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Definition of the Portuguese frameworks with international relevance as an input for the European geological heritage characterisation

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This work constitutes the first contribution for the systematisation of geological heritage knowledge in Portugal, following the international recommendations for the characterisation of geological heritage (IUGS, ProGEO). The application of the ProGEO methodology has resulted in the creation of fourteen frameworks with international relevance, established by consensus among the Portuguese geological community. The description of each category in this paper is not exhaustive and only the most relevant scientific settings are presented. The following are the three key outcomes of this work: i) At a national level, the most important geosites are identified, indicating where geoconservation efforts should be prioritised based on scientific justification; ii) At a regional level, conditions have been developed to foster dialogue with Spanish colleagues in order to create Iberian frameworks; iii) At an international level, it is now possible to integrate Portuguese geosites in to the global inventories promoted by IUGS, UNESCO, and ProGEO.

Introduction *(by J. Brilha)*

The identification, characterisation, conservation, and grading of geological heritage are gaining interest among the geological community. During the 32nd International Congress, held in Italy on August 2004, three thematic sessions were organised with about 160 oral and poster presentations. During the last decade, many countries have developed several initiatives to increase knowledge of geological heritage. This individual effort brought different approaches to this task making the establishment of a constructive dialogue between specialists difficult.

In spite of national initiatives, the first step towards the organisation of inventory strategies was given by ProGEO (The European Association for the Conservation of the Geological Heritage) following the GILGES work (of IUGS and UNESCO) and by the International Union of Geological Sciences (IUGS) (Wimbledon, 1996a). In 1996, this international institution created Geosites: a project engaged in the promotion of a factual basis to support national and international geoconservation initiatives. Until 2004 the IUGS's Global Geosites Working Group, together with UNESCO and ProGEO, supported the establishment of national inventories and promoted links between neighbour countries (ProGEO, 1998).

Recently, IUGS changed the focus and direction of its efforts towards geotourism and geoparks and GEOSEE was created in 2004. ProGEO continues with the construction of national and regional comparative inventories in Europe, furthering the original Geosites aims. The methodology proposed by the IUGS for national inventories was defined during the First Workshop on Geosites at the 2nd International Symposium ProGEO on the Conservation of the Geological Heritage held in Rome in 1996, based on ProGEO experience (Wimbledon et al., 1999). The inventory is founded on the identification of geological thematic categories in each country rather than on the recognition of isolated sites. The definition of national frameworks systematises local inventories and allows the establishment of trans-national comparisons (Wimbledon, 1996b). This comparison and correlation task has already been initiated in Scandinavian countries (Fredén et al., 2004), Baltic states (Satkunas et al., 2004) and southeastern European countries (Theodossiou-Drandaki et al., 2004), mainly promoted by ProGEO.

In Portugal, the inventory, characterisation and valuation of geological heritage has been done in an unsystematic manner. A list of outstanding geosites and places at risk has been collected with contributions from the former Geological Survey, National Natural History Museum, University Geology Departments and League for Nature Protection. Unfortunately, the state institutions responsible for Nature Conservation policies have never adopted geoconservation approaches as a priority. The few conserved geosites have resulted from occasional and local circumstances with no continuity.

The Portuguese ProGEO group, created in 2000, congregates geologists from a majority of the geological institutions. This group decided to implement in Portugal the methodologies suggested by IUGS and ProGEO and started the work of defining national frameworks of international relevance. This priority was established in order to provide a Portuguese entry for the Geosites list and to promote a dialogue with Spanish colleagues (Garcia-Cortés et al., 2001).

The process was opened to all national geological institutions and publicised by circulars and on the ProGEO-Portugal web site. In May 2004, during an open meeting held in the former Geological Survey headquarters, fourteen frameworks with international relevance were established:

– A geotraverse through the Variscan Fold Belt in Portugal;

– Geology and metallogenesis of the Iberian Pyrite Belt;
– The Iberian W-Sn Metallogenic Province;
– The Silurian of the Portuguese Ossa Morena Zone;
– Meso-Cenozoic of the Algarve;
– Low coasts of Portugal;
– River network, rañas and Appalachian-type landscapes of the Hesperic massif;
– Tertiary basins of the western Iberian margin;
– Jurassic record in the Lusitanian Basin;
– Dinosaurs of western Iberia;
– Ordovician fossils from Valongo Anticline;
– Karst systems of Portugal;
– South Portuguese Palaeozoic Marbles;
– The Azores Archipelago in the America-Eurasia-Africa triple junction;

This paper is therefore the result of all contributions and suggestions. New well-justified proposals will be considered in a future revision of this work. The next immediate step will be the nomination of the most relevant geosites representative of each framework, based on an accurate identification, characterisation and quantification. These geosites will constitute the most remarkable elements of geological heritage in Portuguese territory. Therefore, they must be given a high priority in any implementation of geoconservation strategies.

The fourteen frameworks are presented according to their geographical relevance illustrating the high geodiversity level in Portugal (Figure 1). The description of each category is not exhaustive and just the most relevant scientific settings are presented.

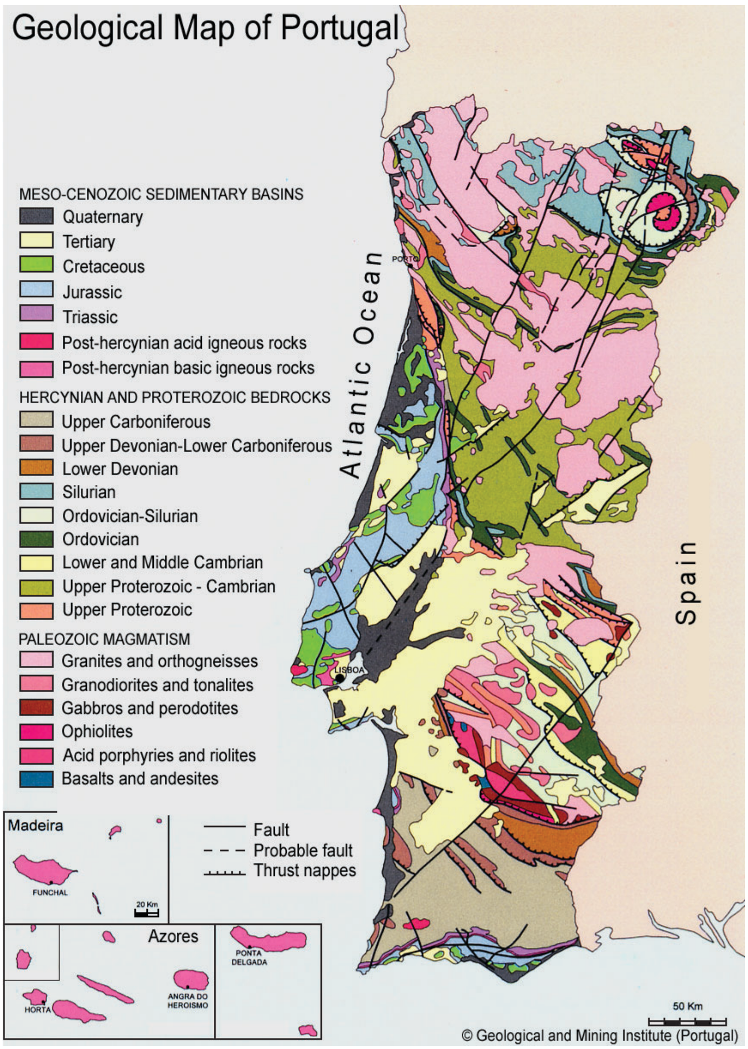

Figure 1 Geological map of Portugal.

A geotraverse through the Variscan Fold Belt in Portugal *(by A. Ribeiro)*

The backbone of the Iberian Peninsula is formed by basement rocks that are part of the Variscan Fold Belt. This Belt extends from Central Europe to Western Europe and Morocco delineating a series of arcuate mountains. This belt was generated by the opening and closure of oceans of variable size between the upper Proterozoic (~540 Ma) and the upper Paleozoic (~250 Ma).

The best traverse across this Variscan Fold Belt is in the Iberian Peninsula because: i) the transverse is the most complete, foreland (Cantabrian Zone around Oviedo in NE Spain) to foreland (South Portuguese Zone in SW Portugal), and ii) the basement is exposed continuously if we avoid the Meso-Cenozoic basins in its borders and the discontinuous Cenozoic basins in the center of Iberia. Therefore, its pristine geological features are preserved from more recent events related to the opening of the Atlantic and closure of Tethys (Ribeiro et al., 1991).

Finally, the climatic conditions and vertical movements provide beautiful exposures of rocks and structures in coastal cliffs, deep rivers and elevated mountains. In fact, some of the most significant exposures of the Belt are located at different spots in Iberia. They contribute to a deeper understanding of the processes that shaped the belt and its extension downwards to deeper crustal levels.

Geology and metallogenesis of Iberian Pyrite Belt *(by F.J.A.S. Barriga, J.M.R.S. Relvas, J.M.X. Matos)*

The Iberian Pyrite Belt (IPB) contains a colossal amount of volcanic-hosted massive sulphides, with a pre-mining total of more than 1750 Mt containing 22 Mt Cu, 34 Mt Zn and 12 Mt Pb, respectively. This is comparable only, on a worldwide basis, to the Urals Belt of Russia. However, while the Urals Belt extends for nearly 2500 km, the IPB is only about 250 km long. Thus, the concentration of sulphide ores is an order of magnitude greater in the IPB.

The IPB has been mined continuously since the Chalcolithic era. The Rio Tinto deposits of Spain, the first to gain world fame, are considered the largest of their class ever to form, with over 500 Mt of sulphide ores. The Aljustrel and Neves Corvo deposits (Portugal) are among the world's richest deposits of their class in Zn and Cu (>8Mt and >4Mt, respectively). Additionally, Neves Corvo's copper and tin ores depict the highest grades recorded for deposits of their class (e.g. Carvalho et al., 1999; Relvas et al., 2002).

The deposits are hosted by a well-preserved volcanic-sedimentary complex, in a tectonic setting interpreted to represent continental fragments that collided obliquely during the Variscan orogeny, following subduction of an oceanic realm. The tectonic evolution produced thrusting and formation of pull-apart basins, which host the deposits (see Tornos et al., 2002). The post-depositional history of the deposits is well recorded.

All geological and metallogenetic aspects of the IPB are well studied and many constitute classic studies in the literature. Detrital and chemical sedimentation, volcaniclastic deposition, hydrothermal activity and mineralization, syn-sedimentary and transpressive deformation are all clearly visible. Additionally, the IPB is studied also through detailed comparisons with present-day submarine hydrothermal sites, including examples not only in the Atlantic but also in the Pacific (e.g. Pacmanus in Papua New Guinea). The IPB is still an actively studied geological object. Among the main aspects being researched, we can mention sedimentation and its role with respect to mineralization, submarine physical volcanology, the position of mineralization with respect to the coeval sea floor, and the origin of metals from different crustal reservoirs.

It should be noted that the erosion level deepens markedly from West to East in the IPB. Thus, most mines in Portugal are underground, whereas in Spain open pits abound. This generates different types of exposures and different degrees of weathering, adding to the variety of situations to visit.

The trans-national Iberian Pyrite Belt has already been proposed for inclusion in the Geosites list of geological frameworks, from a Spanish national point of view (Garcia-Cortez et al., 2001). The present contribution is intended for fusion with the latter.

The Iberian W-Sn Metallogenic Province *(by F. Noronha)*

The W/Sn province contains many spectacular exposures, in both the field and underground. The Panasqueira mine specifically is a world famous field trip destination. Many other occurrences and ancient mines are easily accessible, including exposures with abundant scheelite, prone to nocturnal investigation with a mineralight. In general, field relationships are easily seen and interpretable. The W and/or Sn deposits are distributed through an area from Galicia to Castilla (Spain) through Northern and Central Portugal. The Sn deposits are mainly of pegmatitic type. The W deposits can be considered of two types: quartz vein type, the most important, and skarn type. Where the W and/or Sn mineralization occurs we can see the presence of granite intrusions in marine sedimentary series dated from Upper Precambrian to Silurian (Neiva, 1944; Thadeu, 1973; Schermerhorn, 1981).

The Variscan granitic magmatism (orogenic) can be subdivided in two groups: peraluminous granites or two-mica granites (muscovite is the dominant mica); monzonitic granites and granodiorites (Ferreira et al., 1987). The peraluminous granites (320 Ma – 300 Ma) are of mesocrustal origin; the second group (300 – 290 Ma) originated deep in the crust and corresponds to hotter dry magmas. Although Sn pegmatites occur mainly associated to the granites of the first group, the W quartz veins are dominantly related with the second group of granites. The granites spatially associated with mineralization can be considered as "specialized" granites, where the "specialization" is related with the mechanisms of concentration like magmatic differentiation and/or late to post-magmatic events responsible for deuteric alteration. The W content in granites associated with mineralization is low (<7 ppm) whereas the granites associated with Sn pegmatite mineralization are high (>30 ppm) (Derré et al., 1982). This means that magmatic differentiation and/or late to post magmatic events cannot be solely responsible for the W deposits, a contribution of geofluids is necessary for ore genesis. The fluid inclusions in minerals of the main deposits, like Panasqueira and Borralha, do not register the presence of magmatic fluids. The main fluids present in these W/Sn Variscan geothermal systems were meteoric fluids re-equilibrated after deep circulation in the crust and then responsible for the mobilization of stock metal from the rocks. The orebodies were deposited mainly in structural traps (Kelly & Rye, 1979, Bussink et al., 1984; Polya, 1989; Noronha et al., 1999).

The Silurian of the Portuguese Ossa Morena Zone *(by J.M. Piçarra)*

The Barrancos area, within the southeastern Portuguese part of the Ossa Morena Zone, contains the well-documented Silurian succession from Portugal (see Robardet et al., 1998, for references; Piçarra, 2000), which is now being used globally as a reference in biochronostratigraphy and paleogeography.

The Graptolites (19 biozones recognized) are the most common fossils, but other biological groups occur, such as orthoceratids, bivalves, crinoids and hexactinellid sponges, like *Protospongia iberica* (Rigby et al., 1997).

The lowermost part of the Silurian succession assigned to the basal Rhuddanian *Parakidograptus acuminatus* Biozone (Piçarra et al., 1995) corresponds to the boundary beds of the Colorada and "Xistos com Nódulos" formations. Graptolite-bearing rocks consist of quartzitic beds and lydites alternating with black shales. It is followed by strongly weathered black shales, 20-25 m thick, with rare lydite layers, that constitute the dominant lithofacies of the "Xistos com Nódulos" Formation. This formation extends from the Rhuddanian *Cystograptus vesiculosus* Biozone (lower Llandovery) up to the Gorstian *Lobograptus scanicus* Biozones (lower Ludlow). The graptolite biozones identified in this interval are: the Rhuddanian *Coronograptus cyphus* Biozone, the Aeronian *Demirastrites triangulatus, D. convolutus* and *Stimulograptus sedgwickii* biozones, the Telychian *Spirograptus guerichi, S. turriculatus-Streptograptus crispus, Monoclimacis griestoniensis* and *Oktavites spiralis* biozones, the Sheinwoodian *Cyrtograptus murchisoni* and *C. rigidus* biozones, the Homerian *C. lundgreni, Pristiograptus parvus-Gothograptus nassa* and *Colonograptus*? *ludensis* biozones, and the Gorstian *Neodiversograptus nilssoni* Biozone. This part of sucession includes a 12 cm thick yellow band that marks the Lundgreni Event of graptolite extinction (Gutiérrez-Marco et al., 1996).

The uppermost Silurian strata are represented by the lower part of the "Xistos Raiados" Formation, about 20-30 m thick. It consists of dark siltstones alternating with shales yielding graptolites of the Pridoli *Neocolonograptus parultimus* and *Monograptus bouceki* biozones (Piçarra et al., 1998).

The Silurian-Devonian boundary is placed in the first occurrence of graptolites of the basal Lochkovian *Monograptus uniformis* Biozone (Piçarra, 1998), within those dark siltstones.

The Silurian succession of the Barrancos area is lithologically and faunistically similar to that of the Peri-Gondwan Europe and North Africa areas (i.e. Spanish Ossa Morena Zone, Catalunia, Sardinia, Saxothuringia, Barrandian and Morocco).

Meso-Cenozoic of the Algarve *(by M. Cachão, P. Terrinha, A. Santos)*

By its geographical position, ENE-WSW orientation and lithological diversity the Algarve geological province stands out as unique from stratigraphic (from Late Triassic to Quaternary with major hiatus from Cenomanian to Lower Miocene) and morpho-tectonic points of view. The Variscan most external Carboniferous unit constitutes the basement of the Mesozoic and Cenozoic sedimentary packages, deposited on two totally distinct superposed basins (Terrinha, 1998)

From Middle-Upper Triassic (Rhaetian) to Hetangian sediments evolved from continental (fluviatile red sandstones), to shallow marine, deposited over the entire Algarve region, including evaporites and syn-sedimentary tholeiite fissural magmatism (Hettangian-Sinemurian Basaltic lava flows, volcanic ashes and pyroclasts) (Martins, 1991). To the south of the Tavira-Algoz-Sagres tectonic line, the Hettangian Silves pelites are richer in evaporite facies. One of its salt walls, the Loulé diapir (Central Algarve), is currently being explored in an underground mine. Subsidence and carbonate platform conditions were established until the end of Jurassic. Lower to Middle Jurassic reef barrier to open external platform facies outcrops at Sagres. Here Aalenian-Bajocian karstified reefs are covered by Upper Bajocian-Lower Bathonian *Zoophycus* rich pelagic grey marls (Praia da Mareta and Forte de Belixe) followed by Middle Oxfordian condensed ammonite rich limestones indicating that the Algarve Basin remained a Mediterranean sub-domain province of the Tethyan domain (Rocha, 1976).

The most important tectonic inversion of the basin pre-dated the Miocene (Terrinha, 1998), and includes the peralkaline (nepheline syenite) Late Cretaceous intrusion of Monchique, (Rock, 1979, 1982a, b).

The Middle Miocene Lagos-Portimão formation is correlative of the global positive eustatic trend evidencing coastal marine sedimentation over a relatively stable and syn-betic remarkably minor deformed cold limestone shelf platform, (Cachão, 1995; Cachão & Silva, 2000; Brachert et al, 2003). An intra-Miocene stratigraphic hiatus of 2.5 Ma led to generalized exposure and development of a karst that magnificently influences present day coast line. Subsequent Cacela Formation indicates the Algarve margin became part of the distal western boundary of the Guadalquivir foreland basin (Cachão, 1995). Study on the classical mollusc fossil-site of Ribeira de Cacela (Ria Formosa Natural Park), goes back to the mid-nineteenth century, with works by Pereira da Costa and Cotter and many others (e.g. Antunes et al., 1981; Antunes & Pais, 1992; Cachão, 1995, González-Delgado et al., 1995; Santos, 2000).

Low coasts of Portugal *(by M.C. Freitas, C. Andrade, P.P. Cunha, H.M. Granja)*

The Portuguese littoral contains numerous sections of low coast, usually corresponding to wetlands, which are natural archives of changes in coastal dynamics with great scientific value to reconstruct and understand palaeogeographical, palaeoclimatic and palaeoenvironmental processes and effects since the Late Glacial.

Along the southern coast of Algarve, the complex system of Ria Formosa is a well preserved unique non-coastal plain barrier island – lagoonal structure. It connects with the magnificent marshes of the Guadiana estuary through the beach-ridge and dune plains of Manta Rota and forms the western border of the Gulf of Cadiz (Andrade & Freitas, 2004). The Boca do Rio lowland, an infilled estuary, preserves the most complete and didactic geological record of tsunami flooding (associated with the Lisbon event of 1755) known in the European literature (Dawson et al., 1995).

The coastal lagoons of Santo André and Albufeira, together with the estuaries of Mira, Sado and Tagus rivers, in the SW coast, contain the most complete and continuous morphological and sedimentary records of sea level, vegetation and climate since the Late Glacial (Freitas et al., 2002; 2003). These sites are key elements to the understanding of past environmental changes along this coast and to help predict responses in the context of expected global change by climatic forcing. Further north the barrier-lagoon systems of Óbidos, S. Martinho do Porto, Aveiro and the Mondego estuary represent functional equivalents, yet located along a high-energy wave-dominated coast (Cunha et al., 1997). Northward of the Mondego estuary a unique residual lagoon is located (Apúlia), that is a geoindicator of a wider lagoon system present along the coast during the Holocene. Between Aveiro and Nazaré a vast and well-preserved dune field documents several generations of aeolian activity and dune encroachment that deserve conservation for their scientific and scenic values (Almeida, 1997; André et al., 2001). Between Esmoriz and Furadouro there are hidden remains of a buried paleoforest of *Pinus sylvestris* that represents the Last Glacial Maximum (LGM) along this coast (Granja, 1999; Groot & Granja, 1998).

The examples quoted are represented by complex associations of active, barred or semi-enclosed lagoons or estuaries, spits, barrier-islands, tidal-flats, marshes, mobile to vegetated dunes and salt- to brackish-water swamps. Beyond their intrinsic value as records of past environmental changes, the present-day state of preservation of these features is sufficient to sustain their function as self-reorganizing physical barriers against flooding and efficient water purifiers.

River network, rañas and Appalachian-type landscapes of the Hesperic massif *(by P.P. Cunha)*

The diverse and rich geomorphological heritage that can be observed in the NW of Iberia provides evidence of a geological history of international interest and importance. Erosion of the Hesperic Massif has resulted in a region of low relief called the Iberian Meseta, surrounded by sedimentary basins. However, the denudation was not continuous and involved a succession of cycles of erosion and weathering that never resulted in perfect planation. Due to the different resistance to weathering of the basement, the narrow NW-SE trending Palaeozoic synclines produced quartzitic ridges, whereas the large anticlines, that consist of slates and metagreywakes, developed flat valleys (Appalachian-type relief; Martín-Serrano, 1988). In west central Portugal, Albian sedimentary rocks onlapping these quartzitic inselbergs suggest that the long period of general chemical weathering occurred in Early to Middle Jurassic and Early Cretaceous times (Cunha & Pena dos Reis, 1995). Sedimentary and geomorphological evidence of extensive Palaeogene to middle Miocene alluvial plain drainage systems contrasts with evidence of geographically restricted later Miocene-Zanclean alluvial fan sedimentation. This change happened correlative with uplift events of the Portuguese Central Range and other higher relief areas (Cunha, 1992a). Alluvial fan sedimentation culminates with poorly-sorted ochre conglomerates, containing large quartzitic boulders in proximal areas fed by quartzitic relief areas, called rañas in the Portuguese and Spanish Central Range piedmonts. Locally, fan sedimentation passes laterally into fluvial deposits that document the first evolutionary stage of the present river networks draining to the Atlantic, considered to be of Piacenzian age, predating the progressive fluvial incision that produced the staircases of river terraces (Cunha et al., 2005).

In working out this framework the geological diversity of Portugal has several advantages: 1) Sedimentary evidence of the progressive lateral and longitudinal facies evolution, from the interior areas of the Massif to the near Atlantic ocean, a major external forcing (Cunha et al., 1993); 2) The best dating of the sedimentary episode (allostratigraphic unit USB13-Piacenzian; Cunha, 1992b) that contains the rañas, but also fluvial and estuarine/coastal marine deposits with fossils providing precise biostratigraphy (Cachão & Silva, 1990); 3) Evidence of late Cenozoic tectonic events that have controlled the morphodynamic episodes (Cabral, 1995). The allostratigraphic unit UBS13 display characteristics typical of kaolinization and hydromorphism, reflecting a more humid and hot climate and important Atlantic fluvial drainage (Cunha, 2000a).

Because of their geomorphological and sedimentary records, rivers provide important archives of Earth history, particularly as indicators of tectonic, climatic or eustatic events. The analysis of long fluvial sequences, like the ones in which the rañas represent the first stage of fluvial evolution, provides stratigraphic keys for understanding other Cenozoic sequences on land.

Tertiary basins of the western Iberian margin *(by P.P. Cunha and J. Pais)*

A wide range of Cenozoic geological features occur in Portugal, such as the Central Portuguese Cordillera (CPC) and Estremenho Massif, with its intervening craton, and other significant topographic features (e.g. the Western Mountains and the Arrábida chain), offshore margin-bounding structures, and sedimentary basins providing evidence for the regional evolution. These basins vary considerably in size and have formed under compressional and transpressional tectonic regimes (Ribeiro et al., 1990; Alves et al., 2003), generated during the phases of compression between Iberia, Europe and Africa.

The main Portuguese Tertiary basins (Mondego and Lower Tagus) are located in the western border of the Iberian Massif and separated by the CPC, a southwest-trending cordillera uplifted in the late Cenozoic. Further inland, smaller Tertiary basins occur, both to the north and south of the CPC. The Portuguese Tertiary basins have marked tectonic, morphological and lithological differences. Their depositional records include continental units grading westwards into marine sediments that document the post-Mesozoic palaeogeographic, tectonic, climatic and eustatic events that occurred in western Iberia. Additionally, the limited vegetation, weathering and the considerable fluvial incision observed onshore have produced good exposures, the majority of which are located along the coast in regions of present-day temperate climate.

Unconformity-bounded units have been recognised in the western Iberian margin (Cunha, 1992a, 1992b, 2000b; Pena dos Reis et al., 1992) and high-resolution sequence stratigraphy is currently being applied to the estuarine Miocene units of the Lower Tagus Basin (Antunes et al., 2000; Legoinha, 2001). The distribution of depositional facies, particularly alluvial deposits interfingering with marginal marine siliciclastics, and the abundance of macro- and microfaunas recorded in this basin demonstrate the exceptional importance of the Lisbon-Set·bal Peninsula sediments for the study of the Neogene evolution of Iberia. Correlations are based on several taxonomic groups — foraminifera, ostracoda, dinoflagellates, pollen, spores and mammals — coupled with isotopic dating and palaeomagnetostratigraphy. Inland, continental successions clearly reflect the influence of tectonics and climate on the stratigraphic evolution of the basin.

The geological importance of the Tertiary basins of western Iberia is underlined by its specific location on the Atlantic coast, which allows the use of detailed biostratigraphic and sedimentary information in the study of the major tectonic, climatic and eustatic events affecting the North Atlantic margin.

Jurassic record in the Lusitanian Basin *(by M.H. Henriques, A.C. Azerêdo, L.V. Duarte, M.M. Ramalho)*

The Jurassic System in Portugal crops out in two basins, related with the genesis of the Atlantic Ocean: Lusitanian (West Portugal) and Algarve (South Portugal). The Jurassic record of the Lusitanian Basin ranges in age from the Hettangian to the Tithonian, providing a unique opportunity for onshore study of pre-, syn- and post-rifting deposits. These are particularly well represented in several reference sections, the most relevant of them located on the western Atlantic coastline. At Cabo Mondego, the Lower-Upper Jurassic section includes the Bajocian GSSP, the first stage boundary established for the Jurassic System by the IUGS (Pavia & Enay, 1997; Fig.1). The "golden spike" has been defined within a thick series of marine and coastal sediments, cropping out in continuity along the coast. At Peniche, the Lower Jurassic section includes the presently proposed candidate for the Toarcian GSSP (Elmi et al., 1996; Fig. 2). Again, the lower boundary of the Toarcian is located within a wide outcrop showing continuous coastal exposure of outer marine sediments (including turbidites), ranging in age from the Sinemurian to Aalenian. The Peniche and Cabo Mondego sections complement each other, representing a complete stratigraphic succession for the Lower and Middle Jurassic distal facies of the basin, and probably are the best record worldwide of the history of the Proto-Atlantic during those periods. In addition, other excellent sections on Lower-Middle Jurassic marine series are displayed at more inner locations in the basin. Their rich palaeontological, stratigraphical and sedimentological information justifies the huge amount of scientific work that has been published worldwide from the 19th century onwards (references in Duarte, 1995, 2004; Henriques et al., 1994; Henriques, 2004). The Middle Jurassic is also largely composed of inner marine carbonate facies, in particular towards the east (Maciço Calcário Estremenho, Serra de Sicó), where excellent exposures exhibit varied litho- and biofacies. These provide detailed sedimentary, palaeogeographical, stratigraphical and micropalaeontological data (Azerêdo, 1993; Soares et al., 1993; and references therein). The Middle-Upper Jurassic transition records a major disconformity, as in other Atlantic basins but with a few uncommon features (Azerêdo et al., 2002). The Upper Jurassic is represented by all of its stages, exhibiting a wide range of facies types in excellent outcrops (e.g. Cabo Espichel, Sintra-Cascais, Torres Vedras-Montejunto, Baleal-Nazaré, Cabo Mondego). These comprise alluvial, fluvial and deltaic deposits; lignites; calcretes; lacustrine, restricted to hypersaline lagoonal sediments; reefal to outer marine limestones; and mass-flow deposits (e.g. Ramalho, 1971; Leinfelder & Wilson, 1998; and references therein).

Dinosaurs of western Iberia *(by P. Dantas, V. Santos, M. Cachão)*

The Lusitanian basin (Western Iberia) contains exceptionally well-preserved body fossils and ichnites of dinosaurs in its Mesozoic units. Ostheological remains were mainly recovered from Upper Jurassic to Lower Cretaceous formations (Pombal, Leiria, Alcobaça and Batalha in the north and Alenquer and Torres Vedras at the south). At Pombal remains of Theropoda and Sauropoda have been recovered (Sauvage, 1897-98; Pérez-Moreno et al., 1999) in particular *Allosaurus fragilis*, an inter-continental species present in the Upper Kimmeridgian–Lower Tithonian Alcobaça Formation (Pérez-Moreno et al., 1999, Dantas et al., 1999). Further South, at Leiria, the Late Oxfordian-to Early Kimmeridgian Guimarota fossiliferous lignite mine (Mohr, 1989; Krebs, 1991; Helmdach, 1971, 1973–74), provided Ornithischia (Hypsilophodontidae, *Phyllodon*; Thulborn, 1973); Sauropoda Brachiosauridae; Theropoda (Allosauridae, *Compsognathus*, Tyrannosauridae, Troodontidae, cf. *Archaeopterix*; Rauhut, 2000) and a remarkable diversity of microvertebrates in particular four orders of Mesozoic mammals: Docodonta, Multituberculata, Dryolestida and Zatheria (Martin & Krebs, 2000), together with plant groups (Charophyta, Pteridophyta, Cycadales, Bennetitales, Aruacariaceae, Cheirolepidiaceae and Cupressaceae) (Helmdach, 1971, 1973-74; Kühne, 1968; Krusat, 1980; Thulborn, 1973; Weigert, 1995; Martin & Krebs, 2000). The rich delta facies of the Lourinhã formation (Wilson et al., 1989) are particularly rich in Theropoda, Sauropoda, stegossaurs, ankylosaurs and Ornithopoda together with dinosaur eggs, gastroliths and footprints, as well as other groups such as Charophyta, Mollusca, Ostracoda, fishes, Quelonia, and Crocodyliformes (Lapparent & Zbyszewski, 1951, 1957; Werner, 1986; Mohr, 1989, Galton, 1991, 1994; Manuppella et al., 1999; Dantas in Sanz, 2000). Recent discoveries include eggs with theropod embryos (Mateus et al., 1998), and the sauropod *Lourinhasaurus alenquerensis* (Dantas et al., 1998). Ichnological remains are found in several locations around Lisbon. At Pedra da Mua (Espichel formation; Upper Jurassic) dozens of trackways preserved both manus and pes morphologies, and reveals aspects of sauropod and theropod behavior such as herd and limping movement (Lockley et al., 1994). Pego Longo-Carenque (Belasian formation; Middle Cenomanian), displays a long trackway of sub-circular footprints (Santos et al., 1992) while at the Galinha quarry (Torres Novas), marly-limestone units of the Dogger (Upper Bajocian -Lower Bathonian) revealed long sauropod trackways, with new manus and pes print morphologies for this group (Santos, 2003).

Ordovician fossils from Valongo Anticline *(by H. Couto)*

The Ordovician rocks of the Valongo Anticline present important and widely known fossil-rich layers. The fossil record shows a great paleobiodiversity, evident by the presence of different forms of animal life, trace fossils and by the presence of seaweeds. The Valongo Formation, one of the most fossiliferous lithostratigraphic units of the Ordovician of Portugal, has become, for about a hundred years, an object of particular interest to several palaeontologists. Delgado (1908) was the first author to identify the fossils in this formation, having classified more than a hundred and a half invertebrate taxa (arthropods, molluscs, brachiopods, echinoderm, graptolites and several groups of uncertain affinity).

Throughout the 20th century, apart from some references to graptolites, brachiopods, cephalopods and echinoderms, the papers about trilobites must be stressed, mainy because some species of these marine arthropods were identified in Valongo for the very first time (Delgado 1892, Curtis, 1961; Romano, 1980, 1982; Romano & Henry, 1982, among others). Recent studies of rarer specimens include those on nautiloids of the *Trocholites* genus (Babin et al., 1996; Couto & Gutiérrez-Marco, 2000), cystoids (Couto & Gutiérrez-Marco, 1999), machaerids, a group of a very rare Palaeozoic marine invertebrates, represented by the genus *Plumulites* already identified by Delgado (Gutiérrez-Marco et al., 2000), ctenostomate bryozoans in brachiopods's "*Orthis*" *noctilio* valves and rostroconch molluscs (Couto & Gutiérrez-Marco, 2000). In relation to echinoderms, specimens of Homalozoa were identified (Gutiérrez-Marco & Meléndez, 1987; Couto & Gutiérrez-Marco, 2000) and the presence of an Asterozoa was pointed out for the first time (Couto & Gutiérrez-Marco, 2000). Finally the occurrence of phosphate levels with lingulid brachiopods in the Santa Justa Formation (Arenigian-Lanvirnian transition) (Couto, 1993, Couto et al., 1999) must be emphasized. This occurrence allows correlation with similar levels in other parts of the Iberian Peninsula, France, Morocco, Yugoslavia and northwest of Argentina and also permits the reconstruction of the coastline at the end of lower Ordovician.

This extremely important palaeontological heritage has been preserved ever since the creation of the Palaeozoic Park of Valongo in 1998, a cooperative venture between the Geology Department of the Faculty of Sciences of the University of Oporto and the Municipality of Valongo (Couto & Dias, 1998, Couto et al., 2003).

Karst systems of Portugal *(by J.A. Crispim)*

Portuguese carbonate rocks support important karstlands, which include ten protected areas of different status. In the Hercynian chain, marbles and dolomitc limestone yielded residual hills of Estremoz and Adiça (Alentejo), which are remnants of past morphoclimatic settings. Palaeokarst is represented by multiphase breccias and mineralizations at the contact with carbonate rock. Three caves are famous: Santo Adriço (Vimioso), with thick calcite deposit mined for alabaster; Escoural (Montemor), with rock paintings and engravings; and Algar de Santo António a rare karst window that supplies water to Alandroal.

Tectonic inversion of Mesozoic basins yielded massifs where karst processes developed karren fields, sinkholes and poljes (Martins, 1949; Feio, 1951; Cunha, 1990) like Pedra Furada (Sintra) and Cerro da Cabeça megalapies (Olhão), and Minde (Alcanena) and Nave do Barão (Loulé) poljes. Fórnea de Alvados is a splendid reculée originated by headward erosion (Rodrigues, 1991).

Spectacular relict wave cut platforms and sea cliffs testify to the advance of the sea during the late Pliocene transgression (Cape Espichel surface, Adrião; Aljubarrota platform, Candeeiros) (Teixeira & Berthois, 1952; Pereira, 1989). Entrenched valleys formed after sea retreat, provide insight into studies of prehistoric Man (Mogo, Alcobaça; Nabão, Tomar; Lapedo, Leiria) (Natividade, 1901; Zilhão, 1987). Coastal karst is well developed on Miocene outcropping in Algarve where current sea erosion opens circular pits and caves filled up by Pleistocene sands (Algar Seco, Praia da Rocha).

Caves, both coastal (Furninha, Peniche; Lapa de Santa Margarida, Arrábida) and inland (Almonda cave, Torres Novas) are important archaeological and palaeontological sites (Ferreira, 1982). The most extensive caves are in Estremenho massif (Almonda and Moinhos Velhos are each about ten kilometres long) but Arrábida contains perhaps the most richly decorated cave, with delicate crystals (Frade cave, Sesimbra) (Neca, 2000).

Diapiric, transtensive and transpressive tectonics associated with uplift of limestone massifs gave rise to peculiar relief and structures, the most outstanding of which are Caldas da Rainha diapir, Serra de Montejunto, Alvados tectonic block and Vale de Todos composite fault structure (Zbyszewski, 1959; Crispim, 1993; Curtis, 1999).

Estremenho massif is the most extensive carbonate aquifer system in Portugal (Almeida et al., 2000) and Alviela spring (Fleury, 1940) is the most important as its flood discharge reaches about 30 m^3/s and it has been exploited as the water supply for Lisbon since the end of the 19th century. Alcabideque spring (Condeixa) has been exploited since Roman times and is associated with Pleistocene tufa deposits.

South Portuguese Palaeozoic marbles *(by P. Henriques and L. Lopes)*

The Estremoz Anticline, located within the Ossa Morena Zone (Estremoz–Barrancos sector), is a NW-SE structure measuring 42 x 8 km in which Cambrian (Carvalho et al., 1971) to (Upper?) Silurian–Devonian (Sarmiento et al., 2000) (although age determination is complicated by the lack of biostratigraphic and geochronological data) marbles with ornamental quality outcrop over 27km^2 (Moreira & Vintém, 1997). It is the main centre for national marble exploitation and has international relevance. A large number of quarries in the area provide unique geological windows that can reach 140 m in depth. The marbles preserve the effects of the Variscan Orogeny and this can be observed in the quarries. Other Palaeozoic marbles also outcrop in the Montemor–Ficalho (Ficalho–Moura, Serpa, Trigaches, Viana-Alvito and Escoural) sector, which are less relevant. In both sectors, the marbles occur in Volcano-Sedimentary Complexes (Estremoz and Ficalho–Moura). Although local variations occur, a similar lithostratigraphic sequence essentially made up of marbles, marble-schist, and intercalations of felsic and basic volcanic rocks is shown (Lopes, 2003).

The high quality, fine- to medium-grained, "Estremoz marbles" show excellent mechanical-physical properties as well as aesthetic beauty, as indicated by the prices they fetch and also by the large volumes of rock quarried, around 370 kt in 2000, and places Portugal at the forefront of world marble production. Colours vary from white to cream, pink, grey or black and streaks with any combination of these colours are possible. The types of pink marble are internationally coveted because of their quality and beauty. Locally, high-quality, white or cream-coloured blocks are also used in statue manufacture.

In recent decades, several exploration studies have been undertaken to evaluate this resource (Reynaud & Vintém, 1994; IGM et al., 2000). Considering the interaction between mining and environment, the application of methodologies that permit the proficient land use planning of this area have been studied, which will lead to an efficient global land management (Falé et al., 2004).

These marbles have been quarried since the Romans through the middle ages. From the 15th Century they were transported by Portuguese explorers to Africa, India and Brazil. They have, since then, been sought after for ornamental purposes and appear inlaid with various polychromatic associations in several national and international monuments, some of which have been classified as World Heritage Sites by UNESCO (Milheiro, 2003). Today the marble industry has leapt forward and these are now exported worldwide.

The Azores Archipelago in the America-Eurasia-Africa triple junction

(by J. Madeira)

The Azores archipelago (a Portuguese Autonomous Region) is located on the triple junction between the American, Eurasian and African plates (Laughton & Whitmarsh, 1974). The intervening plate boundaries are the Mid-Atlantic Rift (MAR), separating the American plate from the Eurasian and African plates, and the Azores-Gibraltar Fault Zone (AGFZ), bounding the latter two plates. In the Azores area, the MAR trends N-S to N20E and is divided by transform faults into seven short segments (Luis et al., 1994). The western AGFZ segment, in the Azores region, is oblique to the spreading direction allowing magmatic intrusion along faults, feeding the volcanism that built the islands (Lourenço et al., 1998). Tectonic and volcanic activities are well displayed in the geomorphology of the islands.

Several active volcanoes, some of which emerge as islands, are responsible for 27 eruptions since early 15th century (Zbyszewski, 1963; Weston, 1963/64, Queiroz et al., 1995, Madeira & Brum da Silveira, 2003).

Earthquakes reaching magnitude 7 that caused >6,000 deaths and well-developed fault scarps represent neotectonic activity (Madeira & Ribeiro, 1990; Madeira & Brum da Silveira, 2003).

Many features in the Azores may be considered candidates to geosite classification. These include volcanic structures (historical eruption centres and products, hydrothermal fields, calderas, maars, hawaiian/strombolian, surtseyan and plinian cones, trachyte domes and coulées, pillow lava outcrops, volcanic caves, prismatic jointed outcrops, pyroclastic deposit exposures), tectonic structures (fault scarps, sag ponds), sedimentary deposits (fossiliferous marine deposits of Miocene to Quaternary age, flood deposits, lahars), and littoral features (e.g. littoral platforms of volcanic or landslide origin — fajãs). As an example, in the island of Santa Maria one site has recently been classified as a Natural Monument; it comprises fossiliferous limestones dating from the Miocene/Pliocene boundary, overlain by pillow lavas, associated with an ancient limestone quarry and lime-kiln (Cachão et al., 2003).

Some offshore sites are also worth mentioning, such as the Lucky Strike and Menez Gwen submarine hydrothermal fields classified as Deep Sea Marine Protected Areas by the Regional Government, and the D. João de Castro submarine volcano that erupted in 1720 and is presently at a depth of 10 m.

Thus, the Azores may be considered a natural laboratory of international relevance with regard to plate tectonics, active volcanism and neotectonics. The archipelago displays varied and abundant geological features of scientific, educational and socio-cultural interest, both on the islands and at sea.

Final considerations

The present attempt to define a framework with international relevance constitutes the first contribution for the systematisation of the geological heritage knowledge in Portugal. The application of the ProGEO methodology has resulted in the creation of fourteen frameworks, established by consensus among the Portuguese geological community. Following are the three key outcomes of this work:

i) At a national level, the most important geosites are identified, indicating where geoconservation efforts should be prioritised through scientific justification;

ii) At a regional level, conditions have been developed to foster dialogue with Spanish colleagues in order to create Iberian frameworks;

iii) At an international level, it is now possible to integrate Portuguese geosites in the global inventories promoted by IUGS, UNESCO, and ProGEO.

To achieve these results, future work should focus on:

i) Identification, characterisation and quantification of geosites representative of each framework;

ii) Proposal of management plans for selected geosites ensuring their conservation.

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References

Almeida, A. Campar, 1997, Dunas de Quiaios, G,ndara e Serra da Boa Viagem: Fundação Calouste Gulbenkian/JNICT, Lisboa, 321 pp.

Almeida, C.A., Mendonça, J.L., Jesus, M.R. and Gomes, A.J., 2000, Sistemas Aquíferos de Portugal Continental: Lisboa, Centro de Geologia da Universidade de Lisboa / Instituto da Água. 661 p.

Andrade, C., and Freitas, M.C., 2004, Stratigraphical evidence of Late Holocene barrier breaching and extreme storms in lagoonal sediments of Ria Formosa, Algarve, Portugal: Marine Geology, v. 210, pp. 339-362.

Alves, T.M., Gawthorpe, R.L., Hunt, D.W., and Monteiro, J.H., 2003, Cenozoic tectono-sedimentary evolution of the western Iberia: Marine Geology, v. 195, pp. 75-108.

André, J. Nunes; Rebelo, F., and Cunha, P. Proença, 2001, Morfologia dunar e movimentação de areias entre a lagoa da Ervedeira e o limite sul da Mata Nacional de Leiria: Territorium, Revista de Geografia Física, Minerva, Coimbra, no 8, pp. 51-68.

Antunes, M.T., and Pais, J., 1992, The Neogene and Quaternary of Algarve, in Atlantic General Events During Neogene, I Cong. RCANS: Ciências da Terra (U.N.L.), no. esp. 2, pp. 57-66.

Antunes, M.T., Bizon, G., Nascimento, A., and Pais, J., 1981, Nouvelles donnés sur la datation des dépôts miocénes de l'Algarve (Portugal), et l'évolution géologique regional: Ciências da Terra (U.N.L.), v. 6, pp. 153-168.

Antunes, M.T., Legoinha, P., Cunha, P. Proença, and Pais, J., 2000, High resolution stratigraphy and Miocene facies correlation in Lisbon and Setúbal Peninsula (Lower Tagus Basin, Portugal): Ciências da Terra (UNL), v. 14, pp. 183-190.

Azerêdo, A.C., 1993, Jurássico Médio do Maciço Calcário Estremenho (Bacia Lusitânica): análise de fácies, micropaleontologia, paleogeografia. Ph.D. Thesis, Dep. Geologia, Faculdade de Ciências da Universidade de Lisboa (Portugal), 366 pp, (unpubl.).

Azerêdo, A.C., Wright, V.P., and Ramalho, M.M., 2002, The Middle-Late Jurassic forced regression and disconformity in central Portugal: eustatic, tectonic and climatic effects on a carbonate ramp system: Sedimentology, v. 49, no. 6, pp. 1339-1370.

Babin, C., Becq-Giraudon, J.F., Lardeux, H. & Gutiérrez-Marco, J.C., 1996, Présence de Trocholites (Cephalopoda, Nautiloidea) dans l'Ordovicien du Massif Armoricain et du Portugal: Bulletin de la Société d'Histoire Naturel de l'Ouest de la France, v. 18, no. 3, pp. 105-112.

Brachert, M.H., Forst, J.J., Pais, P., Legoinha, J.J., and Reijmer, G., 2003, Lowstand carbonates, highstand sandstones?: Sedimentary Geology, v. 155, pp. 1-12.

Bussink, R.W., Kreulen, R., and Jong, A.F.M., 1984, Gas analyses, fluid inclusions and stable isotopes of Panasqueira, W-Sn deposits, Portugal: Bull. Minéral., v. 107, pp. 703-713.

Cabral, J., 1995, Neotectónica em Portugal Continental: Mem. Inst. Geol. e Mineiro, v. 31, 265 pp.

Cachão, M., 1995, Utilização de Nanofósseis calcários em biostratigrafia, paleoceanografia e paleoecologia. Aplicações ao Neogénico do Algarve (Portugal) e do Mediterrâneo Ocidental (ODP 653) e à problemática do Coccolithus pelagicus: Ph.D. dissertation, Fac. Ciências Univ. Lisboa, 356 pp, (unpubl.).

Cachão, M.A.P., and Silva, C.M., 1990, The Pliocene of the Portuguese west margin (Pombal-Marinha Grande sector). Biostratigraphy, paleoecology, sedimentary evolution: IX R.C.M.N.S. Congress, Abstracts, Barcelona, pp. 83-85.

Cachão, M., and Silva, C.M., 2000, The three main marine depositional cycles of the Neogene of Portugal: Ciências da Terra (UNL), v. 14, pp. 303-312.

Cachão, M., Madeira, J., Marques da Silva, C., Azevedo, J.M.N., Cruz, A.P.; Garcia, C., Sousa, F., Melo, J., Aguiar, M., Silva, P., Martins, R., and Ávila, S., 2003, Pedreira do Campo (Santa Maria, Açores): monumento natural: Actas of the VI Congresso Nacional de Geologia, CDRom.

Carvalho, D, Goínhas, J., Oliveira, V., Ribeiro, A., 1971, Observações sobre a geologia do Sul de Portugal e consequências metalogenéticas: Est. Not. Trabalhos, Serv. Fom. Mineiro, v. 20, no. 1/2, pp. 153-199.

Carvalho, D., Barriga, F.J.A.S., and Munhá, J., 1999, The Iberian Pyrite Belt of Portugal and Spain: Examples of bimodal - siliciclastic systems, in Barrie, T. and Hannington, M., eds, Volcanic-Associated Massive Sulfide Deposits: Processes and Examples in Modern and Ancient Settings: Reviews in Economic Geology, v. 8, chapter 16, pp. 375-408.

Couto, H., 1993, As mineralizações de Sb-Au da região Dúrico-Beirã: PhD Thesis, Faculdade de Ciências do Porto, 607 pp, (unpubl.).

Couto, H., and Dias, A.G., 1998, Parque Paleozóico de Valongo, Património Geológico: Câmara Municipal de Valongo, Valongo, 40pp.

Couto, H., and Gutiérrez-Marco, J.C., 1999, Nota sobre algunos Diploporita (Echinodermata) de las pizarras de la Formación Valongo (Ordovícico Medio, Portugal): Temas Geológico-Mineros ITGE, v. 26, pp. 541-545.

Couto, H., and Gutiérrez-Marco, J.C., 2000, Alguns fósseis raros ou pouco conhecidos da Formação de Valongo (Ordovícico Médio, Norte de Portugal). Livro de resumos do I Congresso Ibérico de Paleontologia/XVI Jornadas de la Sociedad Española de Paleontología, pp. 191-192.

Couto, H., Gutiérrez-Marco, J.C., and Roger, G., 1999, Níveis fosfatados com lingulídeos do Arenigiano (Ordovícico) do Anticlinal de Valongo (Portugal): Temas Geológico-Mineros ITGE, v. 26, pp. 546-548.

Couto, H., Lourenço, A., and Poças, C., 2003, Serras de Santa Justa e Pias: Património Geológico e Mineiro a preservar: Ciências da Terra (UNL), no. esp. V, CD-ROM, pp. I28-I31.

Crispim, J.A., 1993, Sobre a estrutura geológica dos poljes da Alvados e de Minde (Estremadura): Algar - Bol. Soc. Portuguesa Espeleologia, no. 4, pp. 13-26.

Cunha, L., 1990, As serras calcárias de Condeixa-Sicó-Alvaiázere. Estudo de Geomorfologia: Coimbra, INIC, 329 p.

Cunha, P. Proença, 1992a, Estratigrafia e sedimentologia dos depósitos do Cretácico Superior e Terciário de Portugal Central, a leste de Coimbra: PhD thesis, Univ. Coimbra, 262 pp.

Cunha, P. Proença, 1992b, Establishment of unconformity-bounded sequences in the cenozoic record of the western Iberian margin and synthesis of the tectonic and sedimentary evolution in central Portugal during Neogene: First Congress R.C.A.N.S. - "Atlantic general events during Neogene", Abstracts, Lisbon, pp. 33-35.

Cunha, P. Proença, 2000a, Paleoalterações e cimentações nos depósitos continentais terciários de Portugal central: importância na interpretação de processos antigos: Ciências da Terra (UNL), v. 14, pp.145-154.

Cunha, P. Proença, 2000b, Tertiary sedimentary architecture, controls and palaeogeographic evolution of central Portugal: 31st International Geological Congress (Abstracts), Rio de Janeiro, Brasil, s.1-5 (A34).

Cunha, P. Proença, and Martins, A.A., 2000, Transição do enchimento terciário para o encaixe fluvial quaternário, na área de Vila Velha de Ródão (sector NE da Bacia do Baixo Tejo): Ciências da Terra (UNL), v. 14, pp. 147-158

Cunha, P. Proença, and Pena dos Reis, R., 1995, Cretaceous sedimentary and tectonic evolution of the northern sector of the Lusitanian Basin: Cretaceous Research, v. 16, pp. 155-170.

Cunha, P. Proença, Barbosa, B.P., and Pena dos Reis, R., 1993, Synthesis of the Piacenzian onshore record, between the Aveiro and Setúbal parallels (Western Portuguese Margin): Ciências da Terra (UNL), v. 12, pp. 35-43.

Cunha, P. Proença, Pinto, J., and Dinis, J.L., 1997, Evolução da fisiografia e ocupação antrópica na área estuarina do Rio Mondego e região envolvente (Portugal centro-oeste), desde 1947: Territorium, Revista de Geografia Física aplicada no ordenamento do território e gestão de riscos naturais, Editora Minerva, Coimbra, 4, pp. 99-124.

Cunha, P. Proença, Martins, A.A., Daveau, S., and Friend, P.F., 2005, Tectonic control of the Tejo river fluvial incision during the late Cenozoic, in Ródão – central Portugal (Atlantic Iberian border): Geomorphology, v. 64, pp. 271-298.

Curtis, M.L., 1999, Structural and kinematic evolution of a Miocene to Recent sinistral restraining bend: the Montejunto massif, Portugal: Jour. Struct. Geol., v. 21, pp. 39-54.

Curtis, M.L.K., 1961, Ordovician Trilobites from the Valongo area, Portugal, Cheiruridae, Pliomeridae and Dionididae: Boletim Sociedade Geológica Portugal, Lisboa, v. 14, no. 1, pp. 1-15.

Dantas, P., Pérez-Moreno, B.P., Chure, D.J., Marques da Silva, C., Santos, V.F., Póvoas, L., Cachão, M., Sanz, J.L., Pires, C., Bruno, G., Ramalheiro, G., and Galopim de Carvalho, A.M., 1999, O dinossáurio carnívoro *Allosaurus fragilis* no Jurássico superior português: Al-Madan, v. 8, pp. 23-28.

Dantas, P., Sanz, J.L., Silva, C.M., Ortega, F., Santos, V.F., and Cachão, M., 1998b, *Lourinhasaurus* n. gen. Novo dinossáurio saurópode do Jurássico Superior (Kimeridgiano Superior – Titoniano Inferior) de Portugal: V Cong. Nac. Geol., Lisboa, 84, pp. A91-A94.

Dawson, A.G., Hindson, R., Andrade, C., Freitas, C., Parish, R., and Bateman, M., 1995, Tsunami sedimentation associated with the Lisbon earthquake of November 1st 1755 AD: Boca do Rio, Algarve, Portugal: The Holocene, v. 5, no 2, pp. 209-215.

Delgado, J.F.N., 1892, Fauna Silúrica de Portugal. Descrição de uma forma nova de Trilobite, Lichas (Uralichas) ribeiroi: Comissão dos Trabalhos Geológicos de Portugal, pp. 1-31.

Delgado, J.F.N., 1908, Système Silurique du Portugal. Étude de Stratigraphie Paléontologique: Commission du Service Geológique du Portugal, pp. 1-245.

Derré, C., Lécolle, M., Noronha, F., and Roger, G.,1982, Minéralisations a Sn-W liées aux granitoides du nord du Portugal: importance des processus magmatiques et métasomatiques hydrothermaux: Comun. Serv. Geol. Portug., v. 68, pp. 191-211.

Duarte, L.V., 1995, O Toarciano da Bacia Lusitaniana. Estratigrafia e evolução sedimentogénica. Ph.D. Thesis, Faculdade de Ciências e Tecnologia da Universidade de Coimbra, 349 pp, (unpubl.).

Duarte, L.V., 2004, The geological heritage of the Lower Jurassic of central Portugal: selected sites, inventory and main scientific arguments: Riv. Italiana di Paleontologia e Stratigrafia, v. 100, no. 1, pp. 381-388.

Elmi, S., Mouterde, R., Rocha, R. B., and Duarte, L.V., 1996, La limite Pliensbachien-Toarcien au Portugal: intérêt de la coupe de Peniche: Aalenews, v. 6, pp. 33-35.

Falé, P., Henriques, P., Midıes, C., Carvalho, C., Sobreiro, S., 2004, GIS: A Tool to Re-Planning Extractive Industry - The Estremoz Anticline case study, *in* Pikryl, R. ed, Dimension Stone 2004 - New perspectives for a traditional building material: Proceedings of the International Conference on Dimension Stone 2004, Prague, Czech Republic, pp. 127-131.

Feio, M., 1951, A evolução do relevo do Baixo Alentejo Algarve: Com. Serv. Geol. Port., v. 32, no. 2, pp. 303-481.

Ferreira, N., Iglesias, M., Noronha, F., Pereira, E., Ribeiro, A., and Ribeiro, M.L., 1987, Granitóides da Zona Centro Ibérica e seu enquadramento geodin,mico, *in* Bea, et al., eds, Geologia de los Granitóides y Rocas asociadas del Macizo Hespérico: Madrid, Editorial Rueda, pp. 37-51.

Ferreira, O.V., 1982, Cavernas com interesse cultural encontradas em Portugal: Com. Serv. Geol. Port., v. 68, no. 2, pp. 285-298.

Fleury, E., 1940, Les eaux du groupe de l'Alviela ou des grandes résurgences des calcaires jurassiques des Olhos de Água, d'Ota et d'Alenquer, in Relatório sobre o Tratamento das Águas de Lisboa, Anexo IV: Lisboa, M.O.P.C., pp. 129-191.

Fredén, C., Karis, L., Lundqvist, S., Ransed, G., Suominen, V., and Johansson, C.E., 2004, GEOSITES in practice - trans-national comparison and correlation, in Parkes M.A., ed, Natural and Cultural Landscapes - The Geological Foundation: Dublin, Royal Irish Academy, pp. 113-116.

Freitas, M.C., Andrade, C., and Cruces, A., 2002, The geological record of environmental changes in southwestern Portuguese coastal lagoons since the Lateglacial: Quaternary International, v. 93-94 (C), pp. 161-170.

Freitas, M.C., Andrade, C., Rocha, F., Tassinari, C., Munhá, J.M., Cruces, A., Vidinha, J., and Silva, C.M., 2003, Lateglacial and Holocene environmental changes in Portuguese coastal lagoons: 1 - the sedimentological and geochemical records of the Santo André coastal area (SW Portugal): The Holocene, v. 13, no 3, pp. 433-446.

Galton, P.M., 1991, Postcranial remains of stegosaurian dinosaur Dacentrurus from the Upper Jurassic of France and Portugal: Geologica et Palaeontologica, v. 25, pp. 299-327.

Galton, P.M., 1994, Notes on Dinosauria and Pterodactylia from the Cretaceous of Portugal: N. Jb. Geol. Palaont. Abh, v. 194, no. 2/3, pp. 253-267.

Garcia-Cortés, A., Rábano, I., Locutura, J., Bellido, F., Fernández-Gianotti, J., Martín-Serrano, A., Quesada, C., Barnolas, A., and Durán, J.J., 2001, First spanish contribution to the Geosites Project: list of the geological frameworks established by consensus: Episodes, v. 24, no. 2, pp. 79-92.

González-Delgado, J.A., Andrés, I., and Sierro, F., 1995, Late Neogene molluscan faunas from the Northeast Atlantic (Portugal, Spain, Marocco): Geobios, v. 28, no. 4, pp. 459-471.

Granja, H.M., 1999, Late Pleistocene and Holocene sea-level, neotectonic and climatic indicators in the northwest coastal zone of Portugal: Geologie en Mijnbouw, v. 77, no 3-4, pp. 233-245.

Groot, T., and Granja, H., 1998, Coastal environments, sea-level and neotectonism from cored boreholes (Northwest Portugal): preliminary results: Journal of Coastal Research, v. 26, pp.115-124.
Gutiérrez-Marco, J.C., and Meléndez, B., 1987, Nuevos hallazgos de Estilóforos (Homalozoos) en los materiales ordovÌcicos de la Zona Centroibérica: Coloquios de Paleontología, v. 41, pp. 41-50.
Gutiérrez-Marco, J.C., Lenz, A.C., Robardet, M., and Piçarra, J.M., 1996, Wenlock-Ludlow graptolite biostratigraphy and extinction: a reassessment from the southwestern Iberian Peninsula (Spain and Portugal): Canadian Journal of Earth Sciences, v. 33, pp. 656-663.
Gutiérrez-Marco, J.C., Rábano, I., Couto, H., and Piçarra, J.M., 2000, Plumulítidos (Machaeridia) de la Formación Valongo (Ordovícico Medio, Portugal): Livro de resumos do I Congresso Ibérico de Paleontologia/XVI Jornadas de la Sociedad Española de Paleontología, pp. 193-194.
Helmdach, F.F., 1971, Stratigraphy and ostracod fauna from the coalmine Guimarota (Upper Jurassic). Contribuição para o conhecimento da fauna do Kimeridgiano da mina de Lignito Guimarota (Leiria, Portugal) — II parte: Mem. Serviços Geológicos de Portugal (N.S.), v. 17, pp. 41-88.
Helmdach, F.F., 1973-74, A contribution to the stratigraphical subdivision of nonmarine sediments of the Portuguese Upper Jurassic. Com. Serviços Geológicos de Portugal, v. 57, pp. 5-21.
Henriques, M.H., 2004, Jurassic Heritage of Portugal – State of the art and open problems: Riv. Italiana di Paleontologia e Stratigrafia, v. 100, no. 1, pp. 389-392.
Henriques, M.H., Gardin, S., Gomes, C.R., Soares, A.F., Rocha, R.B., Marques, J.F., Lapa, M.R., and Montenegro, J.D., 1994, The Aalenian-Bajocian boundary at Cabo Mondego (Portugal): Miscellanea, Serv. Geol. Naz., v. V, pp. 63-77.
IGM, IST, and UE, 2000, Estudo da viabilidade técnica da exploração subterrânea de mármores no Anticlinal de Estremoz. Projecto 02 / 01476: Relatório Síntese. Instituto Geológico e Mineiro, Instituto Superior Técnico & Universidade de Évora.
Kelly, W.C., and Rye, R.O., 1979, Geologic, fluid inclusions and stable isotope studies of the tin-tungsten deposits of Panasqueira, Portugal: Econ. Geol., v. 74, pp. 1721-1822.
Krebs, B., 1991, Das skelett von *Henkelotherium guimarotae* gen. et sp.nov. (Eupanthotheria, Mammalia) aus dem Oberen Jura von Portugal: Berliner geowiss. Abh. (A), v. 133, pp. 1-121.
Krusat, G., 1980, *Haldanodon exspectatus* Kühne & Krusat, 1972 (Mammalia, Docodonta). Contribuição para o conhecimento da fauna do Kimeridgiano da mina de Lignito Guimarota (Leiria, Portugal) ñ IV parte: Mem. Serviços Geológicos de Portugal (N.S.), v. 27, pp. 1-79.
Kühne, W.G., 1968, History of the discovery, report on the work performed, procedure, technique and generalities. Contribuição para o conhecimento da fauna do Kimeridgiano da mina de Lignito Guimarota (Leiria, Portugal) — I parte: Mem. Serviços Geológicos de Portugal (N.S.), v. 14, pp. 7-20.
Lapparent, A.F., and Zbyszeswi, G., 1957, Les Dinosauriens du Portugal: Mem. Serv. Geol. Portugal (N.S.), v. 2, pp. 1–63.
Lapparent, A.F., and Zbyszewski, G., 1951, Découvert d'une riche faune de Reptiles Dinosauriens dans le Jurassique Supérieur du Portugal: C. R. Acad. Sci. Paris, v. 233, pp. 1125.
Laughton, A.S., and Whitmarsh, R.B., 1974, The Azores-Gibraltar plate boundary, in Kristjansson, L., ed, Geodynamics of Iceland and the North Atlantic Area: D. Reidel Publ. Co., Dordrecht, pp. 63-81.
Legoinha, P., 2001, Biostratigrafia de foraminíferos do Miocénico de Portugal (Baixo Tejo e Algarve): PhD thesis, Univ. Nova de Lisboa, 239 pp (unpubl.).
Leinfelder, R.R., and Wilson, R.C.L., 1998, Third-order sequences in an Upper Jurassic rift-related second-order sequence, Central Lusitanian Basin, Portugal, in P.-C. De Graciansky, J. Hardenbol, Th. Jacquin and P.R. Vail, eds, Mesozoic and Cenozoic Sequence Stratigraphy of European Basins: SEPM Spec. Publ., v. 60, pp. 507-525.
Lockley, M.G., Meyer, C.A., and Santos, V.F., 1994, Trackway evidence for a herd of juvenile sauropods from the Late Jurassic of Portugal: GAIA, v. 10, pp. 27-35.
Lopes, J.L., 2003, Contribuição para o conhecimento Tectono — Estratigráfico do Nordeste Alentejano, transversal Terena — Elvas. Implicações económicas no aproveitamento de rochas ornamentais existentes na região (Mármores e Granitos): PhD Thesis, Universidade de Évora, 568 p., (unpubl.).
Lourenço, N., Miranda, J.M., Luis, J.F., Ribeiro, A., Mendes-Victor, L.A., Madeira, J., and Needham, H.D., 1998, Morpho-tectonic analysis of the Azores Volcanic Plateau from a new bathymetric compilation of the area: Marine Geophysical Researches, no. 20, pp. 141-156.
Luis, J.F., Miranda, J.M., Galdeano, A., Patriat, P., Rossignol, J.C., and Mendes Victor, L.A., 1994, The Azores triple junction evolution since 10 Ma from an aeromagnetic survey of the Mid-Atlantic Ridge: Earth and Planet. Sci. Lett., no. 125, pp. 439-459.
Madeira, J., and Brum da Silveira, A., 2003, Active tectonics and first paleoseismological results in Faial, Pico and S. Jorge islands (Azores, Portugal), in Pantosti, D., Berryman, K., Yeats, R.S. and Kinugasa, Y., eds, Ten Years of Paleoseismology in the ILP: Progress and prospects, Annals of Geophysics, no. 46(5), pp. 733-761.
Madeira, J., and Ribeiro, A., 1990, Geodynamic models for the Azores triple junction: a contribution from tectonics: Tectonophysics, no. 184 (3/4), pp. 405-415.
Manuppella, G., Antunes, M.T., Pais, J., Ramalho, M.M., and Rey, J., 1999, Notícia explicativa 30-A (Lourinhã): Inst. Geol. Mineiro, Lisboa, 83 pp.
Martin, T., and Krebs, B., 2000, Guimarota, a Jurassic Ecosystem: Verlag Dr. Friedrich Pfeil, M¸nchen, 155 pp.
Martins, A.F., 1949, Maciço Calcário Estremenho. Contribuição para um estudo de Geografia Física: Coimbra, 248 p.
Martins, L.M., 1991, Actividade Ígnea mesozóica em Portugal (contribuição petrológica e geoquímica): PhD thesis, Fac. Ciencias Univ. Lisboa, 418 pp. (unpubl.).
Martín-Serrano, A., 1988, El relieve de la región occidental zamorana. La evolución geomorfológica de un borde del Macizo Hespérico: Zamora, Ed. Instituto de Estudios Zamoranos Florian de Ocampo, 311 pp.
Mateus, O., Taquet, P.; Antunes, M.T. & Ribeiro, V., 1998, Theropod dinosaur nest from Lourinhã, Portugal. Journ. Vert. Paleontology, 18: 61.
Milheiro, N., 2003, O Mármore como Património Cultural: V Congresso Internacional da Pedra Natural, Vila Viçosa.
Mohr, B., 1989, New palynological information on the age and environment of Late Jurassic and Early Cretaceous vertebrate localities of the Iberian Peninsula (eastern Spain and Portugal): Berliner geowiss. Abh. (A), v. 106, pp. 291-301.
Moreira, J., and Vintém, C. (Coord), 1997, Carta Geológica do Anticlinal de Estremoz, escala 1:25.000: Dept. Prospecção de Rochas e Minerais Não Metálicos, Instituto Geológico e Mineiro, Lisboa.
Natividade, M.V., 1901, Grutas de Alcobaça. Materiaes para o estudo do homem: Portugalia, v. 1, no. 3, pp. 433-474.
NECA, 2000, Riquezas Subterrâneas da Arrábida: Sesimbra, 50 p.
Neiva, J.M.Cotelo, 1944, Jazigos portugueses de cassiterite e de volframite: Comun. Serv. Geol. Portugal, v. 25, 251pp.
Noronha, F., Vindel, E., Lopez J.A., Dória, A., Garcia, E., Boiron, M.C., and Cathelineau, M., 1999, Fluids related to tungsten ore deposits in Northern Portugal and Spanish Central System: a comparative study: Rev. Soc. Geol. España, v. 12, no. 3-4, pp. 397-403.
Pavia, G., and Enay, R., 1997, Definition of the Aalenian-Bajocian stage boundary: Episodes, v. 20, pp. 16-22.
Pena dos Reis, R., Cunha, P. Proença, Barbosa, B.P., Antunes, M.T., and Pais, J., 1992, Mainly continental Miocene and Pliocene deposits from Lower Tagus and Mondego Tertiary basins: Ciências da Terra (UNL), No. especial II, pp. 37-56.
Pereira, A.R., 1989, Aspectos do relevo de Portugal. Litorais ocidental e meridional da Península de Setúbal: Finisterra, v. 23, no. 46, pp. 335-349.
Pérez-Moreno, B.P., Chure, D.J., Pires, C., Marques da Silva, C., Santos, V., Dantas, P., Póvoas, L., Cachão, M., Sanz, J.L., and Galopim de Carvalho, A.M., 1999, On the presence of *Allosaurus fragilis* (Theropoda: Carnosauria) in the Upper Jurassic of Portugal: first evidence of an intercontinental dinosaur species: Journal Geological Society, London, v. 156, pp. 449 - 452.
Piçarra, J.M., 1998, First Devonian graptolites from Portugal: Temas Geológico-Mineros, v. 23, pp. 242-243.
Piçarra, J.M., 2000, Estudo estratigráfico do sector de Estremoz-Barrancos, Zona de Ossa Morena, Portugal: Tese de doutoramento, Universidade de Évora, 268 pp (unpublished).
Piçarra, J.M., Gutiérrez-Marco, J.C., Lenz, A.C., and Robardet, M., 1998, Pridoli graptolites from the Iberian Peninsula: a review of previous data and new records: Canadian Journal of Earth Sciences, v. 35, pp. 65-75.
Piçarra, J.M., Storch, P., Gutiérrez-Marco, J.C., and Oliveira, J.T., 1995, Characterization of the Parakidograptus acuminatus graptolite Biozone in the Silurian of the Barrancos region (Ossa Morena Zone, South Portugal): Comunicações do Instituto Geológico e Mineiro, v. 81, pp. 3-8.
Polya, D., 1989, Chemistry of the main-stage ore-forming fluids of the Panasqueira W-Cu(Ag)-Sn Deposit, Portugal: Implications for models of ore genesis: Econ. Geol., v. 84, pp. 1134-1152.
ProGEO (Wimbledon et al.), 1998, A first attempt at a geosites framework for europe - an IUGS initiative to support recognition of world heritage and european geodiversity: Geologica Balcanica, v. 28, no. 3-4, pp. 5-32.

Queiroz, G., Gaspar, J.L., Cole, P.D., Guest, J.E., Wallenstein, N., Duncan, A.M., and Pacheco, J., 1995, Erupções vulcânicas no vale das Furnas (ilha de S. Miguel, Açores) na primeira metade do século XV: Açoreana, no. 8(1), pp. 159-165.
Ramalho, M.M., 1971, Contribution à l'étude micropaléontologique et stratigraphique du Jurassique supérieur et du Crétacé inférieur des environs de Lisbonne (Portugal): Mem. Serv. Geol. Portugal, v. 19, 212 pp.
Rauhut, O., 2000, The dinosaur fauna from the Guimarota mine, in Thomas Martin & Bernard Krebs, eds, Guimarota, a Jurassic Ecosystem, Verlag Dr. Friedrich Pfeil, München, pp. 11-82.
Relvas, J.M.R.S., Barriga, F.J.A.S., Pinto, A.M.M., Ferreira, A., Pacheco, N., Noiva, P., Barriga, G., Baptista, R., Carvalho, D., Oliveira, V., Munhá, J., and Hutchinson, R.W., 2002, The Neves Corvo deposit, Iberian Pyrite Belt, Portugal: impacts and future, 25 years after the discovery: SEG Special Publication, v. 9, pp. 155-176.
Reynaud, R., and Vintém, C., 1994, Estudo da jazida de calcários cristalinos de Estremoz - Borba - Vila Viçosa (Sectores de Lagoa-Vigária e Borba): Boletim de Minas, v. 131, no. 4, pp. 355-473.
Ribeiro, A., Kullberg, M.C., Kullberg, J.C., Manuppella, G., and Phipps, S., 1990, A review of Alpine tectonics in Portugal: foreland detachment in basement and cover rocks: Tectonophysics, v. 184, pp. 357-366.
Ribeiro, A., Quesada, C., and Dallmeyer, R.D., 1991, Geodynamic evolution of the Iberian Massif, in Dallmeyer, R. and Martinez García, E., eds, Pre-Mesozoic Geology of Iberia: Berlin, Springer, pp. 399-410.
Rigby, J.K., Gutiérrez-Marco, J.C., Robardet, M., and Piçarra, J.M., 1997, First articulated Silurian sponges from the Iberian Peninsula (Spain and Portugal): Journal of Paleontology, v. 71, no. 4, pp. 554-563.
Robardet, M., Piçarra, J.M., Storch, P., Gutiérrez-Marco, J.C., and Sarmiento, G.N., 1998, Ordovician and Silurian stratigraphy and faunas (graptolites and conodonts) in the Ossa Morena Zone of the SW Iberian Peninsula (Portugal and Spain): Temas Geológico-Mineros, v. 23, pp. 289-318.
Rocha, R.B., 1976, Estudo estratigráfico e paleontológico do Jurássico do Algarve Ocidental, PhD thesis, Univ. Nova Lisboa, 178 pp.
Rock, N., 1979, Petrology and origin of the Monchiquites and associated lamprophyre dykes of Serra de Monchique, Portugal: Trans. Royal Soc. Edinburgh, v. 70, pp. 149-170.
Rock, N., 1982a, The Late Cretaceous alkaline igneous province in the Iberian Peninsule and its tectonic significance: Lithos, v. 15, pp. 111-131.
Rock, N., 1982b, Chemical mineralogy of the Monchique alkaline complex, Southern Portugal: Cont. Mineral. Petrol., v. 81, pp. 1-15.
Rodrigues, M.L., 1991, Depósitos e evolução quaternária das vertentes nas depressões de Minde e de Alvados, Maciço Calcário Estremenho, Portugal: Finisterra, v. 26, no. 51, pp. 5-26.
Romano, M., 1980, The trilobite Eccoptochile from Ordovician of Northern Portugal: Palaeontology, v. 23, pp. 605-616.
Romano, M., 1982, A revision of the Portuguese Ordovician Odontopleuridae (Trilobita): Selenopeltis and Primaspis: Comunicações dos Serviços Geológicos de Portugal, v. 68, no. 2, pp. 213-223.
Romano, M., and Henry, J. L., 1982, The trilobite genus Eoharpes from the Ordovician of Brittany and Portugal: Palaeontology, v. 25, no. 3, pp. 623-633.
Santos, A., 2000, Bivalves marinhos do Miocénico superior (Tortoniano superior) de Cacela (Algarve, Portugal): Msc. Dissertation, Univ. Algarve, 207 pp. (unpubl.).
Santos, V.F., 2003, Pistas de dinossáurio no Jurássico-Cretácico de Portugal. Considerações paleobiológicas e paleoecológicas: PhD thesis, Fac. Sciences Univ. Autonoma Madrid, 365 pp. (unpubl.).
Santos, V.F., Lockley, M.G., Moratalla, J.J., and Galopim de Carvalho, A.M., 1992, The longest dinosaur trackway in the world? Interpretations of Cretaceous footprints from Carenque, near Lisbon, Portugal: GAIA, v. 5, pp. 18-27.
Sanz, J.L., 2000, Dinosaurios, los señores del pasado. Martinez Roca, Barcelona, pp. 272-276.
Sarmiento, G., Piçarra, J., and Oliveira, J., 2000, Conodontes do Silúrico (superior?) - Devónico nos "Mármores de Estremoz". Sector de Estremoz - Barrancos (Zona de Ossa - Morena, Portugal): I Congresso Ibérico de Paleontologia / XVI Jornadas de la Sociedad española de Paleontologia. VI International Meeting of IGCP, Resumos, v. 421, pp. 284-285.
Satkunas, J., Mikulenas, V., Lazauskiene, J., Raudsep, R., Taht, K., Markots, A., and Lacis, A., 2004, Towards a Geosites framework in Northern Europe - a first attempt in the Baltic States, in Parkes M.A., ed, Natural and Cultural Landscapes - The Geological Foundation: Dublin, Royal Irish Academy, pp. 117-120.
Sauvage, H.E., 1897-98, Vertébrés fossils du Portugal. Contributions à l'étude des Poissons et des Reptiles du Jurassique et du Crétacique: Direct. Trav. Géol. Portugal, v. 29, pp. 1-58.
Schermerhorn, L.J.C., 1981, Framework and evolution of hercynian mineralization in the Iberian meseta: Leidse Geol. Med., v. 52, no.1, pp. 23-56.
Soares, A.F., Rocha, R.B., Elmi, S., Henriques, M.H., Mouterde, R., Almeras, Y., Ruget, C., Marques, J., Duarte, L.V., Carapito, C., and Kullberg, J.C., 1993, Le sous-bassin nord-lusitanien (Portugal) du Trias au Jurassique moyen: histoire díun "rift avorté": C. R. Acad. Sci. Paris, v. 317, pp. 1659-1666.
Teixeira, C. and Berthois, L., 1952, Les sables et les galets de Casais de Santa Teresa: Bol. Soc. Geol. Port., v. 10, pp. 13-22.
Terrinha, P., 1998, Structural geology and tectonic evolution of the Algarve Basin, South Portugal: PhD Thesis, University of London, 425 pp. (unpubl.).
Thadeu, D., 1973, Les gisements stanno wolframitiques du Portugal: Ann. Soc. Géol. Belg., v. 79, no. 1, pp. 5-30.
Theodossiou-Drandaki et al., 2004, IUGS Geosites project progress - a first attempt at a common framework list for South Eastern European Countries, in Parkes M.A., ed, Natural and Cultural Landscapes - The Geological Foundation: Dublin, Royal Irish Academy, pp. 81-90.
Thulborn, R.A., 1973, Teeth of ornithischian dinosaurs from the Upper Jurassic of Portugal. Contribuição para o conhecimento da fauna do Kimeridgiano da mina de Lignito Guimarota (Leiria, Portugal) — III parte: Mem. Serviços Geológicos de Portugal (N.S.), v. 22, pp. 89-134.
Tornos, F., Casquet, C., Relvas, J.M.R.S., Barriga, F.J.A.S., Sáez, R., 2002, Transpressional tectonics and ore deposit formation: metallogenesis of SW Iberia, in Blundell, D., Neubauer, F., and von Quadt, A., eds, The timing and location of major ore deposits in an evolving orogen: London, Geological Society, Special Publications, v. 206, pp. 179-198.
Weigert, A., 1995, Isoliert zähne con cf. *Archaeopterix* sp. aus dem Oberen Jura der Kohlengrube Guimarota (Portugal): Neues Jahrbuch Geol. Pälaeont., v. 9, pp. 562-576.
Werner, W., 1986, Palökologische und biofazielle analyse des Kimmeridge (Oberjura) von Consolação, Mittelportugal: Zitteliana, v. 13, pp. 1-109.
Weston, F.S., 1963/64, List of recorded volcanic eruptions in the Azores with brief reports: Bol. Mus. Lab. Min. Geol. Fac. Ciências de Lisboa, no. 10(1), pp. 3-18.
Wilson, R.C., Hiscott, R.N., Willis, M.G., and Gradstein, F.M., 1989, The Lusitanian Basin of West – Central Portugal: Mesozoic and Tertiary Tectonic, Stratigraphic and Subsidence History, in A. Tankard & H. Balkwill eds, Extensional tectonics and Stratigraphy of the North Atlantic margins, AAPG Memoirs, v. 46, pp. 341-361.
Wimbledon, W.A.P., 1996a, Geosites - A new conservation initiative: Episodes, v. 19, no. 3, pp. 87-88.
Wimbledon, W.A.P., 1996b, National site selection, a stop on the road to a European Geosite List: Geologica Balcanica, v. 26, no. 1, pp. 15-27.
Wimbledon, W.A.P., Andersen, S., Cleal, C.J., Cowie, J.W., Erikstad, L., Gonggrijp, G.P., Johansson, C.E., Karis, L.O., and Suominen, V., 1999, Geological World Heritage: GEOSITES - a global comparative site inventory to enable prioritisation for conservation: Memorie Descrittive della Carta Geologica d'Italia, v. LIV, pp. 45-60.
Zbyszewski, G., 1959, Étude structurale de l'aire typhonique de Caldas da Rainha: Mém. Serv. Geol. Port., no. 3, 182 p.
Zbyszewski, G., 1963, Les phénomènes volcaniques modernes dans l'archipel des Açores: Com. Serv. Geol. Portugal, no. 47, 227 pp.
Zilhão, J., 1987, A Gruta do Caldeirão (Pedreira, Tomar). Balanço de sete anos de escavações arqueológicas (1979-1985): Algar - Bol. Soc. Portuguesa Espeleologia, no. 1, pp. 3-8.