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JURASSIC HERITAGE OF PORTUGAL: STATE OF THE ART AND OPEN PROBLEMS

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Abstract. The aim of this work is to present a general view on the situation of Jurassic sites outcropping in Portugal, in particular those located in the Lusitanian Basin, which represent geosites with heritage value. The legal instruments on geoconservation are generically presented, and they happen to be designed for Natural Heritage deeply confused with the Biological Heritage. No specific law for geological values exist in Portugal, but the general law on Natural Conservation has allowed the protection of five geosites of national relevance as Natural Monuments. They correspond to a small area when compared to the whole national area of Protected Sites, and they all correspond to dinosaur tracksites of Jurassic and Cretaceous age. Geosites of regional relevance have been also protected using municipal laws and they show important public use, sometimes giving rise to reference museums and to continuous pedagogical actions. On the other hand, geosites of international relevance for its stratigraphic value (the Bajocian GSSP at Cabo Mondego section, the candidate to the Toarcian GSSP at Peniche section) have no formal protection and classification according to the Portuguese laws. They remain safe because they are located on the coast, which is protected due to other environmental laws. Their integration in a supra-national framework supported by UNESCO is obviously recommended and it would be of great impact among the national institutions with formal responsibilities on the Natural Heritage.

Riassunto. L'obbiettivo di questo lavoro è presentare una visione generale sulla situazione dei siti giurassici affioranti in Portogallo, in particolare quelli ubicati nel Bacino Lusitanico, che reappresentano geositi con valore di patrimonio. Vengono genericamente presentati gli strumenti legali per la geoconservazione, e si dà il caso che essi sono designati per il Patrimonio Naturale profondamente confuso con il Patrimonio Biologico. In Portogallo non esiste alcuna legge per i beni geologici, ma la legge generale sulla Conservazione Naturale ha permesso la protezione di cinque geositi di rilevanza nazionale come Monumenti Naturali. Essi corrispondono ad una piccola area se comparati all'intera area nazionale dei Siti Protetti, e corrispondono tutti a siti con impronte di dinosauri di età giurassica e cretacea. Anche dei geositi di rilevanza regionale sono stati protetti usando leggi municipali, ed essi mostrano un importante utilità pubblica, dando a volte origine a musei di riferimento e a continue azioni pedagogiche.

D'altro canto, i geositi di rilevanza internazionale per il loro valore stratigrafico (il GSSP del Bajociano nella sezione di Cabo Mondego, il candidato al GSSP del Toarciano nella sezione di Peniche) non hanno alcuna protezione e classificazione formali per le leggi portoghesi. Essi rimangono al sicuro perché sono ubicati sulla costa, che è protetta per via di altre leggi ambientali. La loro integrazione in un contesto sovranazionale supportato dall'UNESCO è ovviamente raccomandata ed avrebbe un grande impatto tra le istituzioni nazionali con responsabilità formali sul Patrimonio Naturale.

Introduction

The Jurassic System in Portugal includes a significant stratigraphic record ranging from lowermost Jurassic (Hettangian) to uppermost Jurassic (Tithonian). This record outcrops in two different geographic positions, defining two distinct basins: Lusitanian (West Portugal) and Algarve (South Portugal).

Both series are very well exposed, including a lot of coastal outcrops, where continuous erosion provides exceptional conditions for geological observation. But the stratigraphic record of the Lusitanian Basin is by far the most relevant, especially the external areas, where the richness of palaeontological, stratigraphical and sedimentological information are particularly important for the history of Earth during Jurassic times.

Portuguese Jurassic sites with heritage value are known worldwide. They include the Bajocian GSSP (Cabo Mondego section; Pavia & Enay 1997) and the largest Middle Jurassic dinosaur tracksite (Galinha Quarry; Santos et al. 1994). However, these geosites have been consi-

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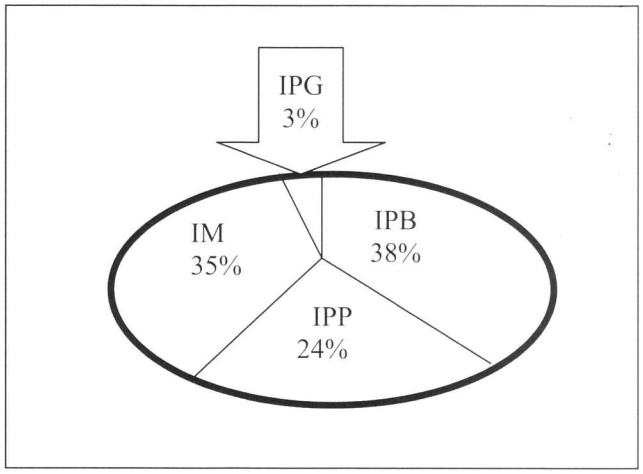

Fig. 1 - Reasons for the classification of current protected areas in Continental Portugal (IPB=mainly biological values; IPG=mainly geological values; IM=mixed values; IPP=mainly landscape values) (data from Oliveira 2000; Oliveira & Henriques 2000).

dered in very different ways by national politicians due to an absence of specific geoconservation laws, a dangerous lack of knowledge on public understanding of Geology and to an only limited pressure on the public opinion by Portuguese Jurassic geologists who could influence the media and the political power.

A new impulse for geoconservation is now on the way, aggregating many Portuguese geologists around the ProGEO-Portugal strategy, which aims to establish a national inventory for the Portuguese geosites and its integration in the Geosites Project, initiated by the IUGS Global Geosites Working Group and supported by UNESCO (Wimbledon 1996, 1998). The site www.geopor.pt, created in 1996, is a crucial forum to achieve this purpose.

Legal instruments for geoconservation in Portugal

There is no specific legislation on geoconservation in Portugal. The national law to protect natural areas (Decreto-Lei n°19/93 of 23rd July) defines five different categories created mainly for biological purposes (Tab. 1).

Besides this national legislation some legal instruments of regional rank are attached to municipalities or to private persons or institutions. This means that about 8,649 080 ha or 7% of the continental territory is under formal protection, but mainly for biological reasons (38% in a total of 37 national protected areas for Continental Portugal) (Fig. 1).

Biological sites have been frequently protected because both the legal instruments and pressure by biologists have worked together in planning the land use with special care for biological issues.

This is not the general scenario for geological issues, and even less for Jurassic values in Portugal, which may attain global relevance in some cases. Portuguese geosites have been classified as Natural Monuments for its scientific interest and they include only dinosaur tracksites (5 Natural Monuments, at the moment, all classified between 1996 and 1997; Tab. 2).

Dinosaur paleontologists, the media and the public opinion have forced politicians to preserve tracksites, using the only available legal instrument for geosites (Natural Monument), by claiming scientific relevance independently of other scientifically important geosites (some of which displaying characteristics, much more significant for the Geological Sciences).

Jurassic geosites of Portugal

In discussing Jurassic geosites from Portugal, some important aspects must be considered in advance. On one hand, the geosites may be important for different reasons (palaeontological, stratigraphical, sedimentological, ...), must be protected for different purposes (scientific, didactic, touristic, ...) and their relevance may also be distinct (international, national, regional, local - according to the methodology presented in Elízaga et al. 1994). On the other hand, the historical background on geoconservation in Portugal (strongly influenced by dinosaur paleontologists) and the social use of some protected geosites, where important infra-structures have been developed for public use, must be taken into account in the presentation of the Jurassic Heritage of Portugal.

In this section both types of sites will be referred to their present situation in terms of geoconservation.

Geosites of global relevance

The Aalenian-Bajocian boundary at Cabo Mondego is, by definition, a geosite of international relevance due to its stratigraphical value, after the establishment of the Bajocian GSSP in 1997 (Pavia & Enay 1997). But the "golden spike" is located in a thick series of marine and littoral sediments (Middle Jurassic and Upper Jurassic ages, respectively), outcropping in continuity on the coast, where palaeontological and sedimentological academic issues can be particularly well explained. In

Category (n° of sites)	Aim of protection
National Park (1)	One or more unaltered systems
Natural Reserve (8)	Floral and faunal habitats
Natural Monument (5)	Natural occurrence of scientific relevance
National rank – Natural Park (11) Regional/local rank – Protected Landscape (3)	Balanced integration of human activity and nature

Tab. 1 - Typology of protected areas in Portugal according to national law. The first column indicates the category (the highest ranked being the National Park and there is only one in Portugal) and the second column indicates the legal reasons for protection.

Name and location	General characterization and age
Galinha Quarry/Ourém	Records the largest Middle Jurassic dinosaur tracksite known in the world (147 m long); Bajocian-Bathonian
Carenque Quarry/Lisbon	Records the youngest and largest Cretaceous tracksite known (141 m long) in Europe; Cenomanian
Lagosteiros/Sesimbra	Records the only Lower Cretaceous dinosaur track in Portugal (controversial for some authors, see Santos, 1998); Hauterivian
Pedra da Mua/Sesimbra	Records the evidence of sauropod gregarious behavior in the European track record; Tithonian
Avelino Quarry/Sesimbra	Records the prints of the smallest sauropod known in Europe; Kimmeridgian

Tab. 2 - Natural Monuments of Portugal, specifically geosites (data from Antunes, 1976; Galopim de Carvalho 1999; Lockey & Santos 1993; Santos 1998).

fact, all the students of geology of all the universities in Portugal carry out practical work in this geo-site during their studies. Some students of Spanish universities located close to the border (Oviedo, Salamanca) frequently visit the outcrop as well and most of secondary teachers of Central Portugal introduce geology to the pupils at Cabo Mondego cliffs.

But no specific protection law has yet been approved by the Environment Ministry in this area. The Municipal authorities of Figueira da Foz took in charge a convenient land use of the site (denying permission for building, for instance), and collaborates regularly in the promotion of the outcrop for didactic actions. The former Ministry of Science and Technology supported a research project during 1999-2001 on the site (Rocha et al. 2001), and continues to develop public activities on Geology during the summer (programme "Geology in Summer").

The Peniche section is a candidate GSSP for the Toarcian Stage (Elmi et al. 1996) and an international reference section for Lower Jurassic times, with continuous coastal exposure of external platform sediments ranging from Sinemurian to Aalenian (Mouterde 1955; Wright & Wilson 1984; Duarte 1997, 2002). The section provides didactic and public use with the same value as Cabo Mondego for Middle and Upper Jurassic. From the scientific point of view, the section also provides new developments of integrated approaches to geological sciences, such as taphonomy and sequence stratigraphy (Fernández-López et al. 2000).

The Dogger sediments of Cabo Mondego and the Liassic sediments of Peniche are the best record worldwide of the history of the Proto-Atlantic during the Lower and the Middle Jurassic. The two sections constitute the complete stratigraphic section of the Lusitanian Basin for the Lower and Middle Jurassic, corresponding to distal facies, where the richness of palaeontological, stratigraphical and sedimentological information justifies the huge amount of scientific bibliography published around the world from the XIX century onwards (Duarte 1995; Henriques et al. 1994).

Geosites of national relevance and intense public use

Geosites of national relevance have been protected and/or promoted in other Jurassic outcrops of Portugal. They all include, besides the outcrops interesting museums providing several pedagogical activities, such as practical work on different aspects on geological sciences.

The Galinha Quarry Natural Monument (Tab. 2) is a Natural Monument supported by the national government. It was classified in 1996 and it has had an intense public use since then, especially students from all learning levels. Special infrastructures have been created for this particular purpose, such as accommodation facilities for groups and others (see: www.icn.pt/areas_protegidas/s_aire/entrata.htm.

The Lourinhã Museum also has a "sauropod" connection, due to the discovery in 1993 of important dinosaur clutches and eggs in the upper Kimmeridgian-lower Tithonian sediments of Lourinhã region (Mateus et al. 1997; Dinis 2002; see: http://www.cm-lourinha.pt/turismo/nivel2.php?id=9&nivel1=6&lingua=PT). The museum is supported by municipal budgets.

The Stone Museum at Cantanhede was founded in 2001 and it was created due to the historical exploitation and artistic use of the Bajocian limestone of nearby quarries in architecture and sculpture, from the XVII century (see: http://www.cm-cantanhede.pt/portal/museupedra/index.html). The museum is supported by municipal budgets, and provides integrated activities both with local secondary schools and with the University of Coimbra.

Problems and solutions

It is largely accepted that the geological heritage of the Earth should be safeguarded and that it corresponds to a worldwide concern that underlies national solutions when they exist. As a consequence, global problems need global solutions, which logically should be supervised by UNESCO.

The UNESCO Geopark Programme is a global geoconservation project, historically and formally strong, involving the UNESCO's Division of Earth Sciences together with partners of the International Union of Geological Sciences (IUGS) and governmental institutions (Eder 1999). This project however, and its European relative, the European Geoparks programme (www.europeangeoparks.maestrazgo.org), emphasises issues related to sustainable development and tourism often related to landscape or palaeontological values, and is not, by itself, a mechanism for GSSP's protection.

The Geosites Project was initiated by the IUGS Global Geosites Working Group, supported by UNESCO, and it aims to produce a global inventory of the Earth´s geological heritage (Wimbledon 1996). Based on supra-national criteria, this project proposes a methodology based on frameworks selected in each country on the basis of their special relevance for the world geological register, where geosites are selected within a chosen context (Wimbledon 1998). Stratigraphic sections are included in the concept of framework, as well as many other significant geological processes or products. The implementation of such models is very slow, but results seem

to be much more reliable for the geological sciences, for they depend only on geologists´ evaluations around the world, based on a scientific language as universal as possible, and on generating national consensus (García-Cortés et al. 2001). But for stratotypes, no formal status has been achieved until now, beyond listing as Geosites.

As geosites of global relevance, the conservation of GSSP´s should not be left to individual governments or wait for the results of the international projects referred to above. In the absence of international agreements or conventions, IUGS could encourage UNESCO to establish World Heritage status to ensure the conservation of these globally important standards (Page & Meléndez 1995). This status, when applied to Cultural Sites s.s., generally promotes national attitudes of protection and valorization of the sites, both in institutions and in the general public.

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