rainfall waters have been recharging the aquifers along the mountains forming waterfalls, springs and extensive travertine deposits.

Besides the abundance of archaeological sites and the extraordinary biodiversity, the region also possesses an important geodiversity: natural rock

exposures, river banks, hills, caves, waterfalls, rapids, doline lakes, sinkholes, and more, that are hidden within the thick rainforest. Furthermore, according to the geological data of the region, the ancient inhabitants took advantage of some of these natural features, for example, the deviation of the rivers course to control seasonal inundations.

The knowledge of the cultural patrimony against the rapid development of tourist activities, deforestation and construction in the area represents an opportunity to work towards the conservation and management of the natural and cultural heritage. In the future, the goal of the project is to incorporate the local people and the visitors into the process of management and conservation, highlighting those that constitute potential tourist attractions and promoting them under a sustainable development framework.

Keywords: karst system, archaeological sites, geodiversity, natural and cultural heritage, sustainable development.

THE ASSESSMENT OF THE MARAGHEH FOSSILIFEROUS GEOSITE

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Fossil vertebrate localities of the Maragheh region in Azerbaijan, northwestern of Iran, are among the most renowned late Miocene localities in Eurasian. The fossiliferous beds are found to the north and east of the Maragheh city, on the southern slope of the inactive Sahand volcanic cone Mountain, at an altitude of 1500-1900 meters.

Maragheh rock formations mainly consist of fluvial deposits. Investigations revealed that the Maragheh fauna spans from a range of 9.5 to 6.5 Myr and presents an especial correlation with that of Samos (China), Pikermi (Greece), Saloniki (Greece) and Mt Luberon (France), the so called Pontian mammals' communities.

With respect to fossils related to Hipparion horses, Rhino, Machairodont, Mastodons, Antelope and other pontian fauna, the site seems more significant. An area about 12.40 km² (since 2004, 1240 ha has been managed as a Natural Monument by the Iranian Department of Environment). In spite of the international and national significance of the Maragheh, the site is threatened due to various risks such as: private ownership, development related to several activities, natural and artificial erosion, development of transport corridors, weathering, etc.

Risks assessment and estimate rate of vulnerability of the geosites, applying some managing methods, can lead to the reduction of the geosite threats. This paper tries to present a method to assess and determine the rate of vulnerability

of the Maragheh geosite, based on the Heyward Assessment Method. Heyward's Method consists of five main criteria, which are divided in thirteen secondary criteria, to score the value of each site. For each site, the scores obtained for each criterion are summed and a cut-off point of at least 40 points must be attained before a site is considered to have sufficient heritage value. Results of the investigations reported here are that all of the Maragheh geosites attain over 40 points by this method, thus it is a necessity to introduce a new category of conservational management. This survey purposes the establishment of a Geopark for sustainable management and usage of this valuable geosite.

Keywords: Risk assessment, Maragheh fossiliferous geosite, Geopark, Iran.

MARAGEH: A GEOPARK OF UNIQUE MAMMAL'S FOSSILS

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The end of the second millennium and the beginning of the third millennium is characterized by the increased interest and attraction to the nature over the world. This is an index that the artificial landscape is not enough to satisfy men who is a part of nature, thus he quartered to tourism and sports and his link to the nature becomes more and more attractive, sometimes by necessity and not for luxury. The amount of tourists who vacate in natural environments for instance, forests, mountains and lacks is increasing, which increases the pressure on some parts of Earth.

Although geosites are unique and non-renewable resources of Earth, so when we lost them, and we also lose unique information and their aesthetic value, they are very attractive for tourists as they are vulnerable phenomenon. It is clear that it is very important to prepare relevant legal elements, based on detailed studies and elaboration of usage roles, which can prevent problems due to unsuitable usage and can promote sustainable usage.

The Fossiliferous Geosite of Marageh in Azerbaijan at northwest of Iran, is one of the most unique geosites around the world whose specimens answer to important questions about mammals evolution. These geosites with a lot of outcrops of unique mammal fossils, such as ancient elephants, rhinos, giraffes, mastodons, a collection of ancient horses, etc., are important sites whose findings may be applied to understand paleoenvironments and weather and climate changes modeling and forecasting. They can also be used in the earth

sciences teaching and in geomorphological researches and environmental alterations. In addition, it seems to be a suitable site for establishing a fossiliferous geopark to serve several goals, for instance, teaching and researching earth sciences and tourism's multipurpose aims. This survey, by reviewing documents and field information and analyzing them, attempt to illustrate the capacities of this site to be a geopark within the Global Geoparks Network, as well as its abilities for geotourism purposes.

Keywords: geopark, geotourism, Marageh mammal fossiliferous geosite, Iran.

GEOSITES, AS EFFECTIVE TOOLS OF TOURISM ATTRACTION: CASE STUDIES OF IRAN AND POLAND

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Generally geosites are located in the mountains or on the highlands. They are not common in lowland areas. If they are present, they are usually connected with river valleys, lakes, swamps, etc. According to geotourism science, geosites play an effective role in the introduction of geological phenomenon and attracting the interested people in enjoying natural beauties. The present study attempts to investigate the role of geosites in attracting geotourists from the scientific and economic aspects. It also aims to find out the critical factors of geosites for a successful development of tourist attraction. This study is designed as a descriptive one based on both geological and economical aspects, with a special reference to two case studies, in Iran and Poland, which reveals that there exists significant differences.

In this paper, Kalat e Naderi, as one of the most attractive and unique geosites in the middle east (including unique features such as Gharesu water fall, Ortkand water fall and its cave, etc.) is considered as the case study in Iran. The geosite case studied in Poland is the Upper Narew River valley, situated in the north-east part of Poland, 10-15 kms to the west of Białystok. The unique character of this part of the river valley is a result of geology and geomorphology on the one hand, and hydrological processes on the other hand. Held back by hills (ranging between 20 and 30 meters) during periods of

high water level, the river divided into numerous branches in places not bordered with high banks, with time forming an anastomosing system. Nowadays the Narew River is the only river of this size in Europe which forms the anastomosing system at a certain section of its course, and that's why a part of its valley can be recognized as a geosite.

Keywords: tourist attractions, geosites, Kalat e Naderi, upper Narew River valley.

**VALUES, GAPS AND GEOTOURIST POTENTIAL OF
GEOMORPHOLOGICAL HERITAGE WITHIN UNESCO WORLD HERITAGE -
ASSESSMENT OF CASES**

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The World Heritage List of UNESCO contains 911 properties (as of 2010), in 151 States Parties, which occur in three categories (cultural, natural and mixed) and are known as the most outstanding values for humanity.

The main goal of that initiative is the recognition, protection, preservation and promotion of the exceptional importance of inscribed sites. Among them only 180 properties represent natural treasures while there are 704 cultural sites and 27 with both natural and cultural features. Besides the description of the World Heritage sites the more detailed assessment of their values has not been accomplished.

The aim of this communication is the assessment of UNESCO World Heritage sites based on scientific and additional values and in accordance with their potential of being the aim of visit by tourists wanting to know more from scientific/educational point of view about admiring sites. The criteria of this evaluation are author's proposals with the assessment of additional value including cultural, ecological and aesthetic features as well as accessibility.

Obviously the main attention is focused on the abiotic World Heritage Natural Sites divided into the categories of landforms and processes like: volcanic, glacial, karstic, coastal, fluvial, aeolian as well as mountainous landscapes and typical geological sites. Many of them are geomorphological icons, including some world records (e.g. the highest waterfall, the largest sand island, etc.).

However, simultaneously, some of the World Heritage Natural Sites with outstanding geomorphology are known only in regional or local scale without enough promotion to the global public with potential interest.

Among the World Heritage Mixed Sites most have been inscribed with focusing on their general aesthetic value what left such a unique site, like e.g. Pamukkale (Turkey), without special mention about its geomorphological values.

On the other hand in a significant number of World Heritage Cultural Sites their outstanding geomorphological features appear overlooked although they have a large geotourist potential with additional cultural/religious/historical values beefing up their attractiveness. The main attention is focused on the recognition and promotion of cultural values.

The proposed assessment helps to identify the geotourist sites within the World Heritage List including the most numerous and poorly represented types of sites in European and global scale. Some examples of their promotion and propositions of addition the existing gaps are also presented. In further way the provisional method can be developed by using field researches.

Keywords: geomorphological heritage, World Heritage, assessment, value, geotourism.

**AMMONITE COQUINA AS PALAEONTOLOGICAL MIRACLE IN THE
ROGOŹNIK KLIPPEN – FORGOTTEN GEOTOURISTIC OBJECT IN THE
PIENINY KLIPPEN BELT (POLISH CARPATHIANS)**

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Palaeontological objects are very often central points of geological monuments in protected areas. Rich fossiliferous outcrops/strata in geological nomenclature usually are described as Fossilagerstätten (Konservat-Lagerstätten) (L) and represented different in age fossil-bearing, perfect preserve record (including soft parts of body or tissue impressions) of ancient life. They are known since Cambrian times (e.g., Chengjiang, Burgess Shale, Sinsk) through Palaeozoic (e.g., Ordovician: Orsten-type fauna, Winneshick L, Soom Shale L; Silurian Eramosa L, Devonian Hunsrück Slate, Pennsylvanian fauna in Mazon Creek), Mesozoic (e.g., Triassic: San Cassiano, Voltzia Sandstone, Hallstatt limestones; Jurassic: Posidonia Shale, La Youtle L, lithographic limestones in Solnhofen and Cerin; Cretaceous: Jehol Biota, Komen L) up to Cenozoic (e.g., Eocene: Messel and Bolca L). Fossilagerstätten older than Phanerozoic are represented mainly by Ediacaran-type fossils (Australia, Russia, Namibia etc.) and recently discovered fossils in Doushantuo limestone, representing embryonic stage of life. In Poland fossiliferous deposits occur in Palaeozoic (e.g., Devonian marine invertebrates of the Holy Cross Mountains), Mesozoic (Jurassic ammonites of Łuków) and Cenozoic (fish associations in the Menilite shales of the Outer Flysch Carpathians) strata. The so-called Rogoźnik Klippen in the Pieniny Klippen Belt of the Carpathians belongs to the most famous localities in the Polish territory. It is full of latest Jurassic/earliest Cretaceous ammonites, which

have been known by European geologists since XIX century. The micritic and sparitic ammonite-bearing coquinas contain rich Tithonian/Berriasian Mediterranean-type fauna. Such type of deposits is absolutely unique in the whole Carpathian arc, both in lithological character and in ammonite assemblage. Their biostratigraphical value as transitional units between Jurassic and Cretaceous epochs and their biogeographical connections within ancient Tethyan Ocean promote these klippen as one of the most important outcrops in the Carpathian geology. It has been a reason for their protection as inanimate nature monument and recently listed in UNESCO geoheritage list. From geotouristic point of view this klippen should comprise the central point of geotouristic trail in this region, being a key for understanding Jurassic-Cretaceous evolution both of the whole Tethys Ocean and its Carpathian part within Alpine-Dinaridian orogenic system history.

Keywords: ammonite coquina, Jurassic/Cretaceous, Carpathians, Pieniny Klippen Belt, geotourism.

GEOMORPHOSITES MAPPING USING GIS IN MID-MAJERDA VALLEY (NORTHWESTERN TUNISIA)

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The Mid-Majerda Valley is well known as being one of the most fertile regions in Northern Tunisia since roman time. Numerous archaeological remains were found on land surface or buried under alluvial accumulations. Sometimes, these were exhumed by erosion in the valleys' bottoms of wadi Majerda after heavy rain periods. The archaeological remains are very useful tools to reconstruct geomorphological evolution since the Antiquity. Indeed, some geomorphosites, in addition to their scientific value, are part of the geoheritage and deserve to be recognised as such and publicised to the general public. The aim of this work is to improve knowledge on the geoheritage and increase the awareness and sensitivity of the geoconservation needs. However, this is not the case in Tunisia and there is a general tendency for the valorisation of archaeological sites independently from their geographical context. Until now, little is known about the geographical environment and landscapes in which roman and berber population were living and how exploitation of resources were made.

From this aspect, this paper is an attempt to contribute to a better understanding of geoheritage through a close knowledge of geomorphosites. For that, geomorphological maps for three geomorphosites selected in the mid-plains of wadi Majerda are made: the fortified Roman cities of Thuburnica, Simithu and Borj Helal. The maps could identify fluvial landforms, processes and deposits of historical heritage, with forms and processes active in the current morphoclimatic conditions. Moreover, they are enriched with usual

indications (symbols, 3D representations...) to help the non specialist such as tourists, to understand better what they are watching.

This study is a result of particular field observations through examination of sediments of river banks, drawing profiles and collection of Roman Pottery. It is also based on Geographical Information System environment (GIS). This one integrates mostly high altimetry GPS data, Google Earth images and Digital Terrain Model (DTM). The datasets allow realizing cross section that shows the landforms (terraces, alluvial bench) and changes in the morphodynamics since the late Pleistocene. Therefore, the GIS environment allows building three dimensional views of the landscape that may simplify the scientific information. Finally, we draw up a brochure filled with a number of photos in order to capture the interest of visitors to geomorphosites.

Keywords: geomorphosites, archaeological remains, GIS, geoheritage.

STUDY OF THE GEOMORPHOLOGICAL AND ARCHAEOLOGICAL ASPECTS OF SINTRA AREA (PORTUGAL) AS CONTRIBUTION TO ITS TOURIST APPRAISAL AND PROMOTION

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The Portuguese city of Sintra is an UNESCO world heritage site for the cultural and environmental aspects. The city is located 30 km from Lisbon and 15 km from Atlantic Ocean, and is a touristic site in every season mainly for its architectural qualities.

This work describes the geomorphological and archaeological aspects of the city and the surrounding Serra in order to give an added value to tourist appraisal and promotion of the area.

Sintra's Serra is an elliptic igneous massif, 10 km E-W and 5 km N-S, 300-500 m above sea level. The geological structure is complex but it can be simplified as a core of sienites surrounded by granites in a calcareous rocks plateau.

The morphogenetic processes, beside common landforms such as valleys, scarps and ridges, shaped a variety of particular morphologies as round blocks, inselberg, tafoni, etc. The most spectacular ones have been described and classified as geosites in a data-base.

The oldest archaeological remains dates to Mesolithic, but the area has been extensively occupied during the Neolithic/Calcolithic, Bronze and Iron Age. In

historical time Romans, Visigoths and Arabs left some interesting architectural and linguistic marks. All the archaeological sites have been classified according to bibliography, museum data and field surveys. They are all included in a database.

Two GeoArchaeo-Tourist maps (at 1:25 000 scale of Sintra Serra and at 1:10 000 scale of Sintra town) are the results of the information collected in the geological and cultural data-bases. The maps have been implemented, by means of ArcGIS computer programme, integrating geological, geomorphological, archaeological and historical aspects with the tourist infrastructure (information point, parking area, accommodations, panoramic points, etc) in order to obtain documents readable, simple, clear but scientifically accurate also for non-expert users.

The main purpose of the GeoArchaeo-Tourist maps is to favour the tourists to discover the Sintra's area also for its landscape and archaeological aspects.

Keywords: geomorphology, archaeology, tourism maps, Sintra.

GEOSITES OF THE AZORES GEOPARK PROJECT: INVENTORY, RANKING, USE, PROTECTION STATUS AND VULNERABILITY

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The Azores Archipelago (a Portuguese Autonomous Region) is located on the North Atlantic Ocean, about 1.600 km west of the European continent, at the triple junction between the North American, Eurasian and African (or Nubian) tectonic plates. The archipelago is composed by nine islands and some islets, aligned with a general WNW-ESE trend on the surrounding seafloor (e.g. the Azores Plateau).

The volcanic landscape of the Azores Islands is the main promotional icon of the archipelago, and presents an important geodiversity with several geosites of high value and relevance, such as several polygenetic and monogenetic volcanoes, historical eruptive centers, hydrothermal fields, pillow lava and prismatic jointing outcrops, volcanic caves, fault scarps, Miocene to Quaternary fossiliferous marine deposits, littoral platforms (locally called “fajãs”) and some offshore sites such as submarine hydrothermal fields, that can be better promoted and exploited under the concept of the “Azores Geopark”.

Since the settlement of the archipelago, in the XV century, the exceptional natural beauty and landscapes of the Azores are a major source of interest that attracts many scientists and tourists to visit these islands. Nowadays, with globalization, namely easier access to information there has been a greater demand for tourism in the Azores Islands.

Thus, the Azores may be considered a natural laboratory of international relevance with regards to active volcanism, volcanic landforms and geodiversity, global plate tectonics, and regional and local neotectonics. The archipelago displays varied and abundant geological features of scientific, educational, scenic, socio-cultural and economic (touristic) interest, both on the islands and at sea.

The most important geosites (about 120, located either on the islands or at the surrounding sea floor) are already identified and characterized, and geoconservation measures for some of them were prioritised based on a scientific approach. Among the 120 sites, 57 main geosites were selected as priority for development of geoconservation actions and strategies within the Azores Geopark project. These more relevant sites are distributed in the archipelago as follows: Santa Maria (5), São Miguel (10), Terceira (7), Graciosa (5), São Jorge (5), Pico (8), Faial (6), Flores (6), Corvo (3) and submarines (2). All these sites of geological interest were categorized based on its geomorphology and were then analysed taking into consideration its importance or relevance, type of use, protection status, vulnerability, and other types of interest.

Keywords: geosites, Azores Geopark project, geoconservation.

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BASALT LANDSCAPES AS A RESOURCE FOR GEOPARK AND GEOTOURISM IN TAIWAN

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This study is trying to demonstrate the suitability of basalt landscape at Penghu archipelago for its designation as a geopark. As this area is under development it is important to develop geotourism for sustainable development. The basalt landscape resource is important for this purpose.

Penghu archipelago is situated at Taiwan Strait, south-eastern China. Because of its subtropical environment, Penghu has a long history on marine life and the marine environment is also an attraction for tourists.

The Penghu archipelago is composed of 64 islands. Most of them are formed by basalt rocks. The basaltic magma evolved since 11 Ma years ago when the southern China Sea expanded. The landscapes have different shapes because of different ways of eruption, weathering and erosion. The linear features of joints, textures, colors and shapes of the basaltic landscapes from Penghu made this area as an important site of scientific interests.

Because of tropical storms, monsoon and subtropical environment, the marine processes such as waves and sea currents have great impact on the shaping of landscape. Salt weathering adds also the great diversity of the basaltic landscapes.

According to the evaluation of landscapes in Penghu, the basaltic landscapes can be classified into three groups of resources: geological/geomorphological, marine biological ones and historical attractions. The local government and

other stakeholders also play an important role to promote this area towards a geopark status.

During the study process, a comparison of the basaltic landscape with Giant Causeway, in Northern Ireland, was also done. It is found that climate is one of the parameters which made landscape very different. The basalt landscapes at different climate environment are also an interesting topic to present here.

The results show that within the framework of Penghu Geopark, there are 10 sites which are highly recommended to design for Geopark purposes. These 10 geosites are separate at ten islands with different landscapes. The geodiversity of the basaltic landscapes could provide more opportunity on scientific education and tourist industry. However, more management works and public education to promote local economics and raise the awareness for sustainable development is needed.

Keywords: geopark, Penghu archipelago, landscape conservation, Taiwan.

**AZORES ISLANDS GEODIVERSITY AND GEOLOGICAL HERITAGE:
CONTRIBUTION TO TOURISM DEVELOPMENT IN THE AUTONOMOUS
REGION OF THE AZORES**

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The Azores Archipelago, located in the North Atlantic, at the triple junction of Eurasian, North American and African (or Nubian) tectonic plates, is characterized by 16 polygenetic volcanoes (mostly silicious and with a summit caldera), 9 of them with Holocene volcanism and active, and about 1750 monogenetic volcanoes (*e.g.* scoria and spatter cones, domes, *coullées*, tuff rings, surtseyan cones and eruptive fissures), scattered on the flanks and calderas of those polygenetic volcanoes or on the 11 fissural basaltic zones existing in the archipelago.

Despite their small area (2323 km²), the archipelago offers a vast variety of rocks, geologic features and structures, which derive mainly from the type of eruption that originated them, its dynamics, the nature of the magmas, and the subsequent actions of weathering and erosion processes, and thus constitutes a natural laboratory of volcanic geodiversity.

The Azorean geolandscapes are the main *ex-libris* of the archipelago with huge potential for tourism, which aims to develop, because it has attributes of great attractiveness and present vast opportunities for sustainable use.

Under the "Strategic Plan of Marketing for Tourism in the Azores - 2008/2010" coordinated by the Azores Tourism Association (ATA), some proposes were submitted for a geotouristic strategy based on two main principles: i) development of intra and inter-islands routes, ii) existence of dissemination actions accompanied by monitoring actions. The main routes proposed include:

- a) "Route of the Volcanic Caves" - "to discover the underground of the islands", valuing the volcanic caves and their interpretation/visitors centers;
- b) "Route of the Viewpoints" - "to discover the Azorean geolandscapes, by car", highlighting the numerous viewpoints and belvederes that exist in the islands;
- c) "Route of the Walking Trails" - "to discover the Azorean geosites, by walk", valuing the Regional Network of Walking Trails and other traditional trails;
- d) "Route of the Thermal Waters" - "to discover and enjoy the power of the Azores volcanism", taking profit of the importance of Azorean thermal waters and muds for health, leisure and well-being;
- e) "Route of the Science Centers" - "to understand and interpret the volcanic phenomena of the Azores", highlighting the use of the several interpretation and visitors centers in the Region.

Keywords: geodiversity, geological heritage, volcanism, geotourism.

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SOME EXAMPLES IN THE FIELD OF GEOTOURISM IN EMILIA ROMAGNA, MARCHE AND ABRUZZO REGIONS (NORTHERN-CENTRAL ITALY)

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Italy is a country with a rich natural heritage that is having difficulty in finding the right areas for acquiring knowledge, protection and improvement. In particular, the *geological component* of the landscape has not yet acquired a sufficient value as a cultural asset which people can learn about and share.

Within the Italian territory geotourism activities and products are recently widespread. In this work examples of activities on geotourism in Emilia Romagna, Marche and Abruzzo regions are described. They are focused particularly on: analysis and enhancement of protected areas and geosites; geotourist and tourist-environmental maps; geological itineraries; portable and on-site geological illustrative materials.

The described examples illustrate the documents implemented for the enhancement of the geological (s.l.) landscapes, at different spatial (from regional to local) and temporal (from Trias to Holocene and present) scales. This is focused on developing the sensitivity of people to read in the landscape long term temporal scales processes, that lead to the present landscape of a region, as well as short term temporal scale processes characterising the resource management or the local geological and geomorphological risks.

The examples include activities at regional and institutional level, as well as at university level, in some cases in collaboration with upper school institutions. They also include activities developed specifically for tourism at local and regional scale or private initiatives, within the Park areas or within the Italian Association for Geology and Tourism. Besides the several possible approaches to geological heritage enhancement, they show a different development level of geotourism in Italy. Indeed, only a wide interregional tourism network integrating initiatives targeted at various potential users and connecting universities, local and regional institutions, Parks and local reserves, schools, private initiatives etc., can lead to reach the goal in term of educational dissemination of geological and geomorphological themes, awareness of the complex meaning of the landscape.

The integrated approach to the discovery of geological heritage - as presented in this work - through various tools and activities and targeted at various potential users can be summarised by quoting a famous statement by Marcel Proust: *“the real voyage of discovery is not in seeking new landscapes but in having new eyes”*.

Keywords: Landscape, geomorphology, geotourism, maps, northern - central Italy.

INVENTORY, DISSEMINATION AND PRESERVATION OF THE GEOLOGICAL HERITAGE IN LISBON CITY

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In urban areas, such as Lisbon city is not expectable to find references of evolution and earth dynamics. However, in Lisbon it is still possible to observe some outcrops preserved among buildings and roads, some of them with large dimensions, materializing several geological formations since Cretaceous to Holocene Periods.

The original paleoenvironments associated to the lithostratigraphic diversity presented in Lisbon area, presents great potentiality to the preservation and dissemination of the geological heritage.

The Lisbon Municipality, in cooperation with the Natural History Museum, The Lisbon University and the Geological Survey, developed works aiming the inventory of the preserved outcrops in Lisbon city, with scientific, educational and cultural interest, liable to be classified as Geomonuments.

In the aim of the “Lisbon Geomonuments” Project 18, outcrops in Lisbon city were already classified as geomonuments. Some of them represent also cultural values as they correspond to ancient quarries.

The next step of the Project includes the constitution of a network, where visitors can observe in each geomonument several lithologies, their deposition environments, paleogeographical conditions and biological activities as well as establish the regional geological depositional sequence and paleogeographic evolution.

As main measures aiming the appreciation and divulgation of these geomonuments and having as base the philosophy “Through interpretation, understanding; through understanding, appreciation; through appreciation, preservation” (Mathis, A., 2005), becomes mandatory to provide the public with tools that allows the interpretation of the outcrops as well as means to allow the access to those places.

Accordingly, a guide book, with a portuguese and english version, about Parks, Gardens and Geomonuments of Lisboa, was edited last year by the Lisbon municipality, with descriptions of the places that can be visited.

It is also being developed thematic trails to general public and schools as well as projects of landscape architecture, with information totems with a brief geological and geographic description.

Keywords: geomonuments, Lisbon, preservation, geological heritage.

THE BASQUE COAST GEOPARK PROJECT (GIPUZKOA, SPAIN) AND THE “FLYSCH ROUTE”: SUPPORT FOR THE GOOD PRACTICES OF PUBLIC AND PRIVATE INITIATIVES

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The geological heritage of the west coast of Gipuzkoa (Basque Country) is characterised by its impressive cliffs and wide abrasion platforms, whose rocks are mainly originated in turbidite systems during the Cretaceous and the Palaeogene. This series of strata, commonly known as “Flysch”, spans some 60 million years in an almost uninterrupted outcrop. A part of the coastline has been protected by it being designated “Protected Biotope of Deba-Zumaia”.

Since 2006, guided tours of the flysch coast by both land and sea (with the option of combined land and sea tours) have been marketed under the “Flysch Route” brand. The main entrepreneurs of this initiative have been the Begi Bistan and Arazi (Arazi IKT S.L.) companies, who have worked under the direction of the tourist offices and the town councils. Year after year, supply has been developing through new guided tours. For example, 171 guided tours were given in 2010 in comparison with 150 in 2009.

Some of the good practices contributing to sustainable development include:

- The “Flysch Route” website (www.flysch.com), which makes it possible to control promotion level, visit flow and group management for the guided tours with the online book and buy options. It also facilitates feedback with the users both before and after the visit.

- The visits via boat enable the coastal flysch to be contemplated without causing any alterations in the outcrops.
- The use of public transport on the overland guided tours contributes to sustainable mobility.

The Basque Coast Geopark Project, which covers the municipalities of Mutriku, Deba and Zumaia and which practically emerged from the “Flysch Route” seed, presented its application to join the European Geoparks Network (EGN) in November 2009.

One of the main objectives of the project management body, the GEOGARAPEN Association, is to make geoconservation compatible with the economic activities stemming from the management of geological heritage. For this reason, it supports certain public and private initiatives through agreements which benefit the collaborating companies: promotion, advice and consultation, guide training, proofreading of the scientific content of the tourist information, etc. With such tools, these companies can differentiate themselves from possible competitors.

Within the framework of the geopark project, the associated companies participate in interdisciplinary working groups together with scientific institutions, management organisations for the territory and others, with the objective of detecting and correcting negative impacts on the environment.

Keywords: Geoconservation, geopark, geological heritage, Flysch Route.

GEOTOURISM MAPS AT A MUNICIPAL LEVEL: THE PORTO DE MÓS EXAMPLE (PORTUGAL)

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The Portuguese Association of Geotourism (APGeotur) was founded in 2007 with the principal aim to promote the geotourism in Portugal. However, since the beginning, the members of the Association considered of great importance to exchange ideas and experiences at international level and cooperate with other countries similar partners.

The model of association adopted was not a simple congregation of persons with the same objectives, but a model with direct intervention in the Portuguese society and public or private institutions.

One of the most important projects developed by the APGeotur members it's connected with the geoheritage survey at a municipal level and the elaboration of a geotourism map with several geotourist trails and a hand book field guide.

The first municipality to welcome this type of geotourism project has the Porto de Mós municipality, with an important area almost all located in a protected region – the Aire and Candeeiros Mountains Natural Park (PNSAC). This Natural Park has a karst landscape and occupies a great part of a geomorphologic karst unit named the Estremadura Limestone Massif (ELM).

In order to make the geotourism map the APGeotur team made the survey of all the already available information in the fields of natural or cultural heritage, as

well as relevant information for tourists: roads and other accessibilities, gas stations, pharmacies, hotels and others accommodations, restaurants and coffee shops, supermarkets, etc. Afterwards, previous to the field survey of the geoheritage, the team produces a standard data sheet for the systematic inventory of the geosites. The final aim is to build a municipal data base with all the information relevant to make (and update) the geotourism map: geoheritage, cultural heritage (material and immaterial as the gastronomy), touristic infrastructures, etc.

In what concerns the geoheritage the three basic steps were needed: identification, classification and mapping. This information will also be used, besides the construction of the geotourism map, to build the geotourist trails and, together with good photos, to edit the hand book field guide.

Keywords: Geotourism map, municipality, geoheritage, geotourist trails, hand book field guide.

**CRIONIVAL LIMESTONE DEPOSITS IN THE CANDEEIRO MOUNTAIN
(ESTREMADURA LIMESTONE MASSIF, PORTUGAL): A
GEOMORPHOLOGIC HERITAGE TO CONSERVE AND PROMOTE**

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The larger known set of relict limestone crionival deposits, with a southern as well as a western position, is located in the Estremadura Limestone Massif (ELM), in Central Portugal, 100km North of Lisbon and some 20km far from the Atlantic Ocean. The ELM is an uplifted compartment reaching moderate altitudes: 680m in the top of Aire mountain and 615m in the top of Candeeiros mountain.

Stratified slope deposits were classified by RODRIGUES, according to field criteria, into three major groups: i) openwork or clast-supported stratified slope deposits with different degrees of consolidation due to calcium carbonate cement (C1, C2 and C3); ii) solifluction deposits, generally matrix-rich (S1, S2 and S3); iii) deposits included in well developed talus screes with vertical and longitudinal classification of clasts by size (E). The episodes C2 and S2 have a larger spatial representation and the sedimentary characteristics are better preserved.

The Candeeiros Mountain forms the western limit of the ELM. It is a narrow elongated fold (with a maximum of 4km width and almost 30km long), consisting mainly of Dogger limestone, with faults in both sides and uplifted like an horst structure. The occidental slope of Candeeiros Mountain it is all cut by narrow,

steep and suspended dry valleys. These valleys are almost inaccessible not only due to the slope gradient and to the talus screes (E) placed over the surfaces of the slopes under the limestone cliffs, but mostly due to the dense Mediterranean vegetation that covers these valleys.

So, a lot of discussion has been made about the deposits of the occidental slope of Candeeiros Mountain, but there is no progress of the knowledge since 1973 (after the synthesis made by Daveau). However, evidences of stratified slope deposits were identified, classified and mapped in detail in two different valleys of Candeeiros occidental slope: the first valley is the northern one, called Vale das Mós, with the highest point in Cabeço Grande (374m); the second valley is located in the central part of the Candeeiros Mountain (so, in a southern position), is called Vale Maior and the highest point is in Cabeço Gordo (549m).

Both valleys show well preserved stratified slope deposits with consolidation due to calcium carbonate cement, corresponding to the type C2 identified the interior areas of the ELM. As these set of relict crionival deposits of the ELM has valuable palaeoenvironmental significance within the frame of Portugal and Iberian Peninsula relict frost-action processes, it is very important to protect these deposits. As they constitute a geomorphologic heritage and some are geomorphosites at a national or international level, they should be subject to particular rules of geoconservation. Afterwards, some of them, according to its accessibility and vulnerability, can be included in geotourist trails and in the geotourism maps.

Keywords: limestone mountain, stratified slope deposits, palaeoenvironmental significance, geoconservation, geomorphosites, geotourism maps.

GEOHERITAGE ASSESSMENT OF THE OURÉM MUNICIPALITY. A PRELIMINARY APPROACH TO THE GEOTOURISM MAP

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The Ourém Municipality is located in the central Portugal and shows a diversified landscape related to the great variety of the substratum rocks and to the fact that encloses different geomorphologic units. The two main geomorphologic units are: 1) the northeast part of the Estremadura Limestone Massif (ELM), mainly the so called Fátima Platform, forming the most uplifted area of the municipality western side; 2) the Ourém basin, that shows lower altitudes in the detritus rocks although the upper limestone sequence, of Cretaceous age, holds the old Ourém castle from the beginning of the medieval age.

In what concerns the geomorphologic unit that belongs to the northern part of the ELM, the S. Mamede Plateau, with the higher altitudes near 490-500m, it's an erosion form in Dogger limestone rocks (mostly Bathonian ones). The Fátima Platform is a lower erosion level with altitudes near 340m that ends through a fold or a fault system towards the Ourém basin. It is also formed by limestone rocks (from Callovian and Oxfordian) where were developed a set of karst and fluvio-karst forms predominantly aligned according to the main faults orientations (NW-SE and NE-SW).

The variety of landscapes and landforms is, almost everywhere, in relation with the presence of limestone rocks from Jurassic or Cretaceous age. The

Cretaceous limestone is responsible by the magnificent hill of the Ourém Castle, but most of the geomorphosites of the Ourém municipality are developed in the Jurassic limestone. These are the cases of the crioclastic deposits inherited from old cold Quaternary periods (more frequent in the ELM interior areas), of the Serra de Aire Dinosaur Traceways and of the great variety of karst surface and underground forms.

The dinosaur tracksite, in Pedreira do Galinha (Bairro), was discovered on July 1994 on the eastern side of Serra de Aire, approximately 10 km from Fátima. This remarkable tracksite of the Middle Jurassic period contains not just the oldest and longest sauropod tracks known anywhere, but also exceptionally well preserved traces of some of the largest land animals that have ever lived. It is classified as Natural Monument, covering an area of about 60 000 m², where we can observe various hundreds of dinosaur tracks grouped at least into two tens of trackways.

The karst landforms include caves (some open to the public, such as Moeda Caves), karst springs (we will focus the particular case of the Agroal karst spring that produces a karst canyon, a thermal pool and gives place to the Nabão river), small and big size dolines and uvalas (such as the big doline of Cova da Iria where it is placed the Fátima Sanctuary) and other fluvio-karstic landforms.

Our aim is, after finishing the geoheritage inventory and classification, to build a geotourism map so the thousands of tourists visiting Fátima every year could also know (and some visit) the geotourist sites of Ourém municipality.

Keywords: karst landforms, geomorphosites, geoheritage, geotourism map.

GEOTOURISTIC ROUTES ALONG THE BIKE PATH FROM BOCA DO INFERNO (CASCAIS) TO GUINCHO BEACH

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The effort to enhance the territory's values, pinpointing the various forms of landscape provided by nature, combining culture, history and knowledge about geoheritage and leisure, will attract more of the population driven by tourism and educational aspects.

The classification of Geosites and Geomorphosites in the area of Cascais, in the south of Sintra Mountain, which is an area whose geotouristic assets are underexplored, is done throughout this study. Several sites with particular characteristics were spotted, as well as some forms of relief worth being subsumed to the category of geomorphologic heritage. The geomorphosites were identified, assessed, classified and integrated in a geotouristic route, were geoheritage values and cultural heritage were included along the existing bicycle path that follows the coast between Boca do Inferno (or Hell's Mouth, Cascais) and Guincho beach.

A two-part journey was proposed: A (Boca do Inferno - Cape Raso) and B (Cape Raso – Guincho beach), allowing geotourists that walk or cycle to make all at once or split it into two different days.

Among the sites identified, 14 sites were picked corresponding to stopping and observation points in order to provide a pleasant and balanced visit

(scientifically and educationally) to the geosites and geomorphosites listed in this section.

The identification of relief forms enabled the recognition of different geomorphologic features (from the mega-forms to the micro-forms). It was possible to register the presence of caves, dunes (consolidated and mobile ones), *Karren* fields (mega-Karren), "matacães", pinnacles, karstic depressions, striated rocks by wind action, among others. Allied to this natural abiotic survey, a parallel assessment was made which included support facilities, such as hotels and restaurants in the area (and its gastronomic heritage), historical buildings (fortress, lighthouses), leisure-related escalation school and the Laboratory of Maritime Guide (Faculty of Sciences, University of Lisbon).

The information on the geoheritage has thus been added to information on cultural heritage (tangible and intangible), as well as to natural tourism data. The result was the proposal of a geotouristic route, consisting of 14 stops, over which further information may be obtained from a network of key words - information boards placed at each stop by the municipal tourist board.

Keywords: Geotouristic route; bicycle path; geosites; geomorphosites; cultural heritage.

A GEOTOURISM MAP OF LISBON CITY: A PRELIMINARY APPROACH

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The prefix GEO (i.e., Earth) immediately shows that geotourism is more close to the meaning of nature tourism, though it covers the abiotic aspects (not the biological ones) of the Nature; and it seems to be far from some others types of tourism such as the ethnic or the urban. However, the evolution of the geotourism concept and its relation to territories and to sustainable development policies, have been giving to geotourism a broader field of intervention.

Thus, as the geoheritage can be taken as a set of values that embodies the geodiversity of a territory, primary to geotourism is fundamental to increase the knowledge about the regional geoheritage and to undertake a detailed survey of geosites that have a scientific, educational, cultural or scenic value.

In fact, geotourism may be included into a global model for promoting those areas with such a rich and diversified natural heritage, as it is the case of many in Portugal. Nevertheless, the concept of geotourism has been developing an integrated vision of the territory, encompassing the cultural heritage and the local traditions, the gastronomic heritage and all other regional features, with the main goal of contributing to the sustainable development of local communities.

A number of thematic geotourist trails are already known: trails that can be associated to certain landscape types (mountains with some particular features, limestone landscapes with caves, underwater morphology, etc.) or those trails relating landforms and gastronomy (with the growing of local oenotourism and other hand-made products).

Our aim is to create an urban geotourism itinerary taking into account the rich example of Lisbon city that has already a set of classified geomonuments (of geologic value), and still preserves a large number of traces of the original landscape and geomorphologic heritage (such as the Tagus northern bank with its tributaries), that may call the attention to both a specialist as well as to a tourist that is willing to know more about Lisbon. After all, Lisbon it is known along the centuries as *the city of the seven hills* though today it has already embraced a few more.

Keywords: Lisbon, geotourism map, geoheritage, cultural heritage, urban routes.

ESTABLISHMENT OF A GEOTOURIST TRAIL IN THE PORTELA DE VALE DE ESPINHO AREA (WESTERN SECTOR OF THE ESTREMADURA LIMESTONE MASSIF, PORTUGAL)

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Located in Central Portugal about 20km far from the Atlantic Ocean, the Estremadura Limestone Massif (ELM) is formed by uplifted limestone blocks that reach moderate altitudes (max. 680m). The massif is affected by major tectonic accidents and the pattern of the joints and other discontinuities (including bedding planes) is a crucial factor in the geomorphologic processes interpretation, such as the karst phenomena and the landscape dynamics.

After RODRIGUES, tectonics is the main responsible for the morphostructural differentiation within the ELM, which is formed by: three landform units developed in anticline structures (Mountains of Aire, Candeeiros and Alqueidão); two plateau units (Santo António and São Mamede); two lineaments that define three tectonic depressions developed in graben structures (Minde, Alvados and Mendiga); one diapiric accident elongated, from the South to the North, between Rio Maior and Batalha.

In the study area the lithology is formed mainly by Jurassic limestone and the structure shows a network of faults with the main orientations NNE-SSW and NNW-SSE. Among these faults we can stand out the one that makes the

western border of the ELM and corresponds to the Candeeiros Mountain occidental slope. The eastern slope of this mountain it is also bordered by a fault and that's why this elongated anticline mountain it's also a big uplifted horst. The dip of the strata shows the strong stresses associated with the uplift, with great variations from soft slope angles to overdip bending and without a clear predominant orientation.

The most important identified karst forms are erosion as well as structural landforms.

The main agent responsible by the erosion processes is the water, through the limestone rocks dissolution. The typical forms resulting from solution are some types of lapias, those minor karst forms so important for the infiltration of the water from the surface to the underground drainage, showing that the processes are active in the present.

From the point of view of the relief tectonic control, we can see clearly the fault scarps with different bounces, the suspended valleys or the asymmetric valleys and depressions. Other karst landforms show also a structural control such as the case of some dolines that, sometimes, may reach several tenth of meters, generally more large then dip, with circular or elliptical forms. Also some types of lapias, show a clear control by the fractures and faults. This is evident in the *Kluftkarren*, the *Karrentisch* or in the *Spitzkarren* that are quite typical and abundant in the area.

After making the identification and classification of those landforms that can be considered as geomorphosites, it was established a geotourist trail of the Portela de Vale de Espinho area.

Keywords: limestone area, karst landforms, relief tectonic control, geotourist trail.

**DOCUMENTS FOR GEOTOURISM IN NATURE.
A GEOTOURISM MAP OF THE PICOS DE EUROPA NATIONAL PARK**

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Geotourism definition includes the interactive interpretation of geographical characters of a place. To interpret the various geographic elements that are part of the geotourism in nature - geology, geomorphology, vegetation, hydrology - are needed documents and initiatives for tourist and tourism workers. Both visitors and hosts need at least a wealth of knowledge, an adequate cultural level and an attitude towards Nature and the territory. In addition, the practice of geotourism need appropriate tools that allow to hosts and tourists to interpret the basic keys of the territory that they want to know and teach. The interactive knowledge and interpretation come from direct contact with nature, but there are tools previous to experience (lecturer, books, booklets and brochures, guidebooks, interpretive centres) and field tools (local guides, posters, geotourism maps) to guide and advise the tourist. The geotourism map is a useful tool for local guides, instructors and tourists, easy to transport and cheaper, than reports the essential qualities of the territory by the spatial representation of geographical features.

The aim of this communication is to present a map that interprets geotourism key elements of a high mountain landscape (geology, topography and mining) of a Natural Protected Area, the Eastern Massif of the Picos de Europa National Park, northern Spain.

Methodology is based on the selection of key elements, the simplification of reading levels and the spatial representation of significant elements. Appropriate pathways to interpret the relief, as a key aspect of the landscape of high mountains are included in the map.

The result is a geotourism map at the scale of 1/25 000. The map represents the topography, geomorphological features (glacial, karst, nivation, landslide) and human remains (mining, grazing), the most significant for shaping the high mountain landscape. The map has five levels of reading (planimetry, altimetry, geomorphology, human uses and tourist routes) and the elements are represented by areas, patterns and symbols in colours. The map contains the routes that allow the interpretation of all key elements and is accompanied by a location map, a geological sketch and a brief text describing the pathways.

The resulting document is a useful tool to advance an approach to the tourist activity and for support in the field. It is aimed at local guides, monitors and tourists-hikers wanting to interpret nature from direct knowledge of the field.

Keywords: Geotourism, Mapping, Geomorphosites, Natural Protected Areas, Picos de Europa National Park.

GEO-TOURIST MAPS: LAND USE, LANDSCAPE ENJOY AND ENVIRONMENTAL EDUCATION AT NATURAL PROTECTED AREAS

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Present day the Mountain Natural Areas receive a big typology of visitors, tourists, hikers, mountaineers until birdwatchers. All of them enter to the mountains by path and tracks to reach huts, scenic views, summits or walls with different objectives, sport, leisure, relaxation or adventure. Mostly admire and enjoy the landscape without understanding the former elements or the landscape itself. The active tourism visiting mountains, playing sports, nature and landscape watching is the main economical activity into and around the Natural Protected Areas.

The geotourist maps (name used by Italian geoscientifics and also denominated “Exploring the landscape maps”, “geo-hiking maps” or “tourist-environmental maps” by previous authors) are intended to help to understand the landscape by a useful and portable document. The tourist map developed by us in the Picos de Europa National Park is a tool for no specialist that serves several principles:

- To emphasize only the recognizable landscape features on the field.

- To be simple, clear and handy in the field.

- To maintain the scientific rigor, being a document of scientific divulgation and environmental education.

- To promote the enjoyment and conservation of the mapped areas by the responsible use and behaviour.

The proposal map includes information in two directions:

Geomorphological and geological information: Representation of landforms and geological elements in the general context of the protected area and detailed maps of geomorphosites to a deeper understanding of the more interesting areas visiting by hikers.

Hikers information: trails linking geomorphosites, hut places, springs or features of natural and cultural values (mining, historical routes).

The geo-tourist map replaces aggressive elements on the field (panels, posters, signs and small building) expensive to build and to conserve, and it permits a particular (hikers, tourist, mountaineers) and collective (teachers, rangers, mountain and tourist guides) use.

The geotourist map of Eastern massif of Picos de Europa has been built in accordance with the mentioned guidelines. The Picos de Europa is a calcareous high mountain massif characterised by karstic and glacial features. The domain of successive thrust faults of north dip implies a hard morphological dissymmetry. Wall and escarpments are dominants in the south side while less abrupt relief are located to the north, where the Quaternary glacier have been more important and the glacial landforms are dominants. The Picos de Europa national Park receive more than 2 million visitors per year, although only a reduced number is moving by the forest and the high mountain. The map guides to the hikers by trails, previously existents, between the gemorphosites and more representatives scenic view points.

The geotourist maps give the park a cultural tool designed to encourage visitors understanding of landscape abiotic elements. Trails are proposed and features are explain like complement of the biological observation (mammals, birds, trees or forests) by three itineraries and the visit to geomorphosites representatives of Cantabrian Mountain nature.

**GEODIV INTERFACE: AN INNOVATIVE OPEN SOURCE TOOL FOR
INTERPRETATION AND PRACTICAL HERITAGE MANAGEMENT OF
THE GEODIVERSITY OF SIERRA DE GRAZALEMA NATURAL PARK
(SW SPAIN)**

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The main purpose of the present work is the development of an innovative WebGis graphical interface, related to Open Source (OS) Database Management System (DBMS), for the interpretation and the management of geodiversity features of the Sierra de Grazalema Natural Park (Andalucia, SW Spain). Located on the Betic Ranges geological framework, the study area shows a wide variety of geological and geomorphological elements, mainly consisting in spectacular exo- and endokarstic landforms. The identification, interpretation and appropriate representation of the major exokarstic forms have been carried out through photointerpretation and spatial analysis functions of OS Geographical Information System (GIS) and Digital Terrain Model analitic tools. Furthermore, the field detection allowed a better understanding of these karst morphologies and their correct positioning in the stratigraphical and geological regional framework. Due to the large proportions of the Park surface (53 411 ha), the smaller scale zone of Sierra de Libar (85 km²) was been chosen as pilot study area, in order to check the feasibility and to improve the design of the main research.

As a result, the large amount of these preliminary data collected for the Sierra de Grazalema Natural Park will be inserted into the PostgreSQL Database (DB) where spatial data are managed by PostGIS DB. PostGIS and PostgreSQL are OS DBMS, as well as all softwares used in the present project. These DB allow the management, implementation and exportation of data, particularly on the web. The aim of the project, in addition to the collection and characterization of the geodiversity, provides the possibility of divulging through WebGIS, all the 2D and 3D information collected. The ability to show all the available data online will be carried out through GeoDIV application, created ad-hoc for the project, using Mapserver OS application that allows viewing, querying and graphical output of spatial data. The continued implementation of the database will be directly linked to GeoDiv that will display automatically updates and changes to the database.

Keywords: Geodiversity, GeoDiv, Open Source, GIS, Sierra de Grazalema Natural Park.

VALUES OF GEOTOURIST SITE AND THEIR SIGNIFICANCE FOR GEOTOURISM PROMOTION

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Geotourist site, an essential element in geotourism movement, appropriately prepared, described and promoted, can arouse public's interest in geology and geomorphology. Environmental and cultural connections of such site can also help to increase the tourist significance as well as conservation activities of surrounded areas.

According to the definition of geotourist site worked out on the Faculty of Geology, Geophysics and Environmental Protection (AGH University of Science and Technology) a geological object may become a tourist one only after proper development and promotion. The public interest of such site can be held on only through the most accurate presentation of the object, which means the best use of its advantages and minimization of its disadvantages.

Based on a few assessing methodologies of geomorphosites (developed in Italy, Portugal, Spain, and Switzerland) a method of geotourist site assessment has been worked out. It seemed appropriate to clearly define four criteria named: educational, scenic, cultural and functional ones, in which several sub-criteria have been determined.

Sub-criteria grouped under the educational criterion among others describe didactical value and clarity degree of the presented geological phenomena. The scenic criterion, verifying colour contrast and esthetical values of the object, it is the only one with the huge subjective impression. Cultural, historical and

religious or pagan belief connections are recognized in cultural criterion. And last, but not least, functional criterion depicts accessibility, the level of protection as well as infrastructure and information base around the site.

To facilitate the process of data collecting, a valuation card has been drawn up. It contains inventory description, short geographical and geological characterization as well as the detailed account of present condition of each object and also the main valuation process with final synthesis. An annex with data indispensable for the appropriate assessment (bibliography, maps and photo documentation) is also included.

The model of geotourist site assessment has been tested at the local scale on selected objects of inanimate nature. This enabled the discussion about advantages and disadvantages of the model which give us the possibility to plan its future development.

Keywords: geotourist site, value, criteria of assessment.

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