

# The geomorphological heritage approach in protected areas: Geoconservation *vs.* Geotourism in Portuguese natural parks

*L'approccio del patrimonio geomorfologico nelle aree protette:  
Geoconservazione contro Geoturismo nei parchi naturali portoghesi*

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**ABSTRACT** – As in many other countries, geology and geomorphology are absent from the majority of the Portuguese protected areas statutes. These areas could be places to protect landforms as a significant component of the natural heritage. However, joining the preservation effort to some ecotourism activities or other human activities could damage or even destroy geomorphological sites. During the last decade, multidisciplinary projects were developed in protected areas from Northern Portugal, with special emphasis in supporting geoconservation strategies and making available products for public advertising of geological and geomorphological features. This paper shows the results of our activities on Montesinho Natural Park (PNM) and International Douro Natural Park (PNDI). Deliverables are being made available to protected areas managers as scientific support for management plans. Other products and initiatives have been implemented in order to raise public awareness of geodiversity and geoconservation and also to improve geotouristic offer. These products are developed in dialogue with park managers who can include them in management plans. Preserving geomorphological sites and making them public at the same time can be possible in protected areas. This approach can be applied to other protected areas with positive results.

**KEY WORDS:** Geomorphological heritage; Geoconservation; Geotourism; Protected areas; Portugal.

**RIASSUNTO** – Come in molti paesi, la geologia e la geomorfologia sono praticamente assenti dagli statuti delle aree protette del Portogallo. Queste aree potrebbero essere luoghi dove proteggere le forme del rilievo come componenti significative del patrimonio naturale. Tuttavia, gli sforzi per la conservazione unitamente ad alcune attività di ecoturismo o ad altre attività antropiche possono danneggiare o addirittura distruggere i beni geomorfologici. Durante l'ultimo de-

cennio, sono stati sviluppati progetti multidisciplinari in aree protette del nord del Portogallo, ponendo particolare attenzione alle strategie di geoconservazione e sviluppando prodotti per divulgare ad un pubblico vasto le caratteristiche geologiche e geomorfologiche del paesaggio. In questo articolo vengono illustrati i risultati delle attività svolte nel Parco Naturale del Montesinho (PNM) e nel Parco naturale internazionale del (PNDI). Una documentazione appropriata è stata fornita alle aree protette come supporto scientifico ai loro piani di gestione. Sono stati inoltre sviluppati prodotti ed iniziative con lo scopo di aumentare la sensibilità del grande pubblico ai temi della geodiversità e della geoconservazione ed anche per migliorare l'offerta per un turismo geologico. Questi prodotti sono stati realizzati di concerto con i parchi e talvolta sono stati inseriti nei piani di gestione. Conservare i beni geomorfologici e renderli allo stesso tempo fruibili ai turisti è infatti possibile nelle aree protette. Questo approccio può essere applicato ad altre aree protette con risultati positivi.

**PAROLE CHIAVE:** Patrimonio geomorfologico; Geoconservazione; Geoturismo; Aree protette; Portogallo.

## 1. – INTRODUCTION

The expression “geomorphological heritage” is being used to define groups of geomorphological sites (PEREIRA *et alii*, 2002). Several studies have established these sites as landforms that are perceived to have a special value, namely scientific, ecological, aesthetic, cultural and/or economic (REYNARD, 2005a). Some authors consider also the landforms with a functional value, as the support

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of environmental system, both physical and biological (GRAY, 2004). In recent years, special emphasis is being given to the relation between geomorphology and culture (PANIZZA & PIACENTE, 2003), namely to the interaction between peculiar landforms and specially connected human activities.

Geomorphological heritage has been discussed in Portugal since the beginning of the 1990's, but practical strategies such as inventories and specialized working groups have begun recently. The geomorphological heritage as well as all the heritage assets should have some kind of statutory protection. In many cases, geomorphological sites have no specific legal protection even when located inside protected areas. However, the heritage protection and its conservation should be included in public policies (REYNARD, 2005b), even when this heritage is part of abiotic nature. As these public conservation strategies demand financial support, it is necessary to carry out a correct inventory and evaluation of geomorphological sites. These can be used to obtain the financial return on that investment by promoting initiatives aimed at tourism and educational purposes. On the other hand, the implementation of tourism strategies, though sustainable, can expose geomorphological sites to damage and destruction. Following this point of view, it is important to discuss the association of protection and promotion strategies and the role of protected areas.

The Portuguese protected areas system covers about 7% of the mainland territory, including: one national park, twelve natural parks, nine natural reserves, three protected landscapes, ten classified sites, and five natural monuments (fig. 1). Besides these, there are other protected areas with specific regional statutes, both on the mainland and on the Madeira and Azores archipelagos.

Usually, the Natural Monument and Classified Site statutes are mostly applied for conservation of remarkable geological or geomorphological heritage features (CARVALHO, 1999). However, due to their size and significance, National Parks and Natural Parks are key zones to implement geoconservation strategies and to increase public awareness of all aspects of nature, biological and geological (BRILHA, 2002). As in many other countries, Portuguese nature conservation is primarily interested in biology, underrating geological and geomorphological criteria in the majority of the protected area statutes. In recent years, efforts have been developed by geologists and geomorphologists in order to change this situation. Nowadays some park managers are beginning to demand relevant geological

information for their park management plans. The work and discussion done about geomorphological and other geological elements of landscape, selected as sites to protect and/or advertise, have changed the approach to abiotic nature in some parks. This new perspective is mainly due to researchers' efforts in raising the awareness of protected area managers on the need for geoconservation.

Nevertheless, there is a long road to run in order to improve the knowledge on geological and geomorphological heritage in Portuguese nature conservation policies. This paper presents the results of a research project carried out in two natural parks from NE Portugal, where products and initiatives were developed in both geoconservation and geotourism.

## 2. – THE GEOMORPHOLOGICAL HERITAGE APPROACH IN MONTESINHO NATURAL PARK AND INTERNATIONAL DOURO NATURAL PARK (NE PORTUGAL)

Two major protected areas are implanted in NE Portugal (fig. 1): Montesinho Natural Park (PNM) and International Douro Natural Park (PNDI), covering an extensive area of 1601 km<sup>2</sup> (PNM 750 km<sup>2</sup>, PNDI 851 km<sup>2</sup>). These parks were created in 1979 and 1998, respectively, mainly due to the high relevance of the wildlife, natural flora and cultural heritage (ALVES *et alii*, 2004; DIAS & BRILHA, 2004).

PNM is located on the Portuguese-Spanish border, in the southern extremity of the Cantabria-Leon Mountain Range. PNM is characterised by a remarkable geodiversity and by the occurrence of exotic terranes, presenting a complex geology. The high lithological diversity and the Cenozoic tectonics have been the main influence in distinctive geomorphological features, such as planation surfaces, fluvial incised valleys, residual relief, tectonic basins and granite landforms (MEIRELES *et alii*, 2002; PEREIRA *et alii*, 2004a, 2004b). These landforms support the diversity of natural and agricultural occupation, with characteristic oak and chestnut groves and pastures. Some minor landforms, such as granite weather pits in Montesinho Mountain, are the habitat for endemic flora.

The PNDI is an example of a national protected area with a notable geodiversity and distinctive landscapes associated with the fluvial canyons of the Douro and Águeda Rivers (NE Portugal-Spain border). The park is a narrow contiguous area of the old peneplain landscape known as Iberian Meseta. The incision of the Douro River and its

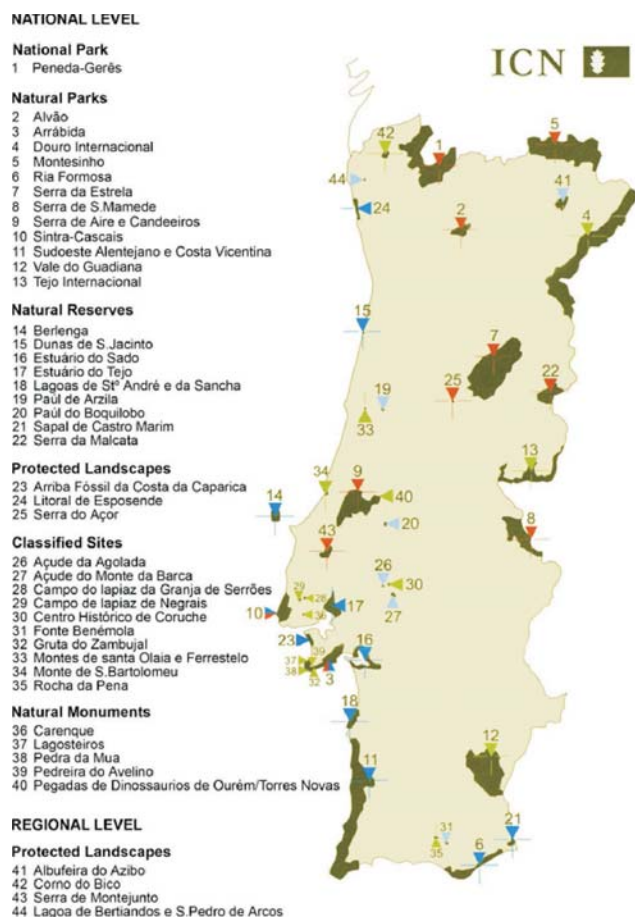


Fig. 1 – Protected areas in mainland Portugal. Adapted from Portuguese Nature Conservation Institute (<http://www.icnb.pt>).

– Aree protette del Portogallo. Immagine adattata dall'Istituto Portoghese di Conservazione della Natura (<http://www.icnb.pt>).

tributaries on the Iberian Meseta has developed spectacular steep cliffs, regionally named *Arribas do Douro*, the ‘ex-libris’ of the PNNDI. This landscape provides the microclimatic conditions for the traditional production of wine, olive and almond, as well as the support for a great biodiversity. The PNNDI is one of the most important nesting habitats in Europe for vultures, eagles and black storks. The floristic heritage found on the rock slopes and ancient floodplains is also relevant. This natural park has a geomorphological heritage that provides the support to human occupation and biodiversity (FERREIRA *et alii*, 2001, 2003; ALVES *et alii*, 2004).

These areas are mainly rural, with a low population ratio, 12 person / km<sup>2</sup> in PNM and 16 person / km<sup>2</sup> in PNNDI. Therefore, the interaction between the resident population and the natural environment creates a human imprint in the landforms and supports a harmonious biodiversity. Evidence of the close relationship between culture, geology and geomorphology is given by the millenarian human occupation of these areas.

The research on the geological and geomorphological heritage in Natural Parks of NE Portugal began in the form of a multidisciplinary research project (PNAT Project), sponsored by the Portuguese Science and Technology Foundation and the Portuguese Nature Conservation Institute. The project aims, presented by DIAS & BRILHA (2004), were: (i) improve the geological and geomorphological knowledge; (ii) proceed with the inventory and characterisation of geosites; (iii) create scientific instruments to support a sustainable management of resources and territory; (iv) contribute to the increase of public awareness of Natural Heritage. In order to achieve the above objectives activities were developed (DIAS *et alii*, 2005a, 2005b), such as: (i) improvement of the geological mapping; (ii) characterisation of geomorphological features and processes and development of the geomorphological mapping; (iii) inventory of geological resources; (iv) systematic inventory and characterisation of geosites, with reference to its content, value, utility and relevance, and their integration in a database; (v) characterisation of geological materials through specific studies, as a support for mapping and geosites characterisation.

### 3. – GEOMORPHOLOGICAL SITES

The multidisciplinary Earth Sciences researchers of the PNAT Project inventoried PNM and PNNDI geosites. In the inventory were considered geomorphological (Gm), palaeontological (Pa), mineralogical (Mi), petrological (Pt), mining (Mn), tectonic (Te), stratigraphical (St) and archaeological-mining (Am) sites. The geomorphological sites were selected, according to a methodology specially developed for geomorphological heritage (PEREIRA, 2006; PEREIRA *et alii*, 2007). This methodology is based on the experts’ knowledge of the studied area and selection of the outstanding landforms, considering their scientific, ecological, cultural, aesthetic and/or economic values.

The inventory of geological sites in the Natural Parks on NE Portugal resulted in 209 sites selected, 139 in PNM and 70 in PNNDI (tab. 1).

In the PNM, the high geodiversity allowed the selection of numerous palaeontological, mineralogical and petrological sites. Most of the PNM geomorphological sites are viewpoints, from where it is possible to observe and describe geomorphological features, such as plain surfaces, incised valleys (fig. 2A) and tectonic basins. Other sites were selected in the Montesinho Mountain, due to its high richness in granite landforms (fig. 2B).

Tab. 1 – *Geosites/geomorphological sites ratios in Montesinho Natural Park (PNM) and International Douro Natural Park (PNDI).*

– Rapporto geositi/geomorfositi nel Parco Naturale del Montesinho (PNM) e nel Parco naturale internazionale del (PNDI).

	Geosites			Total
	Geomorphological sites	Other sites with geomorphological value	Sites without geomorphological value	
PNM (750 Km <sup>2</sup> )	26 (20%)	6(4%)	107(76%)	139
PNDI (851 Km <sup>2</sup> )	32 (46%)	8(11%)	30(13%)	70

In the PNDI, the percentage of geomorphological sites is higher than in the PNM (tab. 1). Areas of great richness in granite landforms were also selected in the PNDI (fig. 2C). The most significant geomorphological features are the fluvial canyons of the Douro River and its tributary, the Águeda River, dissecting the high plateau of the Iberian Meseta (fig. 2D).

All natural and cultural features should be considered in Natural Park management, specially the natural heritage which the managers have the responsibility to preserve. Thus, all information about the inventoried geosites was made available to park managers.

The definition of the geotourism interest of geosites should be made with special care (PRALONG, 2005). Only those that present a low risk of damage by the touristic activities should be considered. Thus, geotourism sites were selected (tab. 2) according to five criteria: value, vulnerability, accessibility, visibility and spatial distribution.

About half of the inventoried geomorphological sites were selected for public use (50% in the PNM and 44% in the PNDI). This selection was due to a high scenic and touristic value.

Geosites suitable for public use represents only 24% of the total number of geosites in the PNM and 29% in the PNDI. The predominance of geomorphological sites is related to a lower damage risk compared with other geosites, particularly the mineralogical, petrological and palaeontological ones.

The making public strategy in these parks is aimed at attracting new visitors interested in abiotic nature. One of the concerns was the spatial distribution of the geomorphological sites in order to cover all the parks areas. Also considered were accessibility and the viewing conditions. In that way, geomorphological heritage can contribute to

the local sustainable development, promoting complementarity between traditional land uses and geoconservation.

#### 4. – DELIVERABLES FOR MANAGEMENT

Several deliverables were made available to park managers as scientific support for management plans (MEIRELES *et alii*, 2005; DIAS *et alii*, 2005a, 2005b), namely: geological, geomorphological, geological resources and geological sites maps (fig. 3). A fruitful dialogue between researchers and parks staff had as a consequence the understanding of their need for more knowledge about geoconservation and geological heritage. This new perspective led to the preparation of management plan reports to meet the demand of park managers.

The geosites map contains all the selected geosites, organised by frameworks, namely palaeontological, mineralogical, petrological, mining, tectonic, and geomorphological sites (fig. 4). This document also contains information about the susceptibility of geosites. In general, the most vulnerable sites have palaeontological and petrological value. Geomorphological sites susceptibility is considered mainly in order to avoid their damage and destruction by the implementation of quarries, roads or other engineering structures.

The training of technical staff and park rangers was another important activity because it was the very first approach to geodiversity, geological and geomorphological heritage and geoconservation issues. Therefore, the technical staff usually skilled in bioconservation issues will be more aware of geological and geomorphological subjects.

Tab. 2 – *Number and density of geomorphological sites and the total of geosites for public advertisement in Montesinho Natural Park (PNM) and International Douro Natural Park (PNDI). Density = number of sites / 100 km<sup>2</sup>.*

– Numero e densità di siti geomorfologici e totale dei geositi utili per la valorizzazione turistica nel Parco Naturale del Montesinho (PNM) e e nel Parco naturale internazionale del (PNDI).  
Densità = numero di siti / 100 km<sup>2</sup>.

	Geomorphological sites				Geosites (total)			
	management		public		management		public	
	Number	Density	Number	Density	Number	Density	Number	Density
PNM (750 Km <sup>2</sup> )	26	3.6	13 (50%)	1.8	139	18.6	33 (24%)	4.4
PNDI (851 Km <sup>2</sup> )	32	3.7	14 (44%)	1.6	70	8.2	22 (29%)	2.6

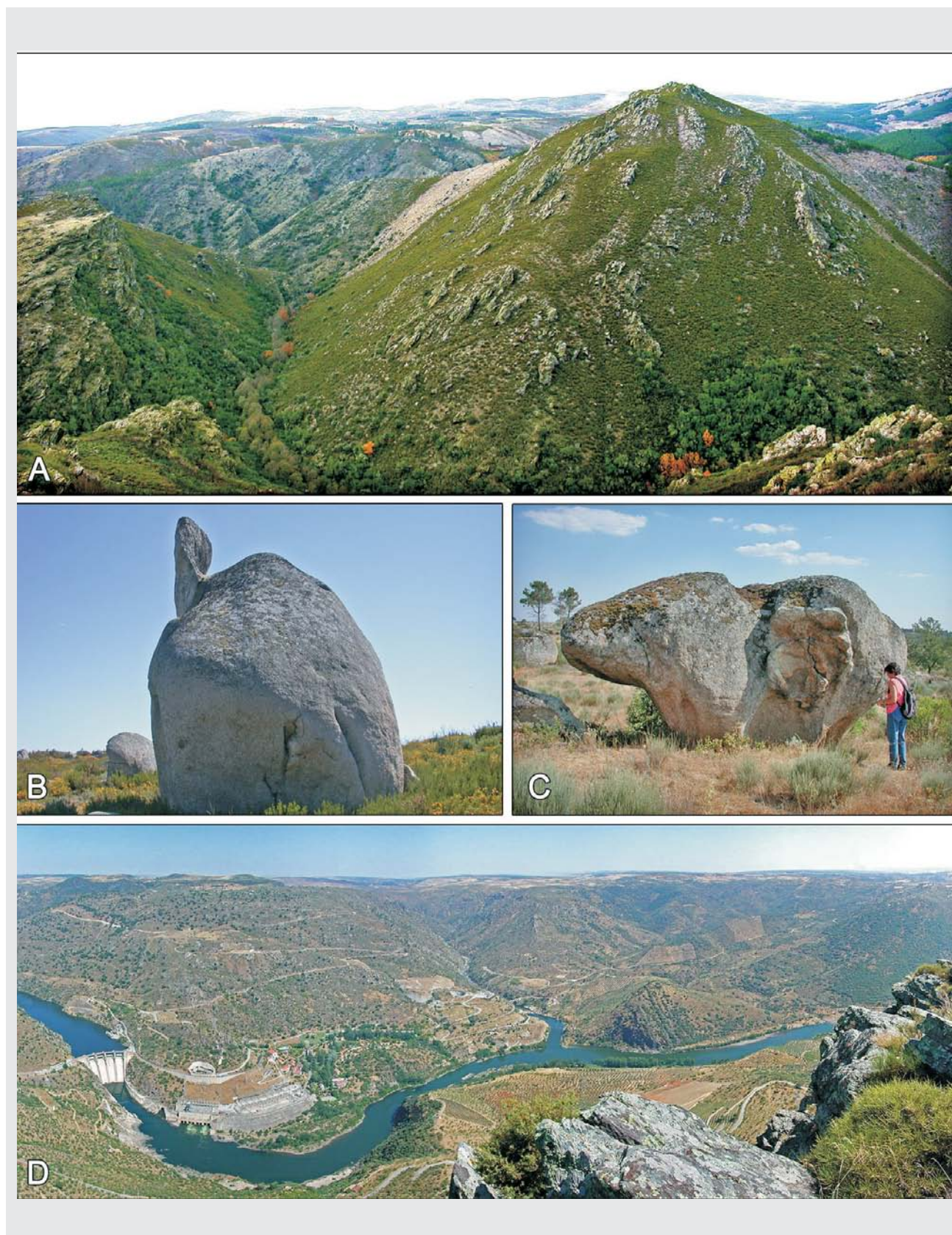


Fig. 2 – Examples of geomorphological sites in Montesinho Natural Park (PNM) and International Douro Natural Park (PNDI): A. Assureira valley (PNM); B. Granite landforms, Montesinho Mountain (PNM); C. Granite landforms, Trigueiras (PNDI); D. Penedo Durão viewpoint (PNDI).  
 – Esempi di siti geomorfologici nel Parco Naturale del Montesinho (PNM) e nel Parco naturale internazionale del (PNDI): A. Valle dell'Assureira (PNM); B. Forme nel granito Parco Naturale del Montesinho (PNM); C. Forme nel granito Parco Naturale del Montesinho (PNM), Trigueiras (PNDI); D. Vista del Penedo Durão (PNDI).

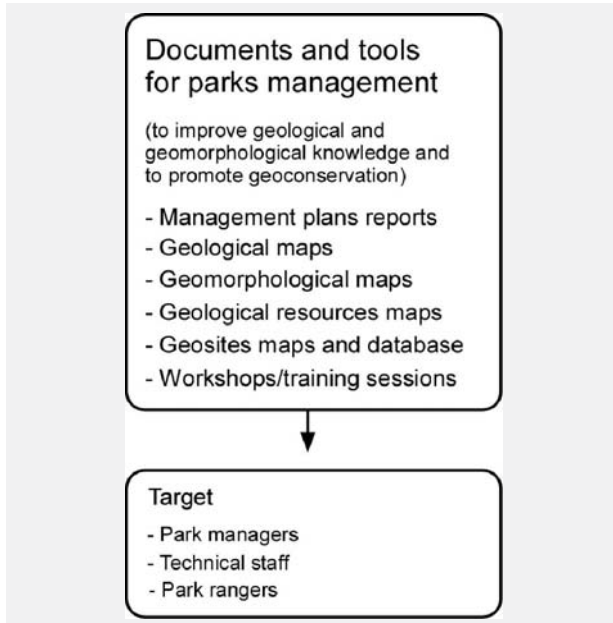


Fig. 3 – Deliverables and tools for the management of the geomorphological heritage in Natural Parks of NE Portugal.  
– *Prodotti e strumenti per la gestione del patrimonio geomorfologico nei parchi naturali del settore nordorientale del Portogallo.*

## 5. – PRODUCTS AND INITIATIVES FOR GEOTOURISM AND GEOEDUCATION

Products and initiatives have been implemented, in order to raise public awareness of geodiversity and geoconservation and to improve geotouristic and geoeducational offerings (fig. 5). The output was prepared aiming in particular at the general public, school population and parks staff (DIAS & BRILHA, 2004; DIAS *et alii*, 2005a, 2005b).

### *Guided tours*

Summer field trips addressed to the general public are being organised, as well as guided field trips specifically addressed to school populations. The Portuguese government promotes, since 1998, a very successful programme called “Geology in the Summer” with the aim of raising public awareness of geology. During the summer season, geoscientists organize field trips and other activities all over the country, which constitute an excellent opportunity to talk about geodiversity, geological heritage and geoconservation, and the importance of geology in our society (DIAS & BRILHA, 2004). Several “Geology in the Summer” activities inside the PNM and the PNDI were organised, where visitors could learn about geomorphology and geomorphological sites (fig. 5A). The experience in these and other parks shows that the public and the school population appreciated guided walks and personal interaction with geoscientists.

### *Pedestrian trails*

Traditionally, protected areas have a set of different pedestrian trails that emphasise natural and cultural features. In fact, these trails have usually biological, cultural or archaeological interest with few or no references to geology or geomorphology. Because of that, the production of information regarding the geological interpretation of pedestrian trails is of great importance. Thus, the insipient information about geomorphology in the booklets of the existing pedestrian trails was expanded. In both parks, new pedestrian trails were developed linking some of the inventoried geomorphological sites (fig. 5B).

### *Simplified maps and booklets.*

Geomorphological mapping was done for each natural park using vectorial software, assembling in several layers different geomorphological information as well as other important natural and cultural features. Digital editing allows the selection of specific layers resulting in a simplified map, addressed to non-expert public. These simplified geomorphological maps are presented at 1:100,000 scale. They include major landforms and faults, simplified lithology, hydrography as well as some anthropogenic features like roads, villages, mines and water reservoirs. These maps also include the location of geomorphological sites as well as pedestrian trails and interpretative panels (fig. 5C).

### *Interpretative panels*

The on-site interpretative panels constitute a support for a synthesis of the observed geological and geomorphological features. Contents, design and presentation of the panels follow a set of

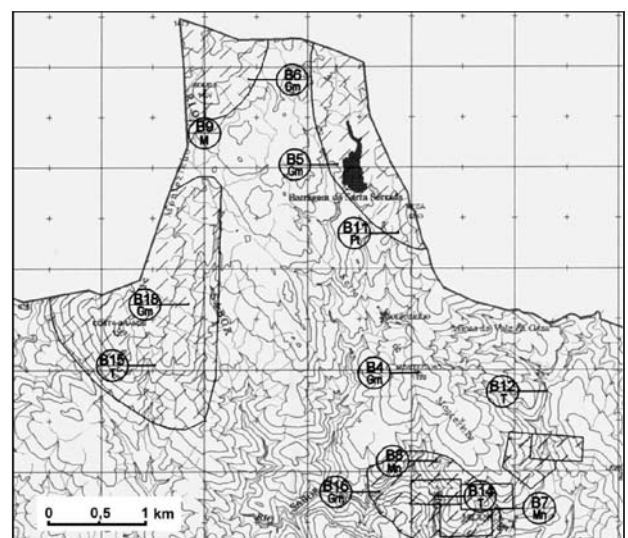


Fig. 4 – Section of the Geosites Map of Montesinho Natural Park. Geosites: Gm - geomorphological; M - mineralogical; Pt - petrological; T - tectonic, Mn - mining (MEIRELES *et alii*, 2005).  
– *Stralcio della carta dei geositi del Parco Naturale del Montesinho: Gm - geomorfologici; M - mineralogici; Pt - petrologici; T - tettonici, Mn - minerari (MEIRELES *et alii*, 2005).*

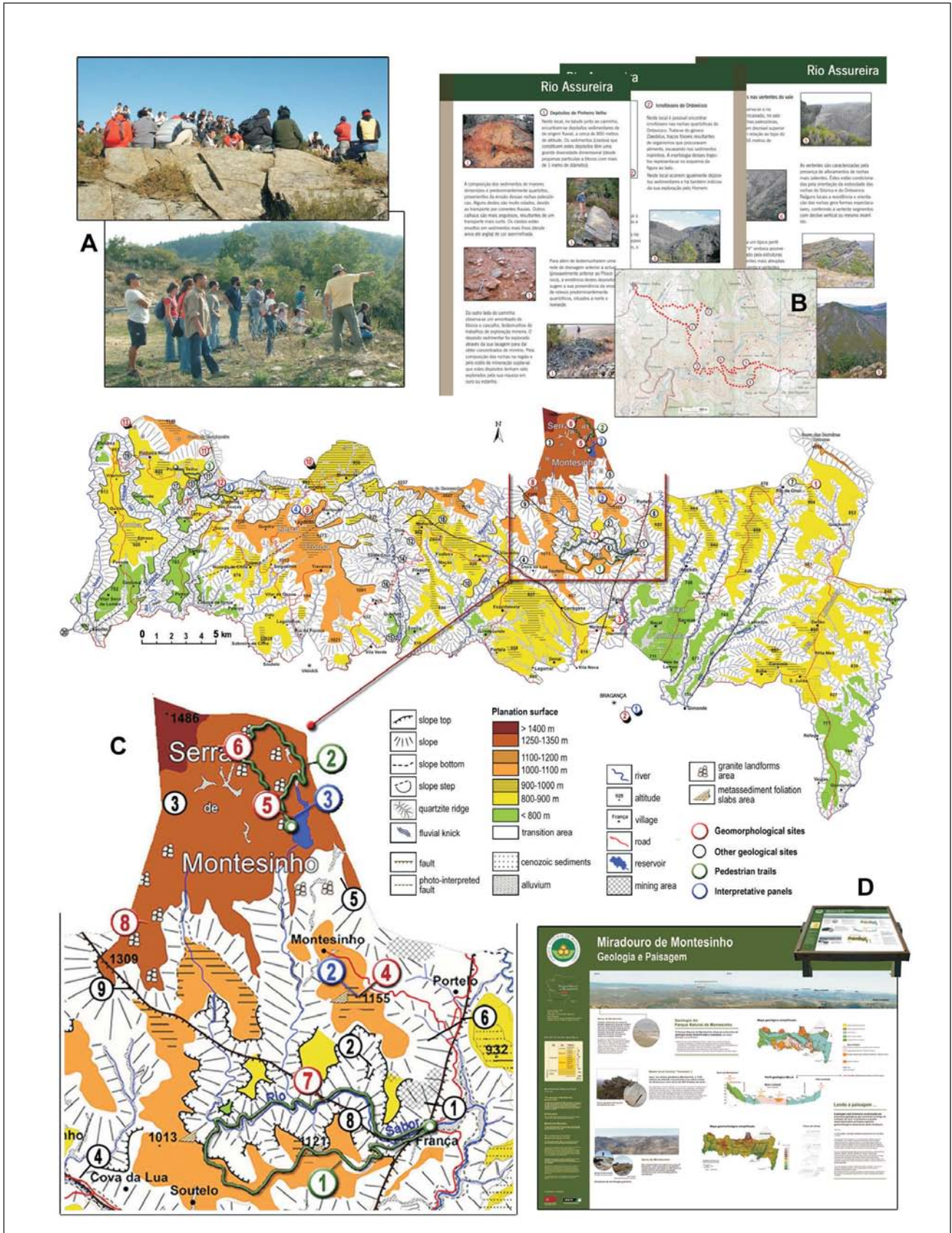


Fig. 5 – Products and initiatives aiming the promotion of geomorphological heritage. Examples from Montesinho Natural Park: A. Guided tours for school population and general public; B. Assureira river pedestrian trail; C. Simplified geomorphological map; D. Montesinho viewpoint interpretative panel.  
 – Prodotti ed iniziative per la promozione del patrimonio geomorfologico. Esempi nel Parco Naturale del Montesinho: A. Tour guidati per scuole e turisti in genere; B. Sentiero lungo il Rio Assureira; C. Carta geomorfologica semplificata; D. Pannello turistico del Montesinho.

guidelines, in order to be appellative for a wider public. Contents are interpretative rather than informative and based on features that can be observed (lithology, folding and land-shaping processes), with a clear distinction between observation and interpretation. A lectern-type (130x100 cm) presentation and a graphics-rich/text-poor layout are used (fig. 5D). Basic contents are displayed at the centre of the panels, occupying the majority of the surface (DIAS *et alii*, 2003; DIAS & BRILHA, 2004; PEREIRA *et alii*, 2004a). Additional information and/or interpretation are given in a left-side coloured strip. At the bottom schematic cross-sections present the geomorphological evolution of the region. Some of these panels are already installed and technical staff of both natural parks is implementing others.

#### *Guide books*

The production of geological guide books for each park is one more possibility. These books include an overview on the geological and geomorphological evolution of the natural park areas. A chapter about geoconservation contains the description of geotourism sites and geo-pedestrian trails. The guide books contain also other information about geological resources, mining history and the simplified geological and geomorphological maps. The geomorphological maps are illustrated with photos of the geomorphological sites and a 3D digital elevation model.

#### *Webpage contents*

Environmental education can also be supported by electronic resources distributed on the Internet. The use of these resources in protected area webpages was already exemplified in the Peneda-Gerês National Park (BRILHA *et alii*, 1999). Normally, geomorphology and geoconservation information on protected area webpages is rather poor and unattractive. For pnm and pndi several multimedia resources were developed in order to promote geosciences and geodiversity for a wider public and included in the protected areas institutional webpages (<http://www.icnb.pt>).

## 6. – CONCLUSIONS

The interest in geomorphological sites has been growing during recent years. The research in this theme emphasises the conservation, education and tourism attractiveness of geomorphological sites. The experiences in Natural Parks of NE Portugal show that geoconservation and geotourism can be developed simultaneously. To achieve this goal, park

managers' awareness of the importance of geomorphological heritage should be enhanced by the involvement of geoconservation experts. Geomorphological information and an adequate technical staff support and training may contribute to the protection of geomorphological sites, reducing their modification, damage or destruction. In spite of being the most public-friendly of all types of geosites, geomorphological sites may be damaged by human pressure. Therefore, managers should attend to this vulnerability and establish limits to the use of these landforms. On the other hand, it should be emphasised that the widespread awareness of geomorphology and geomorphological sites as natural heritage constitutes a key factor in tourism appeal and environmental education.

The geoconservation and geotourism aims need the support of several types of initiatives and products in order to achieve different target groups. The deliverables for management should be technical, though of easy to understand and use by the natural parks staff. The products for the public should be designed according to the target public, although simplified, attractive and well-structured products can be understood by different types of public even without awareness of geomorphological heritage and geoconservation.

Despite its usual connection with biological conservation, protected areas can have an important role in the protection of geomorphological heritage. Being places to which visitors are attracted, they are also perfect displays of these landforms. Therefore, the geomorphological heritage approach can have good results in such areas. Comprehensive projects should be applied to other natural parks where the knowledge and management of geological and geomorphological heritage is still far from adequate.

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