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Palynostratigraphy and systematic palynology of the Devonian and Carboniferous successions of the South Portuguese Zone, PORTUGAL

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PART 2
SYSTEMATIC PALYNOLOGY

Palynostratigraphy and systematic palynology of the Devonian and Carboniferous successions, South Portuguese Zone, PORTUGAL

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Keywords: Devonian, Carboniferous, Palynostratigraphy, South Portuguese Zone

Abstract

This work presents a synthesis of the palynological research undertaken by the authors in the last fifteen years, of the Devonian and Carboniferous successions of the main domains of the South Portuguese Zone (SPZ): Pulo do Lobo, Iberian Pyrite Belt, Baixo Alentejo Flysch Group and the Southwest Portugal Domain.

The Pulo do Lobo Domain, an antiformal structure located in the northern part of the South Portuguese Zone, comprehends in its core the Pulo do Lobo Formation, whose age remains unknown. The north limb of the antiform is occupied by the Ferreira-Ficalho Group which includes from base to top the Ribeira de Limas Fm, the Santa Iria and the Horta da Torre Fms. In the south limb of the antiformal structure is exposed the Chança Group, which comprises from base to top, the Atalaia Fm, the Gafo Fm and the Represa Fm.

The Iberian Pyrite Belt (IPB) stratigraphic succession consists of two major units, the Phyllite Quartzite Group (PQG) and the Volcano Sedimentary Complex (VSC). Iberian Pyrite Belt selected successions, as for the case of Chaparral, Albernôa, Serra Branca, Azenhas sections (Guadiana River) and São Domingos mine of the North Branch and Pomarão, Neves Corvo, Aljustrel and Caveira massive sulphide mines, São Francisco da Serra and Cercal Anticlines of the South Branch, are studied in great detail, and palynological new results are presented.

The Baixo Alentejo Flysch Group (BAFG) comprehends, from bottom to the top the Mértola, Mira and Brejeira Fms.

The Southwest Portugal Domain comprises the Tercenas Formation conformably overlaid by the Carrapateira Group that includes from base to top, the Bordalete, Murração and Quebradas Fms.

Twenty-three miospore biozones, ranging from lower Givetian to upper Moscovian, are recognised in the SPZ and compared with the standard Western European Miospore Zonation. All the localities and boreholes that allow erecting the miospore zonal scheme are presented, together with the description of the diagnostic elements of each biozone.

The following main conclusions are obtained for the SPZ basin:

-Lower Givetian miospores assemblages were recovered from the PQG in the Caveira and São Francisco da Serra Anticlines.

-Lower Frasnian miospore assemblages were obtained from the PQG in Valverde del Camino Anticline, SW Spain, and appear as reworked assemblages at the top of this same group. These Frasnian assemblages are also comparable to those found in the Ribeira de Limas and Gafo Fms. of the Pulo do Lobo Antiform.

- Upper Famennian assemblages in SPZ have a consistent presence of the miospore species *Ancyrospora* sp., *Cristicavatispora dispersa*, *Rugospora explicata* and *Teichertospora iberica*. These assemblages were re-

covered from the PQG and the VSC (IPB) and from the upper units of the Pulo do Lobo Antiform (Horta da Torre, Santa Iria and Represa Fms.

- Analogous upper Strunian miospore assemblages were determined from the IPB: the upper part of the PQG, in the VSC in Spain and also from the Tercenas Formation in Southwest Portugal (Bordeira and Aljezur Anticlines).

- Similarities in Upper Devonian miospore assemblages, strongly suggest that the Pulo do Lobo basin, the IPB basin and Southwest Portugal shallow siliciclastic basin were part of the same palaeogeographic realm during late Devonian times.

- Records of Tournaisian palynomorphs from the Bordalete Formation in Southwest Portugal and reworked Tournaisian associations in the VSC of the IPB show the presence of the same taxa.

- The VSC yield miospores of upper Famennian to mid/upper Viséan age. Mid/upper Viséan assemblages appear to be very consistent along the SPZ as the same assemblages are recorded from the BAFG. Upper Viséan to upper Moscovian miospore assemblages were determided from the turbidite of The BAFG.

The detail achieved now by the palynological investigations of the SPZ makes this technique to be the best tool to date the lithostratigraphic units allowing, therefore, reliable stratigraphic correlations across the basin and giving support to structural, palaeographic and geodynamic interpretations. Data obtained near massive sulphides deposits are considered very useful for the exploration companies activity.

A complete taxonomic description of the miospore and acritarchs taxa encountered is provided, in which 134 miospore taxa and 41 acritarchs taxa are described and illustrated in 17 plates.

Palavras-Chave: Devónico, Carbónico, Palinoestratigrafia, Zona Sul Portuguesa

Resumo

Este trabalho apresenta uma síntese das investigações palinológicas realizadas pelos autores, nos últimos quinze anos, nas sucessões do Devónico e Carbónico presentes nos principais domínios da Zona Sul Portuguesa (ZSP): Antiforma do Pulo do Lobo, Faixa Piritosa Ibérica, Grupo do Flysch do Baixo Alentejo e Domínio Sudoeste de Portugal.

O Domínio do Pulo do Lobo constitui uma estrutura antiformal localizada na parte norte da ZSP, sendo constituída: pela Formação do Pulo do Lobo, aflorante no núcleo da antiforma, cuja idade permanece desconhecida; no flanco norte da antiforma localiza-se o Grupo de Ferreira-Ficalho que inclui as seguintes unidades da base para o topo: Formação Ribeira de Limas, Formação Santa Iria e Formação Horta da Torre; no flanco sul da estrutura antiformal situa-se o Grupo do Chança constituído pelas seguintes unidades, da base para o topo, Formação Atalaia, Formação Gafo e Formação Represa.

A sucessão estratigráfica da Faixa Piritosa Ibérica (FPI) inclui duas unidades principais, o Grupo Filito-Quartzítico (GFQ) na base da sucessão, e o Complexo Vulcano-Sedimentar (CVS) no topo. Sequências estratigráficas da FPI, como as presentes em Chaparral, Albernôa, Serra Branca, Azenhas (Rio Guadiana), mina de São Domingos, pertencentes ao Ramo Norte da FPI e as do Pomarão e minas de Neves Corvo, Aljustrel e Caveira, pertencentes ao Ramo Sul, foram estudadas com grande detalhe, apresentando-se novos resultados palinológicos.

O Grupo do Flysch do Baixo Alentejo (GFBA) é constituído pelas seguintes unidades, da base para o topo, Formação Mértola, Formação Mira e Formação Brejeira.

O Domínio Sudoeste de Portugal compreende a Formação de Tercenas sobreposta em conformidade estratigráfica pelo Grupo da Carrapateira, que consiste, da base para o topo nas Formações Bordalete, Murração e Quebradas.

Vinte e três biozonas de miosporos, repartidas no tempo entre o Givetiano inferior e o Moscoviano superior, são reconhecidas na Zona Sul Portuguesa e comparadas com o esquema de Zonação dos Miosporos da Europa Ocidental. Todas as localidades e sondagens que permitiram estabelecer o esquema de biozonação são apresentadas, em conjunto com a descrição dos elementos diagnósticos de cada biozona.

As seguintes conclusões foram obtidas para a ZSP:

- As associações de miosporos mais antigas pertencentes ao Givetiano inferior, foram encontradas no GFQ presente nos anticlinais da mina da Caveira e de São Francisco da Serra.

- Associações de miosporos do Frasniano inferior foram obtidas em litologias do GFQ na região do anticlinal de Valverde del Camino, no sector espanhol da FPI, ocorrendo, também, como associações de miosporos remobilizados nas camadas de topo do mesmo Grupo. Estas associações do Frasniano são comparáveis às encontradas nas formações Ribeira de Limas e Gafo pertencentes à Antiforma do Pulo do Lobo.

- As associações de miosporos do Fameniano superior da ZSP apresentam consistentemente as espécies *Ancyrospora* sp., *Cristicavatispora dispersa*, *Rugospora explicata* and *Teichertospora iberica*. Estas associações foram encontradas em litologias do GFQ e do CVS da FPI e nas unidades superiores da Antiforma do Pulo do Lobo, nomeadamente nas formações Horta da Torre, Santa Iria e Represa.

- As mesmas associações de miosporos do Estruniano superior foram identificadas na FPI, nomeadamente: na parte superior do GFQ, no CVS em Espanha e, também, na Formação de Tercenas do Domínio Sudoeste de Portugal (Anticlinais de Aljezur e da Bordeira).

- Semelhanças nas associações de miosporos do Devónico Superior da ZSP sugerem que a bacia do Pulo do Lobo, a bacia da FPI e a bacia siliciclástica de águas pouco profundas do Domínio Sudoeste de Portugal, pertenciam ao mesmo domínio paleogeográfico durante o Devónico Superior.

- Os palinomorfos do Tournaisiano na Formação Bordalete do Domínio Sudoeste de Portugal e associações de miosporos remobilizadas da mesma idade encontradas no CVS da FPI mostram a presença dos mesmos taxa. Associações de miosporos com idade compreendida entre o Viseano superior e o Moscoviano superior foram identificados no GFBA.

- O CVS da FPI forneceu miosporos cujas idades estão compreendidas entre o Fameniano superior e o Viseano médio/superior. As associações do Viseano médio/superior são muito consistentes para toda a ZSP, tendo as mesmas associações sido identificadas no GFBA.

O detalhe obtido até ao presente momento pelas investigações palinológicas na Zona Sul Portuguesa, mostra que estas são a melhor ferramenta para datar as unidades litoestratigráficas permitindo correlações estratigráficas precisas ao longo da bacia e suportando interpretações estruturais, paleogeográficas e geodinâmicas. A informação obtida na proximidade de jazigos de sulfuretos maciços polimetálicos tem sido considerada pela generalidade das empresas como uma mais valia na prospecção deste tipo de minérios.

No trabalho é dada a completa descrição taxonómica dos taxa de miosporos e acritarcas identificados, entre as quais 134 taxa de miosporos e 41 taxa de acritarcas são descritos e ilustrados em 17 estampas.

INTRODUCTION

The South Portuguese Zone (SPZ) is probably one of the most studied geodynamic domains of the Iberian Variscides. A major reason for this is the existence of huge deposits of polymetallic massive sulfides in the Iberian Pyrite Belt which have been exploited since roman times. Most of these deposits are exhausted, however there is a great potential for new discoveries as proved by continuing exploration projects led by international companies.

During several decades geological research was mainly concentrated on lithostratigraphy, biostratigraphy, petrology and geochemistry, and structural geology complemented by the use of various geophysical tools. More recently sedimentary geology, sediment geochemistry, physical volcanism, geochronology and biostratigraphy deserved increasing interest and are now current fields of research. Among these fields of research ammonoids palaeontology and palynostratigraphy have made major contributions towards a better understanding of the SPZ geology.

Palynostratigraphy represents now the best tool to date the SPZ lithostratigraphic units, allowing reliable stratigraphic correlations across the basin and giving support to structural, palaeogeographic and geodynamic interpretations.

This Memory presents an overview of all the results achieved by the authors during the last few years in palynostratigraphic research all over the SPZ Portuguese sector and in particular in the Iberian Pyrite Belt. The work involved several researches and mapping projects carried out by the extinct "Instituto Geológico e Mineiro" and the Geosciences Area of INETI. About 50 exploration boreholes, 65 outcrops and approximately 1500 samples have been studied. Part of the palynological work has already been published in scientific papers and internal reports. The high-quality of the palynomorph assemblages obtained and the vast information that was possible to acquire in terms of stratigraphy, mapping and exploration during this research is now organized so that an overall palynostratigraphical synthesis of the SPZ can be made.

The Memory is organized in two parts: Part 1 comprises the geological framework of the SPZ, a historical review of previous palynological studies, the methodologies used and the palynostratigraphic research carried out by the authors in numerous drill cores and outcrops from the main geological domains of the SPZ. Part 2 deals with the systematics of the miospores, acritarchs and prasinophytes.

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PART 1

PALYNOSTRATIGRAPHY OF THE SOUTH PORTUGUESE ZONE AND TECTONO-STRATIGRAPHIC IMPLICATIONS

1. STRATIGRAPHIC SETTING

The South Portuguese Zone (SPZ) is one of the major geological domains that form the Variscan Iberian Massif (LOTZE, 1945, JULIVERT et al., 1972, RIBEIRO, 2006) (Figure 1).

Devonian and Carboniferous rocks are extensively developed and comprise a wide range of clastic, volcanic, volcanoclastic and carbonate rocks. Intimately associated with the volcanic rocks occur world-class massive sulphide orebodies in the so-called Iberian Pyrite Belt. At the boundary between the SPZ and the Ossa Morena Zone (OMZ) outcrops a belt of basic and ultrabasic igneous rocks which show petrological, geochemical and internal cha-racteristics ascribed to an ophiolitic suite known as the Beja-Acebuches Ophiolite (MUNHÁ et al., 1986, FONSECA & RIBEIRO, 1993, QUESADA et al., 1994). In the last two decades several studies have made important progresses on the lithostratigraphy (SCHERMERHORN, 1971, OLIVEIRA et al., 1979, OLIVEIRA, 1983, 1990), biostratigraphy (CUNHA & OLIVEIRA, 1989; PEREIRA, 1997; 1999, KORN, 1997), volcanology (ROSA, C., 2006; ROSA, C. et al, 2004; 2005; 2008) and palaeogeography (OLIVEIRA & QUESADA, 1998; OLIVEIRA et al., 2006; 2008) of the SPZ.

In this section the Devonian and Carboniferous stratigraphy of the SPZ is briefly described. Four geological domains are recognised from north to south (OLIVEIRA, 1990): Pulo do Lobo Antiform, Iberian Pyrite Belt (IPB), Baixo Alentejo Flysch Group (BAFG) and the Southwest Portugal (SWP).

1.1. Pulo do Lobo Domain

The Pulo do Lobo Domain is an antiformal structure located in the northern part of the SPZ. In the core of this structure crops out the Pulo do Lobo Formation, composed of highly deformed phyllites, quartzites, and amphibolites (former basalts) with MORB-type geochemical affinity at the basal part of the succession (MUNHÁ, 1983; EDEN, 1991; QUESADA et al., 1994). The thickness is unknown as well as the age. The unit is affected by three episodes of tectonic deformation with associated folding and cleavages.

The north limb of the antiform is occupied by the Ferreira-Ficalho Group (Figure 1) which includes from base to top the following lithostratigraphic units (CARVALHO et al., 1976; OLIVEIRA et al., 1986; OLIVEIRA, 1990): the Ribeira de Limas Formation composed of phyllites, quartzwackes and minor intercalations of fine volcaniclastic sediments, in apparent transition to the Pulo do Lobo Formation; the Santa Iria Formation that consists of greywackes, siltstones and shales, forming a flysch-like succession; and the Horta da Torre Formation comprising dark shales, impure sandstones, siltstones and quartzite beds showing bioturbation. The group thickness is unknown, but estimated of ca. 500 m. The Ribeira de Limas Fm provided palynomorphs of lower Frasnian age and the Santa Iria and Horta da Torre Fms of upper Famennian age. The Santa Iria and Horta da Torre Fms are affected by a main folding phase with associated cleavage and the Ribeira de Limas and Pulo do Lobo Fms. show three episodes of folding with cleavage. In the south limb of the antiformal structure is exposed the Chança Group, which comprises the following lithostratigraphic units from base to top (PFEFFERKORN, 1968; SILVA, 1989; CUNHA & OLIVEIRA, 1989; OLIVEIRA, 1990; SILVA et al., 1990): the Atalaia Formation composed mostly of phyllites and quartzites, sharing with the Pulo do Lobo Formation the same type of tectonic deformation; the Gafo Formation consisting of greywackes, siltstones and shales forming a thick flysch succession, intercalated and intruded by felsic and mafic rocks; and the Represa Formation which is composed of siliceous siltstones, shales, greywackes and minor intercalations of fine volcanogenic sediments. The overall group thickness is estimated in ca. 1100 m. The Gafo Fm yielded spores of lower Frasnian age and the Represa Fm of upper Strunian age. The Gafo and Represa Fms. show two main episodes of tectonic deformation;

The structure of the Pulo do Lobo Domain has been interpreted as an anticline (SCHERMERHORN, 1971; CARVALHO et al., 1976); as a complex antiform (OLIVEIRA et al., 2006; PEREIRA & OLIVEIRA, 2006; PEREIRA et al., 2006a, b), as an accretionary prism related to a northward dipping subduction (SILVA et al., 1990; FONSECA et al., 1993; QUESADA et al., 1994, SILVA, 1998) and as a suspect terrain (RIBEIRO et al., 1990).

1.2. Iberian Pyrite Belt (IPB)

The Iberian Pyrite Belt stratigraphy (Figure 1) consists of two major units, the Phyllite Quartzite Group (PQG) and the Volcano Sedimentary Complex (VSC). The PQG is dated as Upper Devonian age by ammonoids, conodonts and palynomorphs (BOOGAARD, 1967, FANTINET et al. 1976; CUNHA & OLIVEIRA, 1989; OLIVEIRA et al., 1997; OLIVEIRA et al., 2004, PEREIRA et al., 2004). It forms the IPB detritic basement and consists mostly of phyllites, quartzites, quartzwackes and shales with intercalations of limestone lenses and nodules at the upper part of this unit, which as a whole were laid down in a marine siliciclastic platform. The thickness is in excess of 200m (base not known). The VSC is dated as Upper Devonian to upper Viséan age principally based on palynomorphs and rare conodonts (OLIVEIRA, 1990; OLIVEIRA et al., 1997, OLIVEIRA et al., 2004; PEREIRA et al., 2004). The VSC incorporates several episodes of volcanism, with dominant rhyolites, dacites, basalts and minor andesites, and intercalations of black shales, siltstones, minor quatzwackes, siliceous shales, jaspers and cherts and a purple shale member at the upper part of the complex. The thickness is variable, from few tens of meters to more than 1000m. The VSC was laid down in a submarine environment.

On a regional basis the IPB is divided into two branches (OLIVEIRA, 1990): the North and the South Branch (Figure 1). The North Branch extends from Palma (Alcácer do Sal), below the Cenozoic sediments of the Sado Basin (at the west), to São Domingos mine (at the east) (V. OLIVEIRA et al. 1998a, b; MATOS et al., 1998, 2000, 2003). This branch incorporates both autochthonous and parautochtonous successions, where it is possible to identify the VSC sequence and allochthon sections composed of several tectonic sheets that include PQG sediments and VSC volcanics and sediments. The South Branch refers to the rooted anticlinal structures and extends from the Pomarão Anticline (west termination of the Puebla de Guzmán Anticline in Spain) through the Neves Corvo-Rosário Anticline to the Lousal and São Francisco da Serra region (Figure 1). The Cercal Anticline to the west is also incorporated in this branch. Overlaying the VSC are the turbidites of the Baixo Alentejo Flysch Group (BAFG) whose details are given below.

1.3. Baixo Alentejo Flysch Group (BAFG)

The Baixo Alentejo Flysch Group (BAFG) consists of mostly gravity flow sediments that form a continuous southward prograding turbiditic succession with over 5 km in thickness (Figure 1). Sedimentological and palaeontological data allowed its subdivision into three lithostratigraphic units, which are from the bottom to the top: Mértola, Mira and Brejeira Formations (OLIVEIRA et al. 1979; OLIVEIRA 1983; OLIVEIRA & WAGNER-GENTIS 1983).

The Mértola Formation comprises greywacke beds with variable thickness (few centimetres to more than a meter) interbedded with shales, silstones, conglomerates and rare mudflow deposits. The greywacke beds show typical sedimentary structures of turbidites, namely Bouma sequence and also beds showing amalgamation and fluidisation structures (clastic dikes) and synsedimentary folds (slumps). The petrography of the greywackes show clasts of: volcanic rocks (felsic and mafic), volcanic quartz, chert, quartzites and phyllites with tectonic cleavage. Conglomerate beds are more frequent close to the contact with Iberian Pyrite Belts rocks and are made up of cobbles and boulders of lithologies which are common in the Iberian Pyrite Belt, suggesting therefore that this domain acted as a source area for the sediments, although also provenance from the Ossa Morena Zone cannot the totally discarded. The shaley intervals yielded ammonnoid faunas and miospores that indicate a upper Viséan age. The boundary between the Mértola Fm and the younger Mira Formation is represented by a belt with great lateral continuity, composed of shales and siltstones with ca. 50 to 100 m in thickness. This predominantly shaley interval yielded ammonoids which indicates the uppermost Viséan.

The Mira Formation consists of greywackes interbedded with shale beds and rare conglomerates. Detailed sedimentological studies of this formation are scarce, therefore our knowledge is still very incomplete. However, preliminary studies showed that the turbidites of the Mira Formation are in general thinner bedded and with less sand-rich sequences than the Mértola turbidites. Dispersed ammonoid faunas indicate a Namurian age for this unit.

The Brejeira Formation is the youngest unit of the GFBA and as the previous units, it also shows a turbiditic character. Overall, this formation is composed of greywackes, quartzwackes and impure quartzites interbedded with shales and is divided into two distinct sedimentological belts: the basal beds consist of impure quartzites and quartzwackes interbedded with shales forming a belt with 5 to 10 km wide; the other belt is located to the southwest where it occupies a larger area and is made up of immature greywackes interbedded with shales. The clastic lithologies of this formation are poorer in volcanic fragments than the pre-vious formations and richer in clasts of metamorphic quartz. The decrease of volcanic fragments in the greywackes suggests a source area with diffe-rent geological characteristics from the source areas of the Mértola and Mira formations. Palaeocurrents recorded from the Brejeira Formation show a predominant NNW to SSE flow direction, but towards the S-SW the directions are more variable, probably due to the fact that the turbidite flows had to fill up the submarine topography build on the carbonate platform represented by the Carrapateira Group (see next section). Ammonnoid and palynomorphs indicate a Bashkirian to upper Moscovian age.

1.4. The Southwest Portugal Domain (SWP)

The Southwest Portugal Domain is represented by the Aljezur and Bordeira Anticlines (Figure 1) whose litostratigraphic succession comprise, from base to top the Tercenas Formation conformable overlaid by the carbonates and shales of the Carrapateira Group (OLIVEIRA et al., 1985; KORN, 1997; PEREIRA, Z., 1999).

The Tercenas Formation is composed of sandstones interbedded with shales and siltstones beds forming two coarsening and thickening upward sequences. At the top of the formation a metric intercalation of conglomerates and breccias occurs and in places calcarenites rich in Fe and Mn. The measured sections of this formation have a total thickness of around 100 m, although the base of it is not exposed. The sandstone beds are rich in sedimentary structures, namely, large-scale cross-bedding, herringbone cross-bedding, hummocky-cross bedding, low angle cross-lamination, wave ripples and syn-sedimentary folds. These structures together with the vertical organisation of the sandstone sequences suggests deposition on a shallow marine platform dominated by tidal processes and frequently affected by storm events. Palynomorphs and brachyopodes indicate a Upper Devonian age for this unit.

Carrapateira Group

From base to top, three formations are recognised, Bordalete, Murração and Quebradas (PRUVOST 1914; OLIVEIRA et al., 1985; KORN, 1997).

The Bordalete Formation contains essentially black pyritic shales interbedded with thin-bedded siltstones. Phosphatic and calcisiltone diagenetic no-dules are a common feature of this formation as well as large-scale trough and cross stratification, at the upper part, interpreted as the results of small gravitational slides that occurred at the platform edge. The thickness of this formation is ca. 200 m. The sedimentological features suggest sedimentation on the distal parts of a marine siliciclastic platform under dysoxic to anoxic conditions. Ammonoids are randomly distributed within the Bordalete Formation and belong to only one species, *Becanites algarbiensis* indicating the Tournaisian.

The Murração Formation is sub-divided into two members, the Pedra das Safias at the base and the Vale Figueiras at the top. In its type locality, the sea-cliff at Murração beach, the Pedra das Safias Mb. consists of thick-bedded dolomitic limestones interbedded with thin bedded calcareous shales. The limestone beds are rich is fossil fragments, namely crinoids, corals and trilobites. The Vale Figueiras Mb. is composed of black shales interbedded with tabular and nodular beds of dolomitised

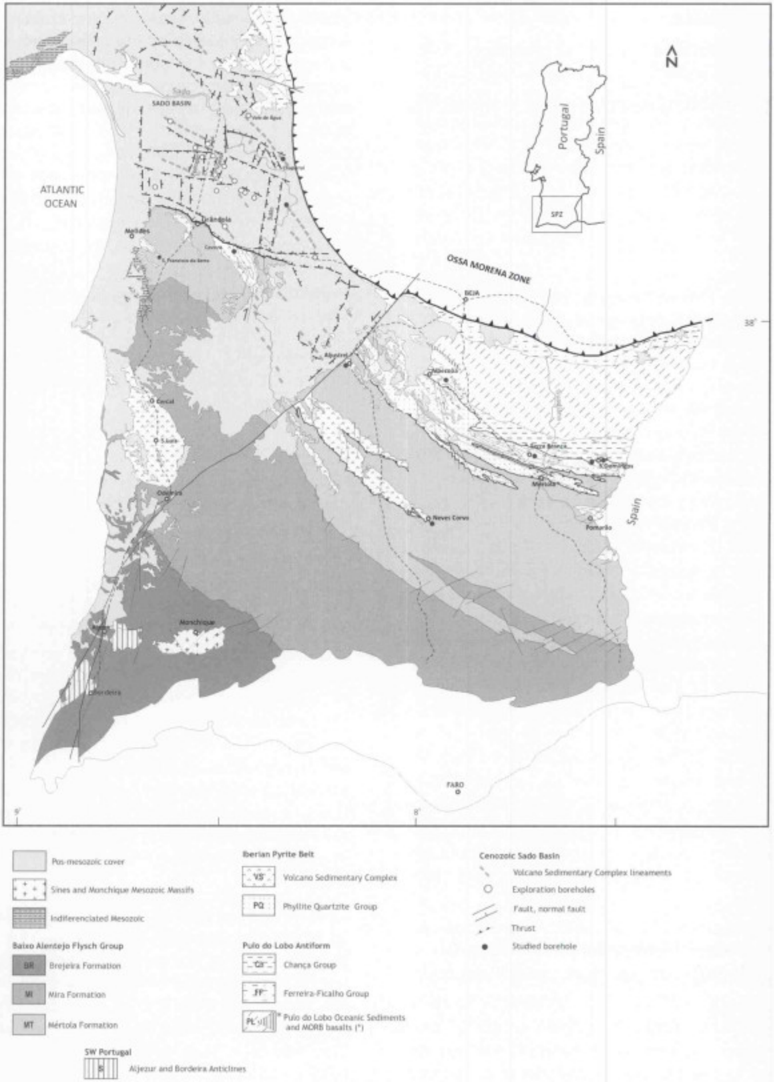

Fig. 1 Geological sketch map of the SPZ (adap. Geological Map of Portugal 1/500 000, OLIVEIRA et al., 1992; OLIVEIRA et al. 2006).

limestones. This member is particularly rich in goniatite faunas, locally associated with levels with abundant bentic faunas of trilobites, brachiopods, echinoderms and rugose corals. The total thickness of the Murração Formation is 60 m. The lithological and sedimentological features characteristics of the Murração Formation suggest deposition on a subtidal carbonate platform, possibly with a ramp morphology deepening towards the north as indicated by the increase in the amount of mud rich layers in the Aljezur Antiform.

The Quebradas Formation has its type section at the Quebradas beach located approximately 500 m south of the Murração beach. The Quebradas Formation consists mostly of interbedded black carbonaceous shales and dark bioclastic limestones about 70 m thick. Diagenetic phosphatic nodules are common towards the top of this formation, The unit may have been laid down in a restricted marine environment of quiet waters with bottom anoxic conditions. This unit is rich ammonoids of Serpukovian and Bashkirian age.

2. PREVIOUS PALYNOSTRATIGRAPHIC STUDIES IN THE SOUTH PORTUGUESE ZONE - HISTORICAL REVIEW

Palynological studies of the SPZ extend back to 1980s. Palynostratigraphy was for the first time tested in several units of the SPZ as part of a mapping programme carried out by the Portuguese Geological Survey (OLIVEIRA et al., 1986; CUNHA & OLIVEIRA, 1989).

In 1986, T. CUNHA (OLIVEIRA et al., 1986) recorded for the first time a fairly well preserved palynomorph assemblage of mid Famennian age in the Horta da Torre Formation, the upper unit of the Ferreira Ficalho Group, north limb of the Pulo do Lobo Antiform. Three localities were sampled near Corte Condessa, west of Guadiana River. Miospore species identified include *Aneurospora greggsii, Ancyrospora langii, Diducites mucronatus, D. poljessicus, D. plicabilis, Pustulatisporites rugulatus, Retusotriletes planus, Samarisporites* sp. A and *Samarisporites* sp. cf. *Acanthotriletes hirtus*. Acritarch species recovered include *Ephelopalla* cf. *gorkae, Unellidium piriforme* and *U. winslowae*.

At that time palynostratigraphic work was also undertaken in the Spanish sector of the Pulo do Lobo Antiform. GIESE et al. (1988) working further east in the Almonaster la Real region, northern limb of the Pulo do Lobo Domain, in Spain, have subsequently determined a upper Famennian to Tournaisian age for a sequence of greywackes possible correlatives of Santa Iria Formation. In this work, the Horta da Torre Formation was considered to stratigraphically underlie the Santa Iria Formation. Due to the high thermal maturity of the assemblages, reflected light microscopy was used, allowing the identification of the miospore species, *Grandispora gracilis, Vallatisporites pusillites, Retusotriletes incohatus* and *Retispora lepidophyta*.

In 1989, CUNHA & OLIVEIRA studied the palynostratigraphy of the Mina de São Domingos region *e. g.* Represa Formation and other units of the Iberian Pyrite Belt. The Represa Formation, north of Tapada Grande, provided three productive samples indicating an lower upper Famennian age. The poorly preserved miospore assemblage contains *Aneurospora greggsii, Auroraspora asperella, A. solisorta, Pustulatisporites rugulatus, Retusotriletes incohatus, R. planus* and *Rugospora flexuosa*. The Phyllite Quartzite Formation was dated as uppermost Famennian based on the occurrence of *Retispora lepidophyta, Rugospora flexuosa, Densisporites spitsbergensis* and acritarchs.

In an unpublished PhD thesis, LAKE (1991) studied the palynology of the Pulo do Lobo Domain succession in Spain. The Aroche road section, in the north limb of the antiform, yielded a palynoflora comprising *Aneurospora greggsii, Cristatisporites inusitatus, C. triangulatus, Diducites mucronatus, Geminospora lemurata* and *Retusotriletes rugulatus*, indicating a Givetian to lower Famennian age. The studied section was compared and correlated with the lithostratigraphic sequence of the Santa Iria Formation in Portugal. In the south limb of the antiform, LAKE studied three samples from the Chança section, located 8 km southwest of Paymogo. The miospore assemblage recovered indicated a upper Givetian to lower Famennian age, based on the presence of *Aneurospora greggsii, Cristatisporites inusitatus, Geminospora lemurata* and *Rugospora flexuosa*. The suited section was correlated with the Gafo Formation in Portugal.

In the following years more focussed projects on the biostratigraphy were developed. The detail study of the Bordeira and Aljezur anticlines in SWP allow the identification of eighteen miospore biozones (PEREIRA et al., 1994; PEREIRA & OLI-

VEIRA, 1995; PEREIRA, 1997; 1999). These successions were specific selected on the basis of a documented biostratigraphic control based on amonoids, trilobites, bivalves and crinoids (OLIVEIRA et al., 1985). This knowledge allow to establish the accuracy of the ages obtained by miospores and ammonoids in addition to an excellent correlation with Western Europe biozonal schemes (KORN, 1997; PEREIRA, 1999).

The palynostratigraphic research extended to the entire Iberian Pyrite Belt, starting with the Neves Corvo mine region where it has allowed the dating of all the local lithostratigraphic units, including the black shales that host the orbodies, and a new tectono-stratigraphic interpretation of the mine succession (BARRIGA et al., 1997; OLIVEIRA et al., 2004; PEREIRA et al., 2004). The first palynological research in Spain was undertaken in the Alznalcollar mine (PEREIRA et al., 1996) followed later by work in the Tharsis mining district (GONZÁLEZ et al., 2002), other areas of the Spanish Iberian Pyrite Belt (GONZÁLEZ, 2005; GONZÁLEZ et al., 2005 a,b) and Rio Tinto mine (PEREIRA & CLAVIJO, 2007).

More recently, research carried out in the context of the projects "VARISCA-Dinâmica das Bacias Sedimentares e Paleogeografia do Terreno Ibérico durante a Inversão Tectónica Varisca" and "PYBE-Contributos para um melhor conhecimento da evolução da Faixa Piritosa" financed by the Fundação para a Ciência e Tecnologia (FCT), allowed a re-interpretation of the stratigraphic successions near the massive sulphide deposits (e.g. Lagoa Salgada and Salgadinho unexploited deposits, Caveira, Lousal, Montinho, Chança, and São Domingos abandoned mines and Aljustrel and Neves Corvo active mines) or related with important geophysical gravimetric anomalies. These projects permitted to investigate the Volcano Sedimentary Complex (VSC) and its relationship with the underlying and overlying units, allowing the establishment of consistent stratigraphic correlations across the basin and a better understanding of the volcanism, tectonism, thermal history and massive sulphide mineralization, opening so new perspectives for mineral exploration (OLIVEIRA et al., 2006; 2008; MATOS et al., 2006; PEREIRA et al., 2007; 2008).

3. METHODS

3.1. Samples Preparation

The studied samples were collected in outcrop sections, boreholes and occasionally spot samples. In the IPB, where a large number of boreholes are available, drilled by mining and exploration companies (e.g. Billiton, RTZ, Somincor, Lunding, Eurozinc, NorthonLion) and by the Portuguese Geological Survey (Gosciences Area of INETI). The majority of the boreholes studied are stored in the INETI borehole warehouses at Alfragide and Aparis.

Samples were preferably collected from drill cores and in a few cases from the mine addicts and open pits (e.g. the case of Neves Corvo, Aljustrel and São Domingos mines). In the SWP Domain samples were mainly recovered along costal sections and road cuts of the area. Sampling program was performed locally in detail, using geological mining mapping at 1/2500 scale and borehole logging at 1/200 scale (e.g. MATOS et al., 2006).

Biostratigraphic research is based on palynomorphs and standard palynological laboratory procedures were employed in the extraction and concentration of the palynomorphs from the host sediments (WOOD et al., 1996). Laboratory preparation techniques involve the use of hydrochloric and hydrofluoridric acids to remove the carbonates and silicates content of the clastic sediments. Oxidation of the palynomorphs was carried out using Shultze Solution prepared with fuming nitric acid and potassium clorate. The resultant residues were mounted as strew slides, under cover slips, using the resin entellan.

The oxidation time varied according to the degree of carbonisation of the palynomorph exines. In general samples from the Pulo do Lobo Antiform, Pyrite Belt and SWP Domain require one and half to two and half hours of oxidation, whereas samples from the BAFG necessitate at least four to eight hours of oxidation time. Samples from the PQG and Tercenas Formation showed major oxidation difficulties caused by the oxidation time which varied from sample to sample and the difficulty to maintain the oxidised state of the palynomorphs. During the drying of the slides, after mounting with standard techniques, the oxidized exine of the miospores reverted to black and became unidentified. This problem was overcome by studding each sample in water complemented by measuring its ideal oxidation time. Using these technics it has been possible to stabilize the exines of the miospores for one or two days. The slides were examined with transmitted light, per BX40 Olympus microscope equipped with an Olympus C5050 digital camera facility. All samples, residues and slides are stored in the Department of Geology, INETI-Geosciences Area.

3.2. Miospore Zonation Scheme

In the history of miospore zonation, a significant part of the development of the palynostratigraphy comes up from the Carboniferous of the British Islands. The pioneering work of KNOX (1948), BUTTERWORTH & WILLIAMS (1958) and SMITH & BUTTERWORTH (1967) documented in detail the composition and succession of miospore assemblages found in strata of upper Viséan to Kasimovian (Stephanian) age. Although limited to the coal seam assemblages, these studies integrate complete range data with quantitative data, and proposed the first scheme with nominate zonal taxa.

It was not until the detail work of NEVES (1972 a,b) NEVES et al. (1973) and NEVES & IOANNIDES (1974) that the first formal scheme of miospore zones were published, for the Dinantian of British Isles, based on sections of SW Brittain, Scotland and Northern England. The definition of the zones were constantly based on the first appea-rance of distinctive associations of miospore taxa. In general two taxa were selected as the index or key taxa, naming the zones. During the same time parallel biozonation schemes were proposed in France, Germany and Spain (ALPERN et al., 1970; GREBE, 1972; LOBOZIAK, 1974; OWENS et al., 1977).

In an attempt to present a unified proposal for the entire Carboniferous of Western Europe, CLAYTON et al., 1977, established a new scheme of twenty four zones, covering from the uppermost Devonian to the lowermost Permian. This work reported the result of a study made by the members of the Commission International de Microflore du Paleozoique (CIMP) - Working Group on Carboniferous Stratigraphical Palynology- and all data available was combined in order to formulate an integrated zonal scheme.

Since the 1977 paper detailed investigations in numerous specific regions have gradually modified and improved the zonation scheme, for the Upper Famennian and to the Carboniferous (CLAYTON, 1974; CLAYTON et al., 1978; CLAYTON & HIGGS, 1979; VAN DER ZWAN, 1980; KEEGAN, 1981; HIGGS, 1984; CLAYTON, 1985; HIGGS et al., 1988; CLAYTON, 1996; OWENS, 1996; OWENS et al., 2004; OWENS et al., 2005). This scheme is today in current usage in Europe. STREEL, et al., 1987 published a miospore zonation for the marine Devonian in the Ardenne-Rhenish region. In this paper the zonation is discussed and compared with international assemblage zones established by RICHARDSON & MCGREGOR (1986) for the Old Red Sanstones continent. Since that paper, exhaustive palynological work allows the refinement of the Devonian zonation scheme (PAPROTH et al., 1983; STREEL, et al., 1988; HIGGS et al., 1988; LOBOZIAK & STREEL, 1989; HIGGS & STREEL, 1993; STREEL & LOBOZIAK, 1996; HIGGS et al., 2000; MAZIANE et al., 1999).

The use of a single taxa miospore zonation scheme for Western Europe is currently under discussion in CIMP meetings (CLAYTON et al., 2003).

The miospore biozonal scheme used in this paper follows the standard Western Europe Miospore Zonation as explained (after: CLAYTON et al., 1977; CLAYTON 1996; CLAYTON et al., 2003; HIGGS et al., 1988; HIGGS et al., 2000; MAZIANE et al., 2002; OWENS, 1996; OWENS et al., 2004; STREEL et al., 1987; STREEL, 1996). The presence of very consistent local miospore assemblages in the la-test Devonian and Carboniferous of the South Portuguese Zone led to the introduction of a small modification in this scheme. The defined zonal taxa used are presented in Figure 2 and stratigraphically important and typical taxa are illustrated in Plates 1-17.

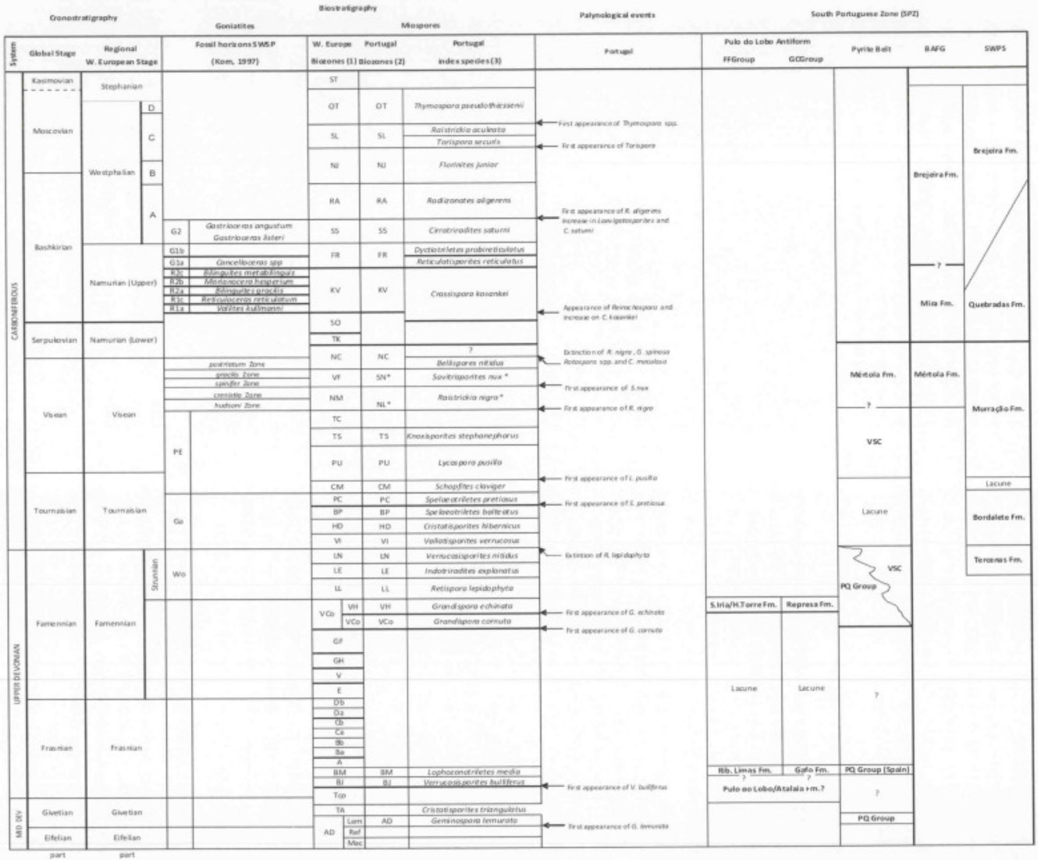

Fig. 2 Latest Devonian and Carboniferous of SPZ (1. Western European Miospore Zonation (CLAYTON et al., 1977; CLAYTON 1996; CLAYTON et al., 2003, HIGGS et al., 1988; HIGGS et al., 2000; MAZIANE et al., 1999; OWENS, 1996; OWENS et al., 2004; STREEL et al., 1987; STREEL, 1996); 2. South Portugal miospore Zonation (PEREIRA, 1999); 3. Defined guide taxa used for the latest Devonian and Carboniferous of the South Portuguese Zone (PEREIRA et al., 2007; Present work)).

4. PALYNOSTRATIGRAPHIC FRAMEWORK OF THE SOUTH PORTUGUESE ZONE

This section deals with the stratigraphic palynology of all sections, boreholes and spot samples stu- died by the authors. Description of the new palynological data is presented here. In case of previously published data only a brief review is presented.

4.1. Pulo do Lobo Antiform

The Pulo do Lobo Antiform units were recently investigated for palynostratigraphy. In this study, 93 rock samples were collected from all the composing units exposed in roads cuts and along the Guadiana river valley (PEREIRA et al., 2006, Figure 3).

Pulo do Lobo and Atalaia Formations

The Pulo do Lobo Formation is very well exposed along the Guadiana River and in road cuts from Corte Gafo to Amendoeira and from Corte Pinto to Serpa (See Figure 3). The black phyllites sampled contain no organic matter.

The Atalaia Formation was sampled near its boudary with the Pulo do Lobo Formation, in road cuts north of Corte Gafo de Cima and in a road section between Corte Pinto and Serpa, near Santa Luzia. This unit is characterised by alternating layers of highly deformed phyllites and quartzites. The black phyllite samples provided residual but highly mature organic matter (%Rr c. 11) in the greenschist facies of metamorphism (PEREIRA et al., 2006 a,b). No palynomorphs were identified.

The high grade of metamorphism that affected these units preclude any age determination, however the sequence is older than lower Frasnian (see conclusions below).

Ribeira de Limas and Gafo Formations

The Ribeira de Limas Formation was sampled in a road cut section, located about 100m north of the Ribeira de Limas bridge, 2 km SE of Santa Iria village(Figure 3). This section constitutes the unit type section and is composed of highly deformed dark shales and phyllites, interbedded in quartzwackes. The dark shales provided 5 productive samples. The assemblages are composed of moderately preserved miospores assigned to the upper part of the BM Biozone of lower Frasnian age. The Gafo Formation was sampled in several localities: from roadcuts along Mértola to Corte Gafo de Cima, in the region north of Corte Sines (cemetery section) and along the Chança River valley near the Volta Falsa old mine and in the borehole CH0601 (Figure 3). Dark shales from the studied sections and the borehole provided several productive samples which yielded moderately preserved miospores assigned to the upper part of the BM Biozone of lower Frasnian age.

The miospore assemblage recovered in these units includes moderately preserved specimens of *Aneurospora greggsii, Chelinospora concinna, Cristatisporites triangulatus, Cristatisporites* sp. cf. *C. inusitatus, Cymbosporites sp., Emphanisporites rotatus, Geminospora lemurata, Lophozonotriletes* sp., *Verrucosisporites bulliferus, V. premnus* and *V. scurrus* (Figure 4). All samples contain rare acritarchs and prasinophytes.

Santa Iria, Horta da Torre and Represa Formations

The Horta da Torre Formation was sampled in several road cuts, near Santa Iria village and in the Moinho da Ordem section (Guadiana River) (Figure 3). Black shales interbedded in centimetric thick quartzite beds provided several productive samples, with well preserved assemblages of miospores assigned to the basal VH Biozone of upper Famennian age.

The Santa Iria Formation was sampled in several sections: Moinho da Vargem (Chança River, east of Ficalho village) road cut near Santa Iria village and in Moinho da Misericórdia (Guadiana River) (Figure 3). In these sections the unit is composed of dark laminated shales interbedded with thin-bedded greywackes. The dark shales revealed well preserved miospore assemblages assigned to the VH Biozone of upper Famennian age.

The Represa Formation was sampled along Ribeira de Vale Travessos section (west of Tapada Grande, São Domingos), where dark shales, siltstones and quartzwackes are the dominant lithologies, with rare intercalations of green and purple shales.

The dark shale samples showed a rather poor miospore content, however CUNHA & OLIVEIRA, 1989, have identified in this area miospores of lower upper Famennian age.

Complementary sampling was done in the MP 3 borehole, located on the west margin of Tapada Grande, São Domingos (Figure 3). This borehole cuts, amongst other units, 80 of meters the Represa Formation in the upper part of the borehole and the boundary with felsic rocks of the Volcano Sedimentary Complex is at 88,4 m depth (see point 4.2. North Branch iv.). Black shales interbbedded in quartzwackes yielded well preserved miospores assigned to the basal VH Biozone of upper Famennian age.

The palynomorphs content of these units yielded well-preserved assemblages of miospores that include abundant *Grandispora echinata* which indicates the base of VH biozone, together with *Ancyrospora* sp., *Ancyrospora? andevalensis, Apiculiretusispora* sp., *A.* cf. *verrucosa, Auroraspora macra, Cristicavatispora dispersa, Diducites versabilis, D. poljessicus, Emphanisporites annulatus, Grandispora cornuta, G. famenensis, G. gracilis, Plicatispora* sp., *Punctatisporites* spp., *Retusotriletes planus, R. triangulatus, R. rugulatus, Rugospora explicata, R. flexuosa* and *Teichertospora iberica* (Fi-

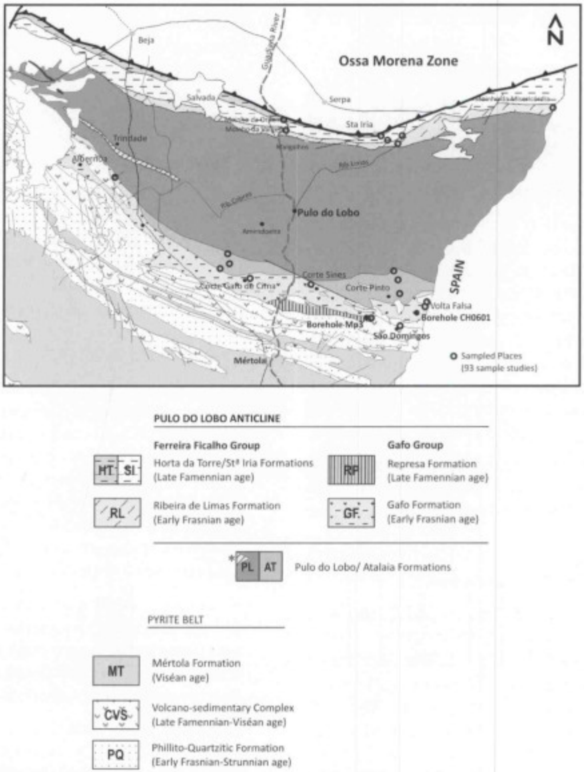

Fig. 3 The Pulo do Lobo Geology with indication of studied localities.

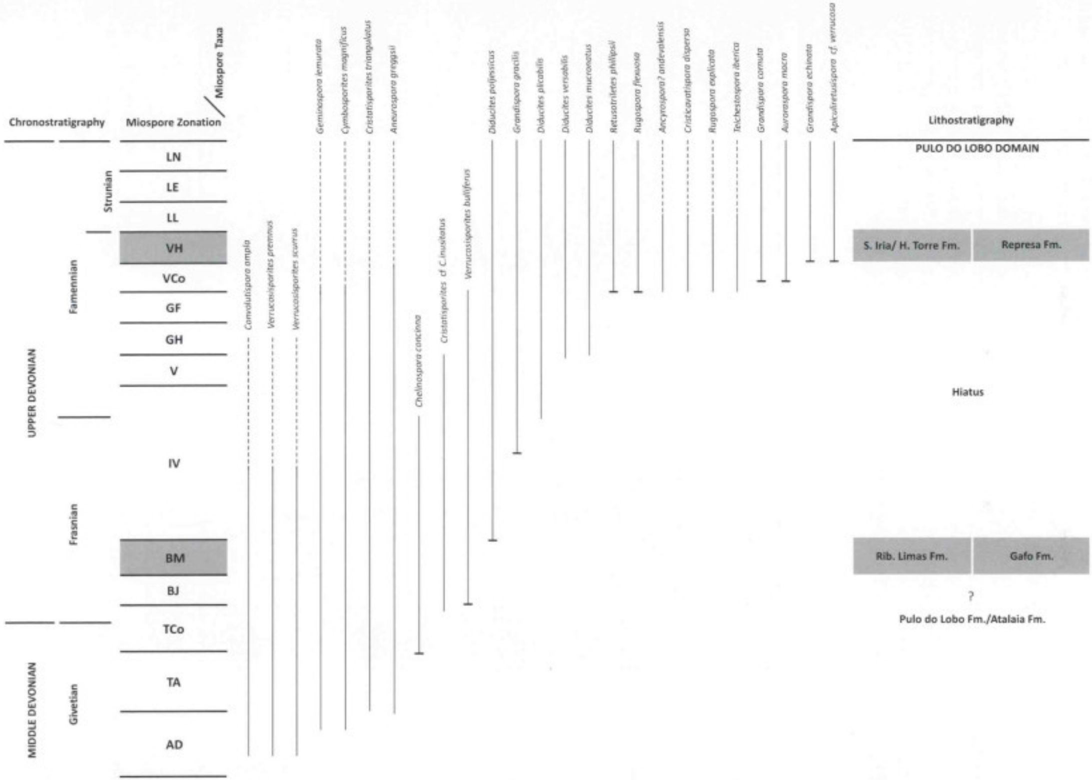

Fig. 4 Chronostratigraphic chart of the Pulo do Lobo Domain units, with stratigraphic distribution of selected species (Adapt. PEREIRA et al., 2006 a,b).

gure 4). All samples contain very rich assemblages of acritarchs and prasinophytes.

The assemblages are assigned to the VH Biozone of upper Famennian age (PEREIRA et al., 2006 a,b).

In conclusion the lower Frasnian and upper Fammennian ages of the Ribeira de Limas/Gafo and Santa Iria/Horta da Torre/Represa Fms., respectively, indicate that they are separated by a hiatus of c. 14 My. This fact reinforces previous structural interpretations that suggested the existence of an unconformity between the Santa Iria/Horta da Torre Fms. and the underlying Ribeira de Limas Formation (PEREIRA et al., 2006 a,b).

The age and stratigraphic correlations of these units on the opposite limbs of this antiform suggests that they were part of the same sedimentary basin that appears to have been superimposed over an old acretionary prism, now represented by the Pulo do Lobo/Atalaia Formation (PEREIRA et al., 2006a,b).

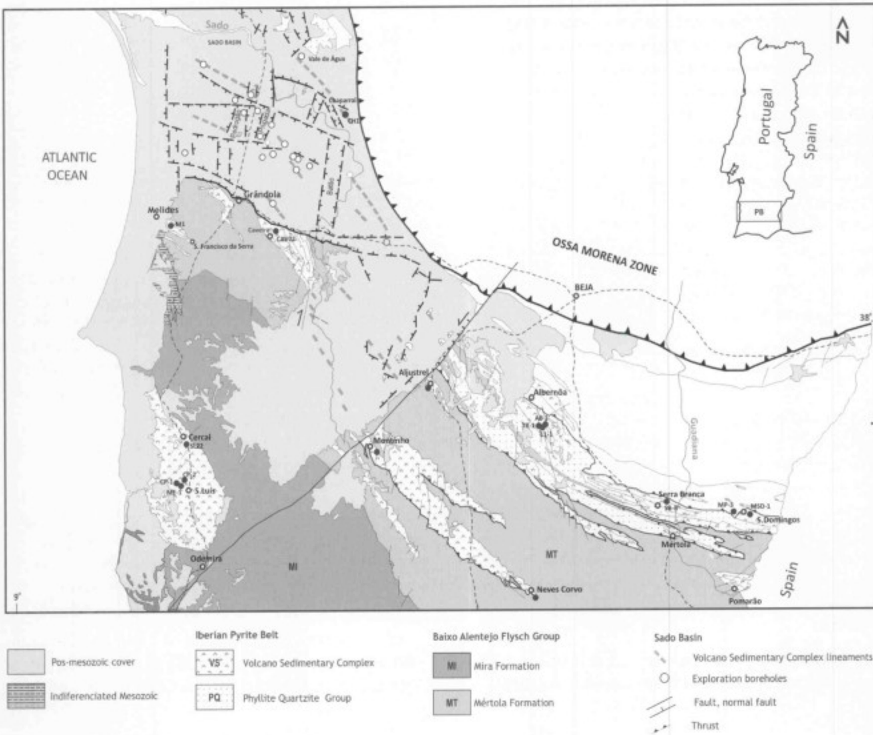

Fig. 5 The Iberian Pyrite Belt (and studied localities and boreholes).

4.2. Iberian Pyrite Belt

North Branch

The studied sections were: the Chaparral (basement of the Cenozoic Sado Basin, northeast of Grândola), Albernôa, Serra Branca and São Domingos mine sectors (Figure 5). The palynomorph assemblages were recovered mostly from drill cores, complemented with outcrop samples.

i. Chaparral region

The Chaparral sector is part of the Vale de Água - Chaparral NW-SE trending lineament located at the Cenozoic Sado Basin (OLIVEIRA et al., 2001; Figure 5). The Palaeozoic basement occurs at depths between 50 and 43 m and is represented respectively by basic volcanics of the VSC with magnetite at Vale de Água (Rio Tinto, borehole GA 14) and by thick PQG quartzites and VSC sediments at Chaparral (IGM, CH1 borehole). The latter locality has been selected for the palynostratigraphic study. It is made up of a 400 m thick monotonous sequence of quartzite beds with intercalations of black shales and siltstones, locally with disseminated pyrite, interpreted as lateral equivalents of the PQG. The black shales revealed the presence of moderately preserved miospores assigned to the LN Biozone of upper Strunian age (Figure 6).

This Biozone assemblage contain abundant specimens of *Auroraspora macra*, *Cristatisporites triangulatus*, *Densosporites spitsbergensis*, *Densosporites* sp., *Epigruspora regularis*, *Emphanisporites rotatus, Geminospora spongiata, Grandispora cornuta, G. echinata, Knoxisporites literatus, Knoxisporites sp., Indotrirradites explanatus, Leiotriletes struniensis, Retispora lepidophyta, Retusotriletes incohatus, Rugospora flexuosa, Tumulispora rarituberculata, Vallatisporites pusillites* and V*allatisporites verrucosus* together with the index species *Verrucosisporites niditus*. Acritarchs and prasinophytes are very common.

The PQG sequence passes downward to dark grey, silicious shales with minor fine volcaniclastic intercalations related to the VS Complex. The boundary between the two sequences is marked by a probable thrust fault. The shales provided several productive samples which yielded moderately preserved miospores of the VH Biozone of upper Famennian age (Figure 6). The assemblages includes abundant presence of *Grandispora echinata* together with *Ancyrospora* sp., *Auroraspora macra, Cristatisporites triangulatus, Cristicavatispora* sp., *Grandispora cornuta, Emphanisporites annulatus, Geminospora lemurata, Retusotriletes planus, R. triangulatus, Raistrickia* sp. and *Rugospora flexuosa*. Acritarchs and prasinophytes are well represented in the assemblages.

The Vale de Água - Chaparral lineament ends south-eastward against the Pulo de Lobo Antiform/IPB N-S boundary, here possibly underlined by a fault.

ii. Albernôa and Serra Branca regions

The Albernôa Antiform comprises mainly felsic volcanic rocks (rhyodacites) in its core which are overlain by siliceous and purple shales (ROSA D. et al., 2004; OLIVEIRA et al., 2005). Phyllites and quartzites ascribed to the PQG. lay geometrically above this sequence. Boreholes AB1 and 11-1 (Figure 7), put in evidence a lithological succession composed of black shales with carbonate nodules (Xc) overlain by felsic volcanic rocks (Va).

Unit Xc, which is conditionally correlated with the upper part of the PQG, yielded a miospore assemblage indicating an upper Famennian age, VCo Biozone as suggested by the zonal species *Grandispora cornuta* and *Auroraspora* sp., *Diducites* spp., *Emphanisporites rotatus, Geminospora lemurata, Punctatisporites* sp., *Retusotriletes planus, R. rugulatus* and *Rugospora flexuosa* (Figure 8).

The lithological succession intersected in borehole TR1 (Figure 9, 10) corresponds to the overturned limb of the antiform. The up side down sequence consists of felsic rocks (rhyodacites) (Va) overlain by: purple shales (bv1); black shales (Xn1); shales, siltstones and fine volcaniclastic sediments (VS1); purple shales (bv2); - shales, quartzwackes and minor tuffites (VS2).

Unit Xn1 provided miospores of upper Famennian VH Biozone. The assemblage is defined by the presence of the key specie *Grandispora echinata* and includes the taxa *Auroraspora* sp., *Diducites poljessicus, D. versabilis, Emphanisporites rotatus, Geminospora lemurata, Grandispora cornuta, Punctatisporites* sp., *Retusotriletes phillipsii, R. planus, R. triangulatus* and *Rugospora flexuosa*. All contain abundant acritarchs and prasinophytes.

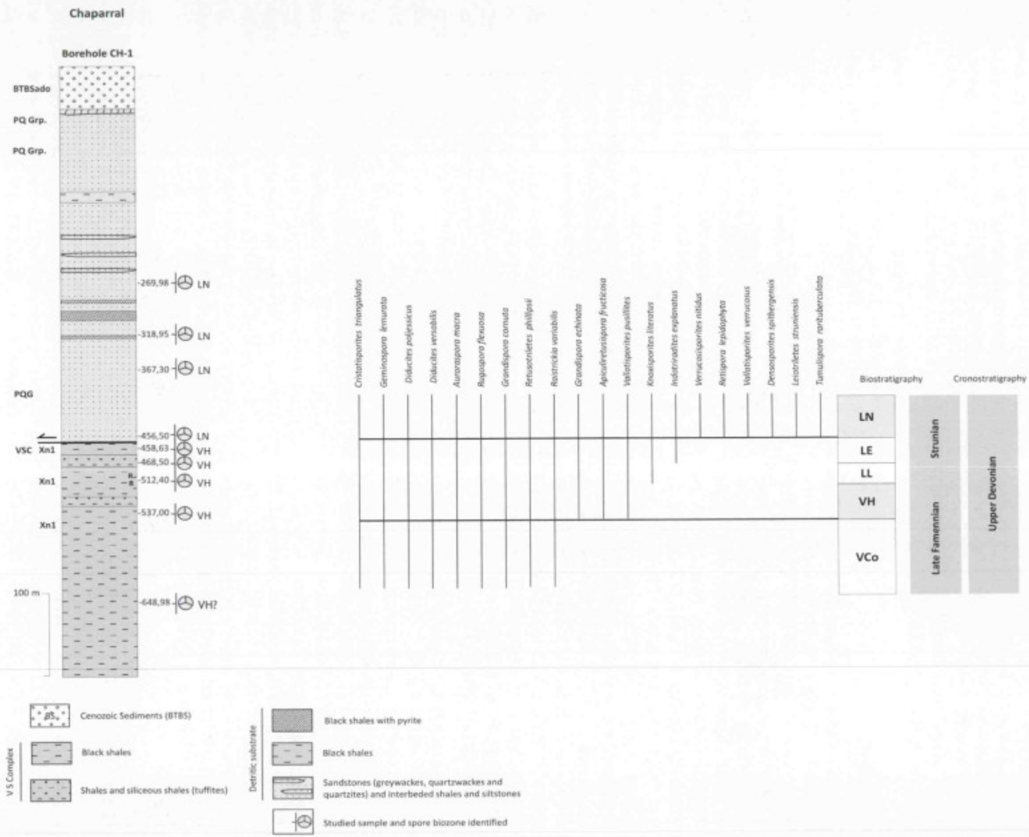

Fig. 6 Log from borehole CH-1 and stratigraphic distribution of selected miospore species from the recognised assemblages.

Thin-bedded siltstones and shales below the purple shale horizon (unit VS1) contain miospores of lower Viséan age, Pu Biozone, as indicated by the zonal species *Lycospora pusilla* in association with *Auroraspora macra, Convolutispora* sp., *Densosporites* sp., *D. spitsbergensis, D. rarispinosum, Dictyotriletes castaneaeformis, Endosporites tuberosus, Knoxisporites* cf. *triradiatus, Vallatisporites pusillites, V. hystricosus, V. galearis, V. verrucosus.*

About 40m above the second purple shale intercalation (bv2) shales of the VS2 unit gave poorly preserved miospores of mid upper Viséan, NL Biozone (locally defined miospore Biozone, see discussion

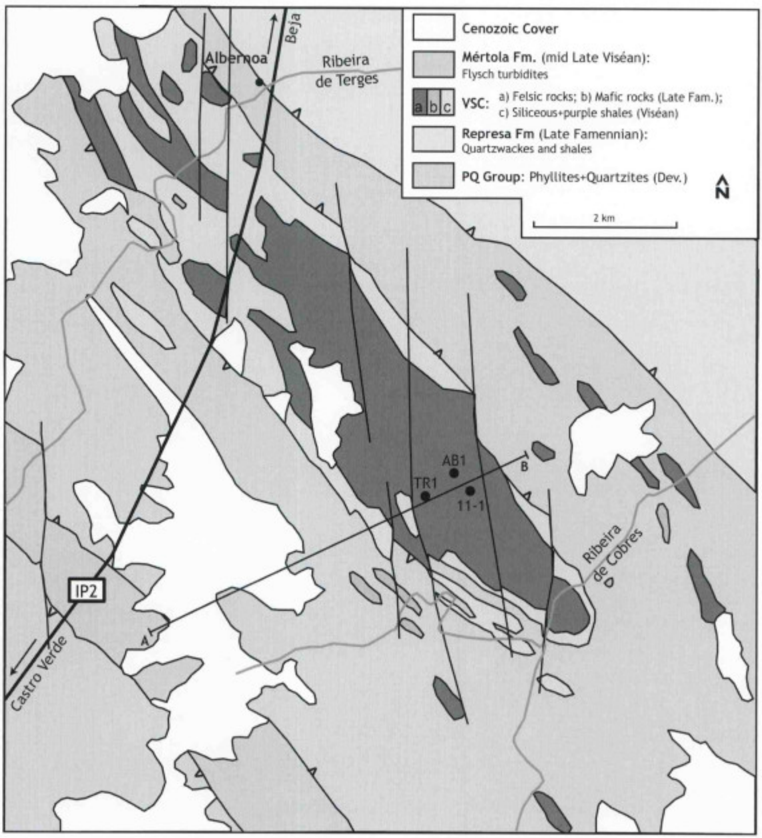

Fig.7 Albernôa geology with indication of studied boreholes (Adapt. OLIVEIRA et al., 2005).

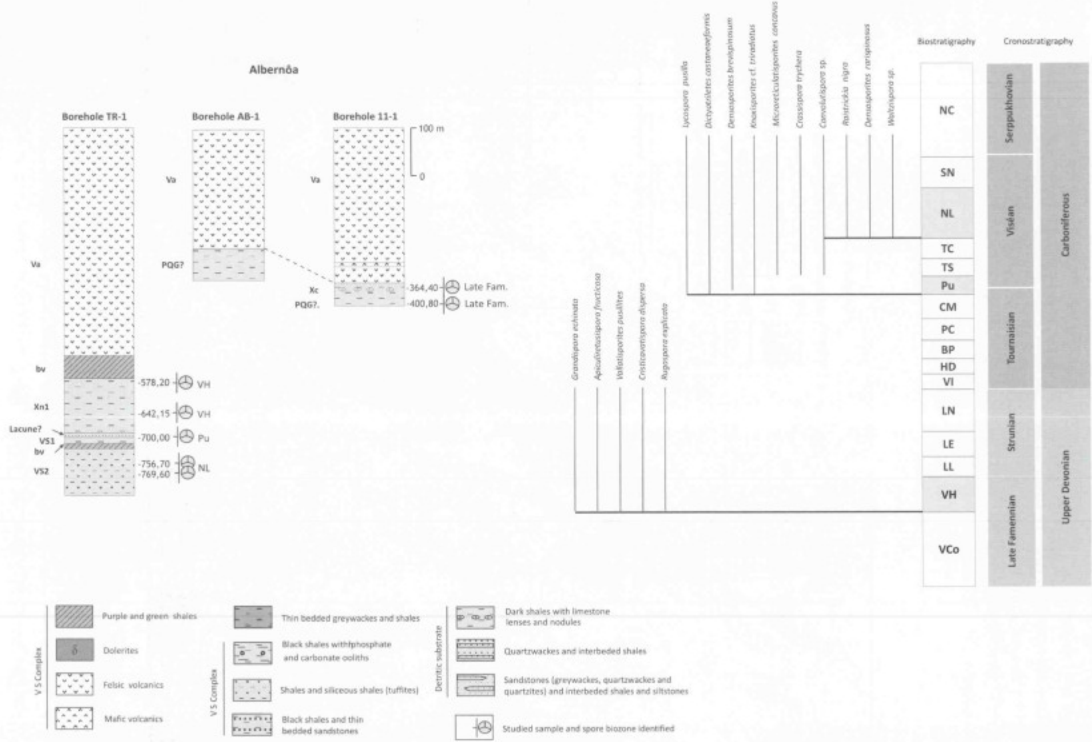

Fig.8 Logs from selected boreholes studied in Albernôa and stratigraphic distribution of selected miospore species from the recognised assemblages.

in point 4.4), indicated the following assemblage: the local zonal specie *Raistrickia nigra* and abundant taxa such as *Ahrensosporites* sp., *Anaplanisporites* sp., *Crassispora trychera, Densosporites sp., D. rarispinosum, D. intermedius, Knoxisporites triradiatus, Leiotriletes tumidus, Lycospora pusilla, Microreticulatisporites* sp., *Vallatisporites vallatus* and *Waltzispora* sp.

U/Pb geochronological datings in zircons of felsic volcanics collected in the Cobres River and in a outcrop along the IP4 road, indicate respectively 355.4±2.9 and 357.2±2.0 My, i.e. lower Tournaisian (ROSA et al., 2009). Palynostratigraphic data suggest that the felsic volcanics age is upper Famennian, thus older than the geochronological ages.

The VSC of the Serra Branca Antiform is composed of andesites overlain by several felsic volcanic episodes followed by shales and a purple shale horizon at the top of the volcanic sequence (OLIVEIRA et al., 2005; ROSA, C., 2006 ; ROSA D. et. al., 2006). This sequence is overlain by the Freixial Formation turbidites, with a thickness of 200m in the type section, which is well exposed in a road track on the western margin of the Guadiana River (Figure 9).

Borehole SB 8 (Figure 9, 10) intersected the following units from top to bottom: Freixial Formation turbidites (Fr); a purple shale horizon, about 20m thick (bv); a pile of felsic volcanic rocks (Va1) with intercalations of dark shales; fine volcaniclastic sediments and intermediate rocks at the lower part (VS3); felsic volcanics (Va2); black shales, siltstones and siliceous shales (VS4).

The Freixial Formation, in the type section, yielded miospores of the mid upper Viséan age, NM Biozone. The assemblage recovered is similar to that described for the unit VS2 identified in the TR1 borehole, Albernôa. Besides these taxa, the unit also contains taxa such as *Emphanisporites rotatus, Geminospora sp., Retispora lepidophyta, Rugospora flexuosa* and *Vallatisporites verrucosus*, which are interpreted as reworked miospores of upper Strunian age.

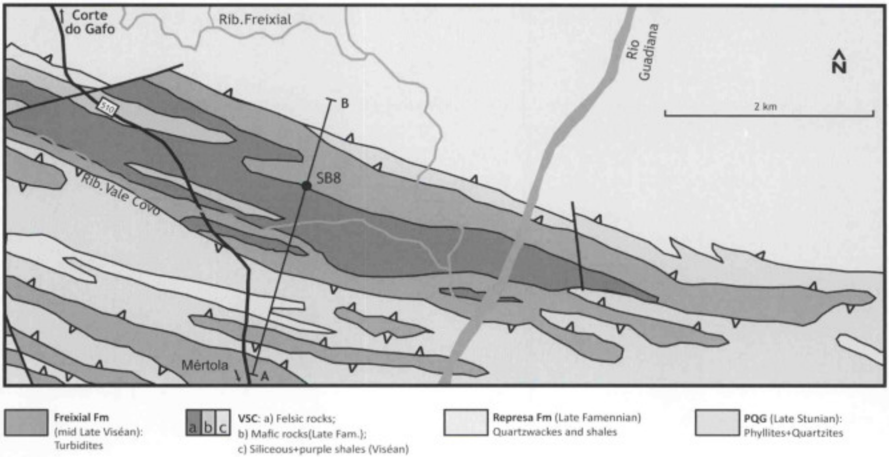

Fig.9 Serra Branca geology with indication of studied borehole (Adapt. OLIVEIRA et al., 2005).

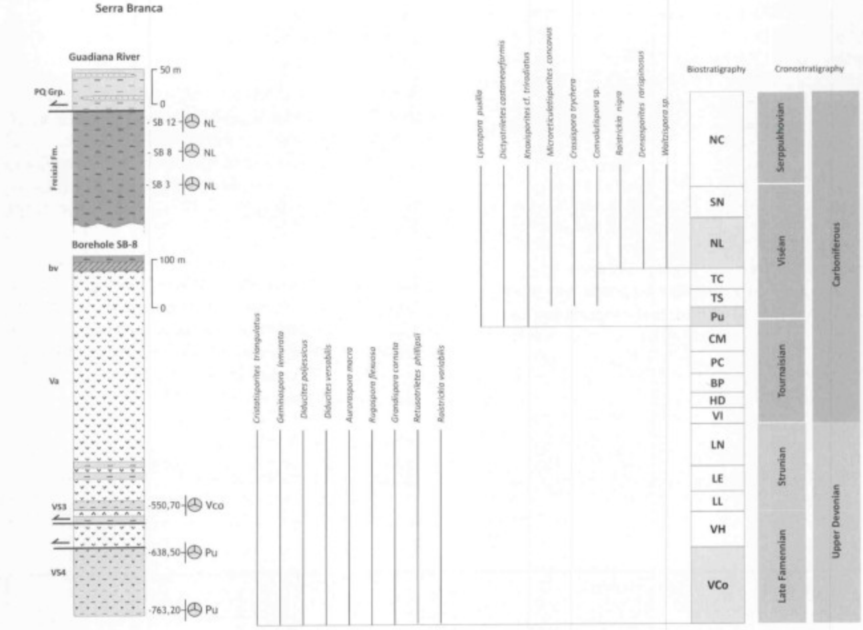

Fig 10 Logs from borehole SB 8 and Guadiana River section studied in Serra Branca region and stratigraphic distribution of selected miospore species.

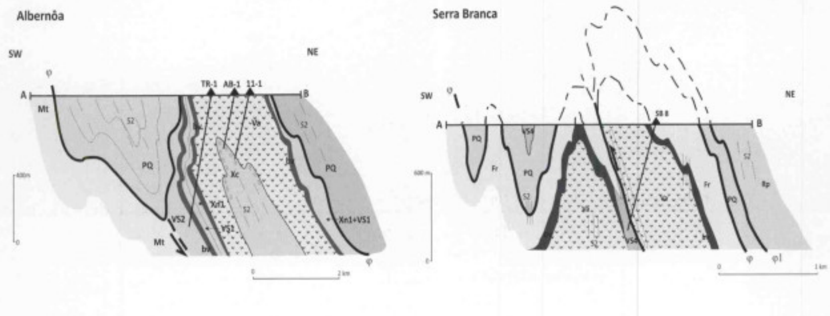

Fig.11 Tectonic structure of the Albernôa (A-B, see Fig. 7) and Serra Branca (A-B see Fig. 9) Antiforms (schematic).

The black shales of unit VS3 gave miospores of upper Famennian VCo Biozone, whose assemblage is similar to that described for borehole TR-1 in Albernôa. Unit VS4 contains a miospore assemblage assigned to the Pu Biozone, identical to that described for unit VS1 of the TR1 borehole. The lithological succession is in normal stratigraphic order up to the base of the intermediate volcanics, which are in turn thrust over the VS4 unit.

Felsic volcanics at the upper part of the Va1 unit, in borehole SB8, have been dated by U/P in zircons as 356.9±5.0 My, so elsewhere between the upper Famennian and the middle Tournaisian (ROSA et al., 2009). The same authors calculated an U/Pb age of 365.8±2.1 My, *i.e.* lower Famennian for zircons of felsic volcanics collected in outcrops on the south limb of the antiform. These two distint U/Pb ages could be related to two magmatic events, as suggested by ROSA et al. (2006). The palynostratigraphic data for the felsic volcanics, derived from borehole SB, indicate an age situated between the VCo Biozone (upper Famennian) and the NM biozone (mid to upper Viséan).

iii. Azenhas Section, Guadiana River (Mértola)

This section situated about 500m NE of Mértola, in the west margin of the Guadiana River is a classical section where overthrusting was firstly demonstrated (FANTINET, 1971; OLIVEIRA & SILVA, 1990; SILVA et al., 1990) based in sedimentary way up and structural criteria (Figure 12). The palynostratigraphic research confirmed this interpretation (OLIVEIRA et al., 2007).

Three main litostratigraphic units can be observed in the Mértola region: the PQG, the VSC and the Mértola Formation (figure 13).

The PQG presents its classical composition, i.e. shales with intercalations of disrupted beds of quarzites, quartzwackes and siltstones, and lenses of limestones.The latter, west of Mértola town, provided conodonts of Upper Devonian age (FANTINET et al., 1976). Poorly to moderately preserved miospores assigned to the LN Biozone of upper Strunnian age were recovered from this unit. The assemblage contains *Verrucosisporites nitidus* the nominal species and the taxa *Auroraspora* sp., *Densosporites spitsbergensis, Diducites* spp., *Gemi-*

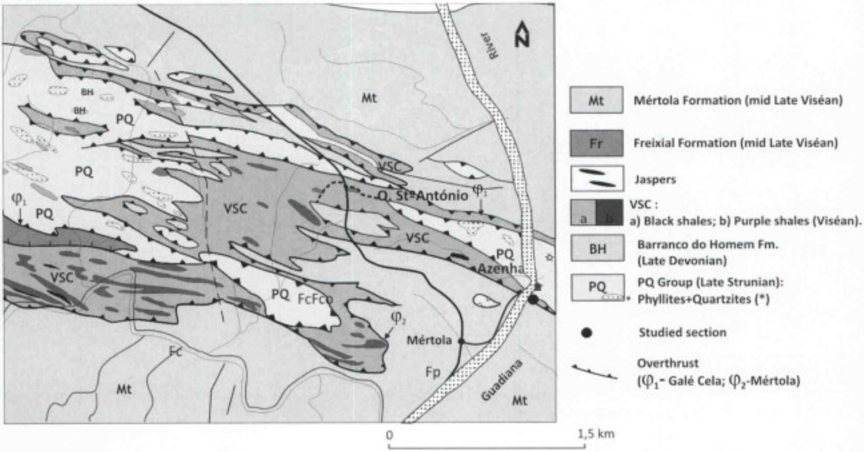

Fig.12 Mértola region geology with indication of Azenhas Section, Guadiana River (Adapt. OLIVEIRA & SILVA, 1990, Sh. 46D Mértola, SGP).

nospora lemurata, Leiotriletes strunniensis, Punctatisporites irrasus and *Retispora lepidophyta*. Rare acritarchs and prasinophytes are present.

The PQG is thrusted over the VSC and this tectonic boundary is the local expression of the regional Galé-Cela (φ1)overthrust (SILVA et al., 1990).

The VSC in this region comprehends fine volcanogenic sediments, green and purple shales, dark grey argillaceous and siliceous shales with lenses and nodules of manganese oxides and silicates. The grey shales and the volcanogenic sediments contain miospores of lower Viséan age. The assemblage includes the zonal specie *Lycospora pusilla* in association with *Auroraspora macra, Convolutispora sp., Crassispora trychera, Densosporites* sp., *D. rarispinosum, Dictyotriletes castaneaeformis, Knoxisporites* cf. *triradiatus, Retusotriletes incohatus* and

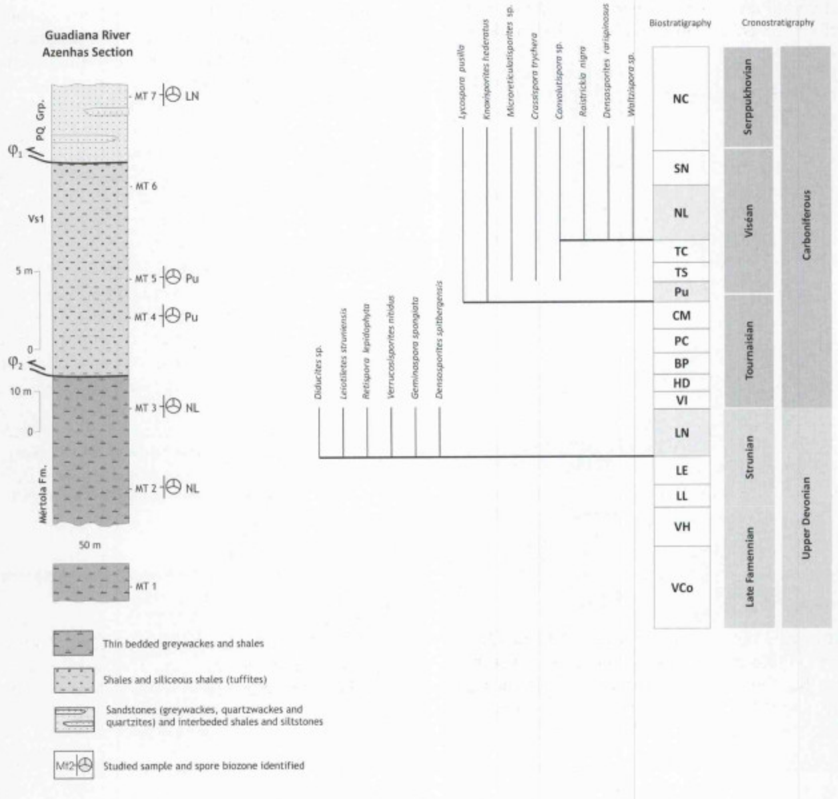

Fig.13 Tectonostratigraphic log of Azenhas Section, Guadiana River and stratigraphic distribution of selected miospore species from the recognised assemblages.

Vallatisporites sp. and rare prasinophytes of the genus *Maranhites* spp..

These shales are tectonically above the underlying Mértola Formation turbidites and their boundary is the local expression of the Mértola (φ2) overthrust (Figure 12). The boundary was reworked during the Late Variscan episodes as shown by the presence of quartz veins.

The Mértola Formation is here made up of classical turbidites with conglomerate intercalations and thick bands composed of shales and thin bedded turbidites, which provided *Posidonia becheri* and a good collection of upper Viséan amonnoids (KORN, 1997).

The shales yielded poorly to moderately preserved miospores assigned to the NL Biozone of mid upper Viséan age. The assemblage contain common *Raistrickia nigra* and is composed of the presence of *Crassispora trychera, Densosporites* sp., *Granulatisporites* sp., *Knoxisporites hederatus, Leiotriletes* sp., *Lycospora pusilla, Microreticulatisporites* sp., *Vallatisporites* sp. and *Waltzispora* sp.

iv. São Domingos mine boreholes and open pit section

The stratigraphic sequence of this complex antiform is composed of felsic rocks (mostly rhyolites), spilites, dolerites, minor andesites, shales, fine volcaniclastics and purple shales. The VSC appears to be tectonically overlain by phyllites and quartzites of the PQG and is also thrust by the quartzwackes, siltstones and shales of the Represa Formation, the upper unit of the Pulo do Lobo Antiform, which extends geographically to the north. Two boreholes (MP3 and MSD1) and two outpit section were examined for palynostratigraphic research (Figure 14, 15) (PEREIRA et al., 2007, MATOS et al., 2006, OLIVEIRA et al., 2006).

In the MP3 borehole located near Tapada Grande dam (Figure 5) four main units were identified, namely: the Represa Formation, silstones and shales (Xn2), felsic (Va) and mafic (Vb) volcanic rocks, black shales (Xn3) (Figure 15).

The Represa Formation shales yielded rich miospore assemblages of the upper Famennian VH Biozone (as described in point 4.1). The black shales intercalated in the felsic rocks (Xn2) and also those intercalated in mafic rocks (Xn3), both gave rich miospore associations of the VH Biozone. This means that at least part of the VSC and the Represa Formation have the same age. A tectonic breccia that occurs at the base of the Represa Formation is interpreted in close relationship with a thrust fault which brought the unit over the VSC.

The VH assemblages contain *Grandispora echinata* the key specie, together with the taxa *Ancyrospora* sp., *Ancyrospora? andevalensis, Aneurospora greggsii, Apiculiretusispora* sp., *Auroraspora* sp., *A. solisorta, Crassispora* sp., *Cristatisporites triangulatus, Cristicavatispora dispersa, Cymbosporites* sp., *Diducites poljessicus, D. versabilis, Emphanisporites annulatus, E. rotatus, Geminospora lemurata, Grandispora cornuta, Punctatisporites irasus, Retusotriletes* sp., *R. crassus, Rugospora explicata, R. flexuosa* and *Spelaeotriletes* sp. (Figure 15).

Borehole MSD1, located in the eastern open pit sector (Figures 14 and 15), intersected the following lithologies, from top to bottom (MATOS et al., 2006): sandstones and shales of the PQG, which are intruded by a dolerite sill (d); shales, siltstones and fine volcaniclastic sediments (VS5); black shales with interbedded phosphate and carbonate ooliths (VS6); shales and quartzwackes ascribed to the Freixial Formation. The shales of the PQG gave well preserved LN miospore assemblages of upper Strunian age, as indicated by the presence of *Verrucosisporites nitidus*, the index species in association with the taxa *Crassispora* sp., *Densosporites spitsbergensis, Geminospora lemurata, G. spongiata, Punctatisporites* sp., *Retispora lepidophyta, Rugospora flexuosa* and *Vallatisporites* sp. with some rare acritarchs and prasinophytes.

The shales of unit VS5 interbeded in the VSC yielded miospores of the Pu miospore Biozone of lower Viséan age, as shown by the presence of *Lycospora pusilla* in association with *Densosporites rarispinosum, Dictyotriletes* sp., *Knoxisporites* cf. *triradiatus* and *Vallatisporites* sp. Prasinophytes includes the species: *Leiosphaeridia* spp., *Pterospermella euriptio, Maranhites brasiliensis, M. britoii, M. mosesii, M. perplexus* and *Tasmanites* spp.

The black shales with phosphate and carbonate ooliths (VS6) and the shales of the Freixial Formation have similar miospore assemblages that indicate the mid upper Viséan NL Biozone. The assemblages have *Crassispora trychera, Densosporites* spp., *Lycospora pusilla, Microreticulatisporites* sp., and *Waltzispora planiangulata*, in association to the nominal specie *Raistrickia nigra* (Figure 15).

This borehole, although located close to the São Domingos mine open pit failed to find any kind of massive sulphides or even felsic volcanic rocks.

Sampling of the dark laminated shales and quartzites of PQG exposed in the western sector of the flooded open pit (Figure 14), revealed very well preserved miospore assemblage assigned to the VH miospore Biozone of upper Famennian age. Besides this, all samples enclose very rich assemblages of acritarchs and prasinophytes. Present are the acritarchs species: *Crassiangulina tesselita*, *Craterisphaeridium sprucegrovense*, *Deltotosoma* sp., *Daillydium pentaster*, *Gorgonisphaeridium ohioense*, *G. plerispinosum*, *Horologinella horologia*, *Micrhystridium stellatum*, *Palacanthus ledanoisii*, *P. tripus*, *Stellinium comptum*, *S. micropolygonale*, *Unellium piriforme*, *Veryhachium pannuceum*, *V. trispinosum* and *Winwaloeusia repagulata*.

The structural geology of the open pit area is now revised. MATOS et al., 2006 have suggested that the lithostratigraphic units are arranged in a sigmoidal tectonic sheet bounded by thrust faults. The fact that what was considered the Represa Formation in the western open pit area is indeed the PQG lead to a new structural interpretation (Figure 14). The VSC units appear tectonically bounded by PQG shales and quartzites forming a true tectonic window, which has been disrupted by

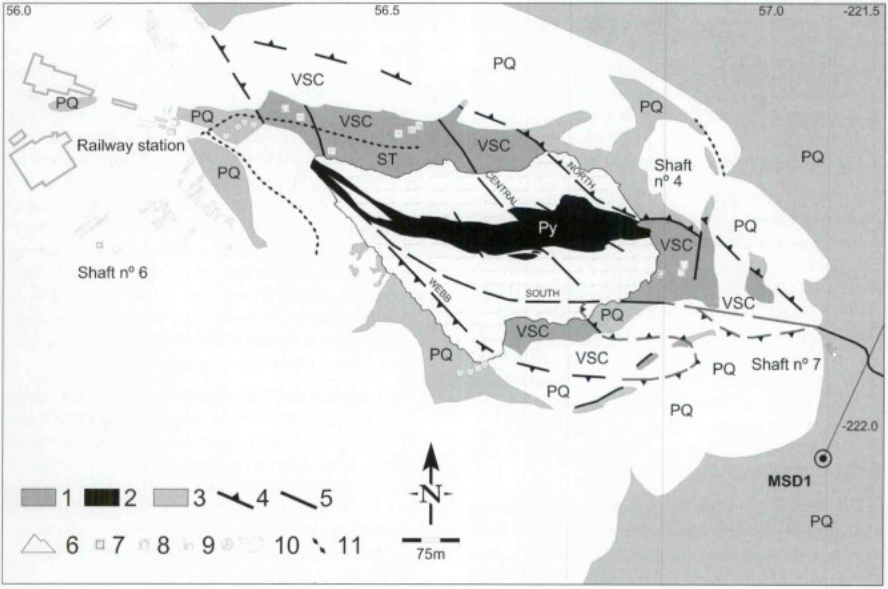

Fig.14 São Domingos open pit geology (adapt. MATOS et al., 2006).

Geology: Volcano Sedimentary Complex (VSC): 1 – Volcanic and sedimentary rocks; 2 - São Domingos massive sulphide orebody (Py). ST - São Domingos stockwork and related hydrothermal system; 3 - Phyllite-Quartzite Group (PQG); 4 – Thrust; 5 – Strike-slip fault; 6 - Mining waste and landfill; 7 – Shaft; 8 - Addict, 9 - Sample point; 10 - Flooded open pit, acid water level 107m; 11 - Pedestrian mining heritage track.

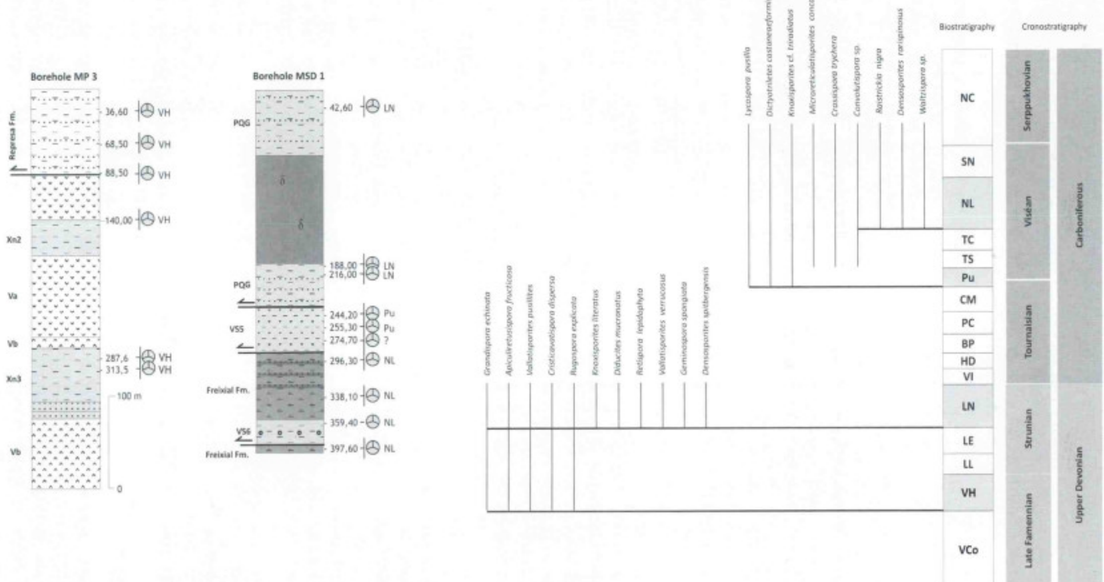

Fig.15 Logs from boreholes studied in S. Domingos mine region and stratigraphic distribution of selected miospore species from the recognised assemblages.

the Late Variscan South Fault along with a dolerite intrusion was installed.

South Branch

In the South Branch palynostratigraphic research has been concentrated in the Pomarão anticline, Neves Corvo, Aljustrel and Caveira mines, São Francisco da Serra and in the Cercal anticline (see Figure 5).

i. Pomarão Anticline

The Pomarão Anticline exposes the most complete lithostratigraphic succession of the Portuguese Iberian Pyrite Belt (BOOGAARD, 1967; OLIVEIRA & SILVA, 1990, Figure 5). From base to top are recognised the following units: phyllites and quartzites of the PQG (Eira do Garcia Fm); dark shales with carbonate nodules and lenses (Nascedios Fm); Cerqueirinha acidic volcanics; black shales with lenses of cherts and volcaniclastic sediments (Xistos Negros Fm); shales and quartzwackes with lenses of Fe/Mn oxides (Varjotas Mb); Corte Machado acidic volcanics and siliceous shales; siliceous shales with lenses and nodules of Mn oxides (Achada da Mina Mb); purple and green shales (Borra de Vinho Mb); Águia Fm acidic volcaniclastics which are conformably overlain by the Mértola Fm turbidites. As a whole, the succession thickness is in excess of *c.* 500m.

Conodonts, rare clymenids and brachyopodes recovered from the carbonate lenses and nodules of the Nascedios Fm indicate an upper Famennian age. In terms of palynology, only the shales of the Nascedios Fm yielded miospores assigned the LL Biozone of upper Strunian age (OLIVEIRA et al., 2006).

The assemblage comprises moderately preserved specimens of *Auroraspora* sp., *Diducites* sp., *Emphanisporites rotatus, Knoxisporites literatus, Retispora lepidophyta* and *Retusotriletes* sp., rare acritarchs and prasinophytes are also present.

ii. Neves Corvo mine region

The most comprehensive palynostratigraphic study undertaken in the Portuguese part of the Iberian Iberian Pyrite Belt is the investigation of the lithostratigraphic units of the Neves Corvo mine. Up to 39 drill cores were sampled from all the tectonically imbricated units which allowed the accurate dating all the units, and so concluded a long stan-ding stratigraphic controversy (OLIVEIRA et al., 1997; PEREIRA et al., 2004; OLIVEIRA et al., 2004).

The stratigraphic sequence comprises from base to top (Figure 16):

- The Phyllite Quartzite Formation, with a thickness in excess of 100m, is composed of dark shales with intercalations of thin-bedded siltstones and quartzites. Lenses of limestones, at the top of the lithological sequence yielded conodonts of the marginifera Biozone indicating a mid Famennian age (BOOGAARD & SCHERMERHORN, 1981). The age of the PQG is upper Famennian based on moderately to well preserved miospore assemblages assigned to the VCo and VH Miospore Biozones.

The VCo Biozone assemblage includes the type species *Grandispora cornuta* and abundant specimens of *Auroraspora macra, Cristatisporites triangulatus, Diducites versabilis, D. poljessicus, Emphanisporites annulatus, Geminospora lemurata, Retusotriletes planus, R. triangulatus* and *Rugospora flexuosa*. Reworked Frasnian miospores (*Cristatisporites* sp., *Contagisporites optivus, Aneurospora greggsii, Retusotriletes rugulatus, Verrucosisporites premnus* and *V. scurrus*) are well represented in the VCo studied assemblages.

The VH Biozone is marked by the abundant presence of *Grandispora echinata* together with *Ancyrospora* sp., *Auroraspora macra, Cristatisporites triangulatus, Diducites mucronatus, D. poljessicus, D. versabilis, Grandispora cornuta, Emphanisporites annulatus, Geminospora lemurata, Retusotriletes phillipsii, R. planus, R. triangulatus, Raistrickia variabilis, Rugospora flexuosa, Spelaeotriletes* sp., *Vallatisporites pusillites* and *V. hystricosus*. Acritarchs and prasinophytes are well represented in the assemblages. Reworked Frasnian miospores are also documented in the VH assemblages.

- The Volcano Sedimentary Complex (VSC) is lithologically divided into the Lower and Upper Complexes.

The Lower VSC, with a total thickness of *ca.* 350 m, is well represented and includes, in ascending order: basic rocks (b, b1) composed of dolerites and microandesites; acidic volcanics (V1) mostly represented by rhyolitic lavas and tuffs; the Corvo Formation (c) made up of dark and black shales with interbedded carbonate nodules and locally small clasts of tuffs; the Neves Formation (n), composed of black pyritic shales and thin bedded siltstones; acidic volcanics (V2), represented mostly by quenched rhyolites and minor volcaniclastics; massive sulphide orebodies (ms) hosted in black shales; a metre thick unit with jaspers and carbonates (JC) that lies immediately above the massive sulphides.

The Corvo Formation provided assemblages of miospores assigned to the VH Biozone of upper Famennian age, whose composition is similar to that of the PQG.

The Neves Formation yielded a spore assemblages characteristic of the LN miospore Biozone of upper Strunian age. This Biozone is marked by the presence of well preserved and abundant specimens of *Auroraspora macra, Densosporites spitsbergensis, Diducites mucronatus, D. poljessicus, D. versabilis, Epigruspora regularis, Geminospora spongiata, Grandispora cornuta, G. echinata, Knoxisporites literatus, Leiotriletes struniensis, Retispora lepidophyta, Retusotriletes incohatus, R. phillipsi, Rugospora flexuosa, Tumulispora rarituberculata, Vallatisporites pusillites, V. hystricosus* and *Vallatisporites verrucosus* together with the index species *Verrucosisporites niditus*. Rare specimens of *Aratrisporites saharaensis* also occur. Reworked Givetian to Frasnian miospores are present in the LN assemblages.

Acritarchs and prasinophytes are very common, including *Cymatiosphaera* sp., *Chomotriletes vedugensis, Dupliciradiatum crassum, D. tenue, Duvernaysphaera tessella, D. stellata, D. tenuicingulata, Gorgonisphaeridium elongatum, G. ohioense, G. plerispinosum, G. solidum, Horologinella quadrispina, Maranhites brasiliensis, M. britoii, M. gallicus, M. mosesii, M. multioculus, M. perplexus, Maranhites sp. A, Maranhites sp. B, Multiplicisphaeridium ramusculosum, Navifusa bacillum, Onondagella* sp., *Palacanthus ledanoisii, P. tripus, Pterospermella euriptio, Stellinium comptum, S. micropolygonale, Unellium piriforme, Umbellasphaeridium saharicum, U. deflandrei, Veryhachium pannuceum, V. trispinosum* and *Winwaloeusia repagulata.*

The absence of miospores characteristic of the LE and LL spore biozones suggests that a hiatus separates the Corvo and Neves formations. This hiatus is identified for the first time in the Iberian Pyrite and may be related to local submarine erosion (OLIVEIRA et al., 2004).

The massive sulphide orebodies are intercalated in latest Famennian (late Strunian, LN Biozone) black shales.

The Upper VSC is well represented in drill cores and crops out partially at surface. It includes in ascending order: the Graça Shales (r') composed of black shales with dispersed siliceous-phosphatic nodules; acidic volcanics (V3) represented by acidic lavas and volcaniclastics; basic sills (b2) that are intruded into the Graça shales; Grandaços Formation (s) made up of black and siliceous shales with dispersed centimeter-scale carbonate lenses; "Borra de Vinho" Formation (bv) with interfingering purple and green shales which are typical of the upper part of the VS Complex (also known as "pizarras moradas" in Spain); Godinho Formation (g) comprising acidic volcaniclastics and siliceous shales; and the Brancanes Formation (r) composed of black shales rich in pyrite and organic matter, and thin layers of graded siltstones and fine greywackes that mark the beginning of turbidite sedimentation. The total thickness of this complex is estimated in about 350m.

The Graça Formation provided miospore assemblages of the lower Viséan miospore Biozone TS. The TS Biozone is defined by the presence of the key species *Knoxisporites triradiatus* and *K. stephanephorus*. Other taxa present include *Anapiculatisporites* sp., *Convolutispora nigrata, Densosporites rarispinosus, Diatomozonotriletes rarus, Dictyotriletes propius, Hymenozonotriletes caperatus, Knoxisporites hederatus, K. rhulandii, Microreticulatisporites concavus, Proprisporites* sp., *Spelaeotriletes pretiosus, S. arenaceus, Vallatisporites pusillites, V. hystricosus* and *V. galearis*. Reworked Tournaisian palynomorphs are common.

The Grandaços Formation yielded miospores ascribed to the upper Viséan NL Biozone. The NL Biozone is a local biozone defined by the fist occurrence of *Raistrickia nigra*. Other taxa include *Convolutispora* sp., *Diatomozonotriletes* sp., *Knoxisporites hederatus, K. triradiatus, K. stephanephorus, Leiotriletes* sp., *Lycospora pusilla, Microreticulatisporites concavus* and *Proprisporites* sp.;

The Godinho Formation has miospores assigned to the NL Biozone. The assemblage includes abundant

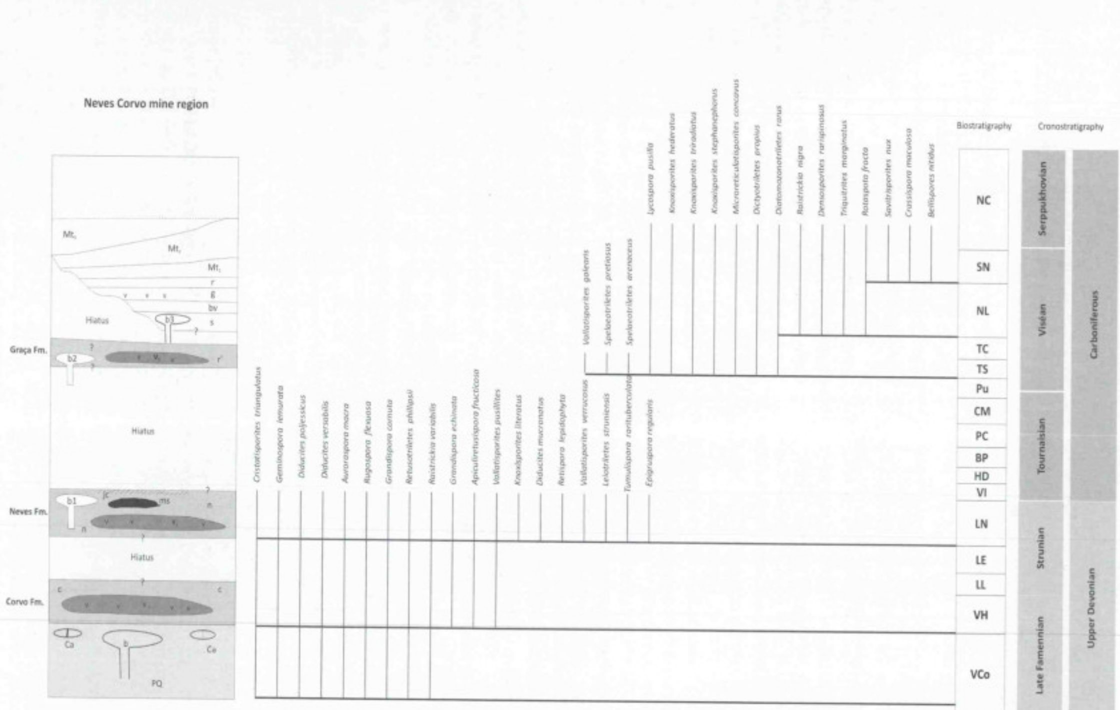

Fig.16 Chronostratigraphic chart of the Neves Corvo mine region with stratigraphic distribution of selected miosore species in (adapt. OLIVEIRA et al., 2004; PEREIRA et al., 2004). Legend: Mt1 to Mt3: Mértola Formation; r: Brancanes Formation; g: Godinho Formation; bv:Purple and Green Shales; s: Grandaços Formation; r': Graça Formation; n: Neves Formation; c: Corvo Formation and PQ: Phyllite Quartzite Formation.

Densosporites rarispinosus, D. annulatus, Knoxisporites hederatus, K. triradiatus, K. stephanephorus, Leiotriletes sp., *Lycospora pusilla* and the guide specie *Raistrickia nigra*. No miospores were recovered from the Brancanes Formation but the unit yielded ammonoid faunas of upper Viséan age (OLIVEIRA & WAGNER-GENTIS, 1983).

No miospore biozone of Tournaisian age was identified in present study. However, one miospore assemblage ascribed to the VI Miospore Biozone was recovered from shales in a borehole situated 3 Kms NW of the mine. A similar situation seems to occur in Spain (RODRIGUEZ et al., 2002). It is worth noting that sediments of Tounaisian age younger than VI Biozone are unknown in the Iberian Pyrite Belt. However, reworked Tournaisian miospores are found in younger units suggesting that sediments of this age may have been deposited elsewhere. This Tournaisian lacuna may well be due to widespread submarine erosion (OLIVEIRA et al. 2004).

Another hiatus embraces the TC Miospore Biozone of lower Viséan age. This is probably of local origin induced by the impressive tectonism.

- The Mértola Formation (Mt1) is a typical flysch succession comprising alternations of greywacke and dark grey shales. Three distinct sequences of turbidite beds are known in the mine region (Figure 16, 17): Mt1 beds that surround the Neves-Corvo mine antiformal structure; Mt2 beds which are only known from drill cores and rest unconformably on the shales of Graça Formation; and

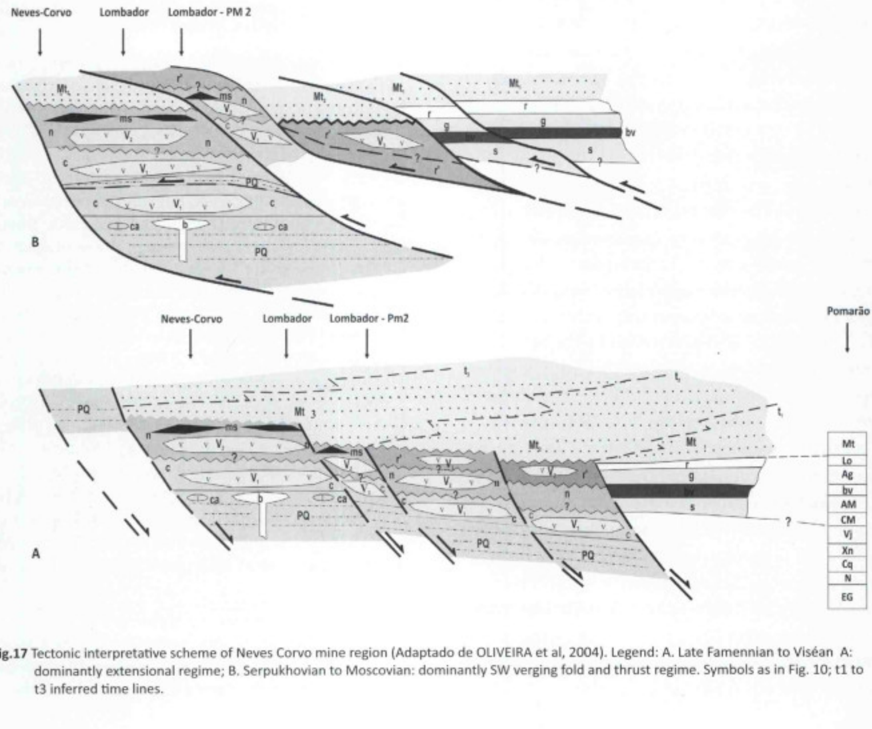

Fig.17 Tectonic interpretative scheme of Neves Corvo mine region (Adaptado de OLIVEIRA et al, 2004). Legend: A. Late Famennian to Viséan A: dominantly extensional regime; B. Serpukhovian to Moscovian: dominantly SW verging fold and thrust regime. Symbols as in Fig. 10; t1 to t3 inferred time lines.

Mt3 beds, which are the deepest beds of the Mértola Formation and lie unconformably on the Neves Shales, on the JC sediments and even on the massive sulphides.

The geometric and spacial position of the Mt1, Mt2 and Mt3 beds of the Mértola Formation shows that the flysch sediments are getting older as far as we ascend in the tectonic pile (Figure 17). This is due to the conjugate effect of the southwestward flysch progradation on an already consolidated substrate and the tectonic thrusting in the same sense (OLIVEIRA et al., 2004). The Mértola Formation flysch sediments yielded poorly to moderately preserved miospore assemblages refered to the Biozones NL, SN and NC Miospore Biozones of the upper Viséan age. The NL Biozone includes the guide specie *Raistrickia nigra* and also common specimens of *Densosporites rarispinosus, D. annulatus, Diatomozonotriletes* sp., *Knoxisporites triradiatus, K. stephanephorus, Leiotriletes* sp., *Lycospora pusilla, Microreticulatisporites concavus* and *Proprisporites laevigatus*. Reworked Viséan and Tournaisian palynomorphs were also determined. The SN Biozone, a local zone, was defined by the presence of abundant *Anaplanisporites baccatus, Densosporites intermedius, D. brevispinosus, Lycospora pusilla, Knoxisporites triradiatus, K. stephanephorus, Raistrickia nigra, Savitrisporites nux* and rare *Rotaspora fracta, Diatomozonotriletes* sp. and *Triquitrites marginatus*. The NC Biozone is characterised by the first occurrence of *Bellispores nitidus* together with abundant species of *Crassispora maculosa, Convolutispora venusta, Diatomozonotriletes* sp., *Dictyotriletes* sp., *Leiotriletes tumidus, Rotaspora fracta* and *Savitrisporites nux*. In the entire studied NC assemblages reworked Strunian and Tournaisian miospores are common. The Mértola Formation also yielded the goniatites *Goniatites hudsoni* and *G*? *globostriatus* of upper Viséan A age and *Arnsbergites arnsbergensis, Arnsbergites falcatus* and *Hibernicoceras*, which indicate the upper Viséan B confirming the results provided by the palynomorphs in the Neves Corvo mine region (OLIVEIRA et al., 2004);

iii. Aljustrel mine region

The Aljustrel antiformal structure comprehends entirely VSC lithologies, the PQG is not known here. The startigraphic succession was originally described by SCHERMERHORN & STANTON (1969) and ANDRADE & SCHERMERHORN (1971) who have erected the following sequence: Megacristal Tuffs in the lower central part, which are overlain by the Green Tuffs; laterally these units grade respectively to the lower volcanics felsitic facies and upper volcanics ("Mine Tuffs") that has in its top the massive sulphides ore. Total thickness of VSC is up to 200m, base unknown. BARRIGA (1983) simplified the startigraphic sequence, proposing only two units, the Quartz Eyes Tuffs Formation (that includes the Megacristal and Green Tuffs) and the Mine Tuff Unit. Over the volcanic suite, extensive jasper lenses occur along with the Paraíso Formation, consisting of purple and green shales, black shales, fine volcaniclastic sediments and locally mafic rocks (LEITÃO, 1998).

More recently (DAWSON et al, 2001,) visualized a distinct stratigraphic sequence composed, from base to top of: the Lower Volcanic Unit (with three types of rhyolites, equivalent to the Mine Tuff); the Massive Sulphides unit, 1-100 m thick; and the Upper Volcanic Unit, with volcanics and rare lapili with rhyolitic composition, considered as the Green Tuffs equivalent, and the Quartz Feldspatic Rhyolites. These authors assume that the unit Quartz Feldspatic Rhyolites is equivalent to the Megacristal Tuffs and is intrusive in the previousl-ly described succession and also in Paraíso Formation. The Lower Rhyolites were dated as 352.4±1.9 My by zircons (BARRIE et al., 2002) i.e. lower to mid Tournaisian age. ROSA et al., 2009 dated the Mine Tuffs (equivalent to the Lower Volcanic Unit, Santa Bárbara gallery) as 354.6±1.7 My, the Megacristal Tuffs in the Feitais ramp as 364.0±1.7 My (mid to upper Famennian) and in the São João quarry as 356.6±2.1 My (upper Famennian). The unit Megacristal Tuffs appear so the oldest unit in the Aljustrel volcanic suite and cannot be intrusive in the other units as interpreted by BARRIE et al. (2002).

A preliminar palynostratigraphic study (sampling program on recent 1/5000 scale unpublished map, Matos 2005) of the Aljustrel sequence allowed the identification of moderately preserved miospore assemblages, assigned to the Pu Biozone of lower Viséan age in the Paraíso Formation. The assemblages show the presence of *Lycospora pusilla* in association with *Densosporites rarispinosum, Acanthotriletes* sp., *Convolutispora* sp., *Dictyotriletes* sp., *Knoxisporites* cf. *triradiatus, Secarisporites* sp. and *Vallatisporites* sp. Prasinophytes includes the species: *Maranhites brasiliensis, M. britoii, M. mosesii, M. perplexus* and *Tasmanites* spp.

The Mértola Formation flysch sediments yielded poorly to moderately preserved miospore assemblages assignable to the NL Biozone of mid upper Viséan age. The Biozone is defined by the presence of moderately preserved *Raistrickia nigra*, the zonal key specie and also common specimens of *Densosporites rarispinosus, D. annulatus, Diatomozonotriletes* sp., *Knoxisporites triradiatus, K. stephanephorus, Leiotriletes* sp. and *Lycospora pusilla*.

iv. Lousal/Azinheira de Barros/Mina da Caveira regions

In the Lousal/Azinheira de Barros/Mina da Caveira region the Iberian Pyrite Belt develops complex antiformal structures. The age of the lithostratigraphic units is still poorly constrained.

Shales of the PQG, recovered from a road cut north of Azinheira de Barros village provided a moderately preserved miospore assemblage that contains the index species *Verrucosisporites nitidus*, the index species and the following taxa *Crassispora* sp., *Densosporites spitsbergensis, Geminospora lemurata, G. spongiata, Punctatisporites* sp., *Retispora lepidophyta, Rugospora flexuosa* and *Vallatisporites* sp. that indicate the LN Biozone.

The VSC shows two main volcanic suites: one dominated by felsic volcanics, shales and intrusive diabases; the other composed mostly of basic volcanics and intrusives. The VSC suite is followed by the Mértola Formation turbidites that yielded a moderately preserved miospore association with *Crassispora* sp., *Densosporites* spp., *Lycospora pusilla, Microreticulatisporites concavus, Proprisporites* sp. and *Waltzispora planiangulata*, in association to the nominal species *Raistrickia nigra*. This assemblage is asssigned to the NL local Biozone of mid upper Viséan.

The Caveira mine is located in a complex N-S trending antiformal structure with a core composed of PQG shales and quartzites surrounded by VSC felsic volcanics (OLIVEIRA et al., 2006, MATOS, 2006, Figure 18). Several massive sulphides <10m thick lenses occur near the PQG/VSC boundary, forming two main ore horizons: the Helena Shaft and the Luísa Shaft. The structure is affected by N-S and NE-SW late Variscan reverse faults. The borehole CAV 02 (Figure 19) was selected to illustrate the lithological succession and the palynostratigraphic study. The following units were identified: dark shales with thin-bedded siltstones and quartzites (Xn1); felsic porphyritic volcanics (Va); black shales (Xn2) with massive sulphide intercalations (Luisa Shaft orebodies); dark shales with

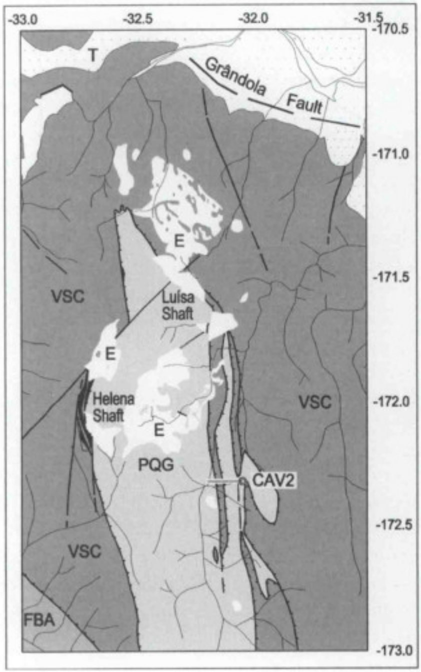

Fig.18 Simplified Caveira mine geology (adapt. MATOS, 2006): FBA - Mértola Fm. Flysch; VSC - Volcano-Sedimentary Complex; PQG - Phyllite-Quartzite Group; T - Tertiary sediments; E - Mine waste tailings. Hayford-Gauss coordenates in km;

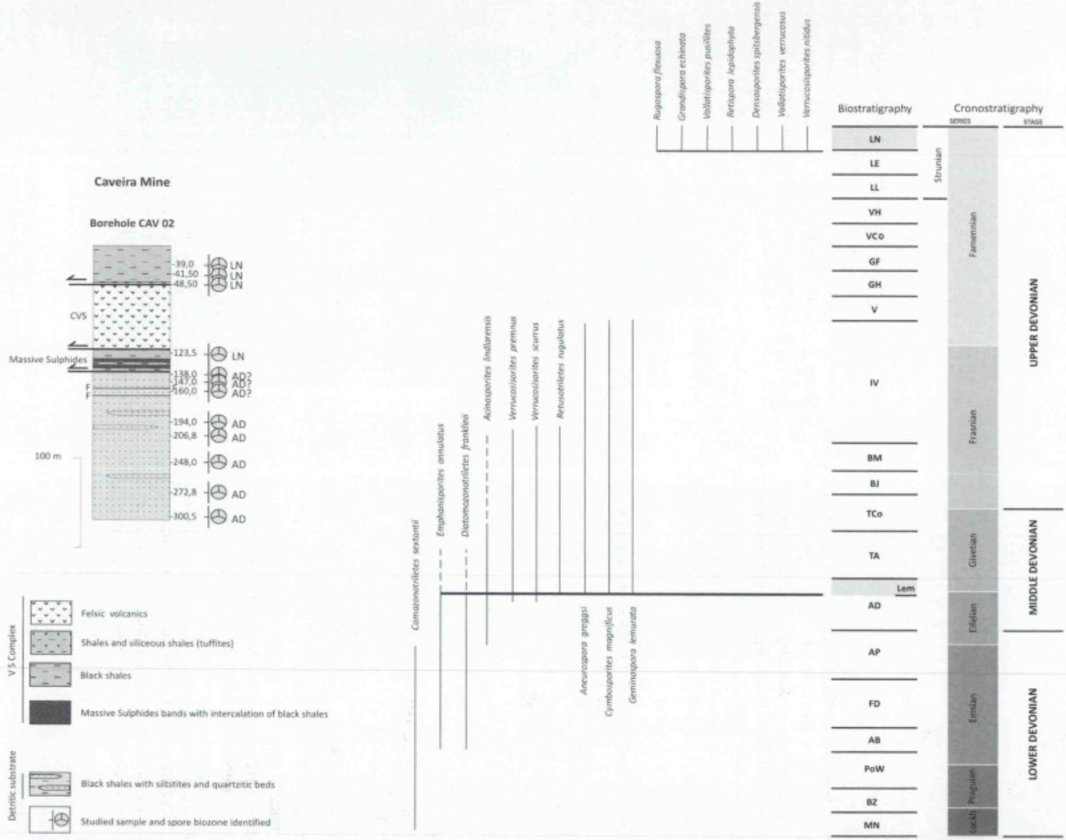

Fig.19 Logs from borehole CAV 02 studied in Caveira mine and stratigraphic distribution of selected miospore species from the recognised assemblages.

siltstones and quartzitic beds (PQG). The Unit Xn1, interpred as a PQG equivalent, is thrusted over the felsic volcanics Va and the contact between unit Xn2 and the PQG lithologies is faulted (extensional shear zone?).

The black shales of unit Xn1 and also those intercalated in the massive sulphides (Xn2), both gave rich miospore associations of the LN Biozone characterized by abundant specimens of *Auroraspora macra, Cristatisporites triangulatus, Densosporites spitsbergensis, Dictyotriletes fimbriatus, Discernisporites* sp., *Geminospora spongiata, Grandispora cornuta, G. echinata, Knoxisporites literatus, Punctatisporites irrasus*, *Retispora lepidophyta, Retusotriletes incohatus, Rugospora flexuosa, Vallatisporites pusillites* and *Vallatisporites verrucosus* together with the guide specie *Verrucosisporites niditus* (Figure 19). *Maranhites* spp are also present.

The black shales interbbedded in the PQG quartzites revealed the presence of moderately preserved miospores indicating the AD miospore Biozone, subzone Lem, of Lower Givetian age (Figure 19). This Biozone, shows moderately preserved species of *Cristatisporites* sp., *Geminospora lemurata, Cymbosporites magnificus, Aneurospora greggsii, Emphanisporites annulatus, Grandispora* sp., *Retusotriletes rugulatus, Verrucosisporites premnus* and *V. scurrus* (Figure 19). Reworked older miospores of Lower Devonian age make part of the assemblage (e.g. *Camarozonotrilestes sextantii* and *Diatomozonotriletes* sp.).

Together with the ages determined for the PQG lithologies in the São Francisco Anticline (see below) these are the oldest sediments ever found in the Portuguese part of the Iberian Pyrite Belt.

The time gap between unit Xn2 and the PQG lithologies covering the Famennian, the Frasnian and a big part of the Givetian is probably due to the effect of the extensional fault between the two units.

Recent U-Pb geochronology data in zircons recovered from felsic volcanics ca 300m SSE of Luísa Shaft indicate an age of 361±4My (ROSA et al., 2008) e.g. upper Famennian. Available palynological data suggest that the age of the Caveira massive sulphides is upper Strunian.

v. São Francisco da Serra region

The stratigraphic succession of this anticline comprehend shales and quartzites, in places thick-bedded and amalgamated, of the PQG which are overlain the VSC lithogies dominated by shales, siliceous shales and fine volcaniclastic sediments, minor felsic volcanics, purple shales and dark carbonaceous shales at the upper part.

Preliminary palynologic study of borehole M1 (made by the Sociedade Mineira Riofinex, in 1993), located in the central part of the anticline shows a highly fractured black shales sequence, with interbeded thin-bedded quartzites (Figure 20). This succession yielded a moderately preserved miospore assemblage assigned to the upper part of AD miopore Biozone, subzone Lem, of Lower Givetian age.

The most common species present are: *Acinosporites lindlarensis, Aneurospora greggsii, Cymbosporites magnificus, Geminospora lemurata, Emphanisporites annulatus, E. rotatus, Grandispora protea, Retusotriletes rugulatus, Verrucosisporites premnus* and *V. scurrus* (Figure 21). *Cristatisporites triangulatus* is missing. The first occurrence of this specie is at the base of TA Biozone, confirming the age of the assemblage, as pre-TA miospore Biozone (see Figure 21). Present are also reworked miospores of Lower Devonian age (e.g. *Archaeozonotriletes chulus, Brochotriletes* sp., *Camarozonotrilestes sextantii* and *Diatomozonotriletes franklini*).

vI. Cercal Anticline region

The Cercal Anticline (CA) is located in the westernmost region of the Iberian Pyrite Belt. The exposed stratigraphic sequence includes, in ascending order, the VSC followed by the Xistos das Abertas Fm, which passes gradually to the flysch sequence of the Mira Formation (CARVALHO, 1976) (Figure 22). The VSC is composed from base to top by: Felsic Volcanics (Vα), that comprehend lavas, pumice and volcaniclastic beccias with intercalations of volcanogenic shales; diabases and intermediate/basic subvolcanics (Vβ); jaspers and the S. Luís Formation (SL), a unit composed of shales, phyllites, siliceous shales and volcanogenic sediments. About 500m NW of São Luís village, at the base of this last unit, brachiopods ascribed to the upper Strunian were found (QUIRING, 1936). This determination led CARVALHO (1976) to assume that the volcanics of the VSC are older than the Strunian, meaning so that this volcanism is the oldest in the Portuguese IPB.

Detail palynostratigraphic research in the Cercal Anticline is currently being undertaken. The stratigraphic succession is still poorly constrained, in terms of lithostratigraphy and age. In fact, three boreholes drilled out in the hinge zone of the anticline by the Elf Aquitane company (Borehole ME1 in Lugar de Medouros and boreholes CP1 and CP2 in Corte Pinheiro about 1km NW of São Luis village), showed from top bottom (Figure 23, 24): 20 m of partially weathered shales and siltstones (borehole CP2) ; 20 m of chloritic tuffs (boreholes CP1 and CP2) and 130 m of felsic lavas (borehole ME1) followed by a thick (>550 m) succession of dark shales and siltstones (XnS). Forty four samples of shales from the three boreholes were studied and of these thirty eight yielded very well preserved specimens of *Grandispora echinata* together with *Ancyrospora sp., Ancyrospora? andevalensis, Apiculiretusispora fructicosa, Auroraspora macra, Cristatisporites triangulatus, Cristicavatispora dispersa, Diducites poljessicus, D. mucronatus, D. versabilis, Endoculeospora gradzinskii, Emphanisporites annulatus, Geminospora lemurata, Grandispora cornuta, Punctatisporites* spp., *Retispora* cf. *macroreticulata, Retusotriletes phillipsii, R. planus, R. triangulatus, Rugospora explicata* and *R. flexuosa* (Figure 24, 25). This assemblage indicates the VH Biozone of upper Famennian age. All samples studied contain rich assemblages of acritarchs and prasinophytes, including *Gorgonisphaeridium ohioense, G. plerispinosum, Maranhites mosesii, M. perplexus, Multiplicisphaeridium ramusculosum, Stellinium comptum, S. micropolygonale, Veryhachium pannuceum, V. trispinosum* and *Winwaloeusia repagulata.*

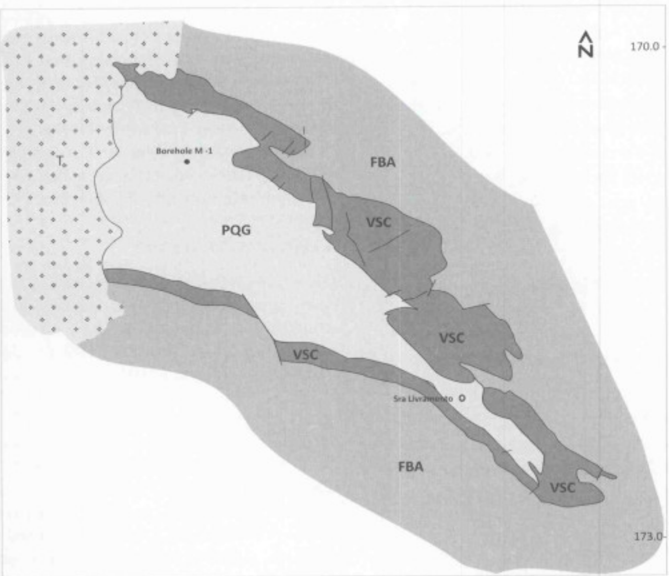

Fig.20 Simplified S. Francisco da Serra Antiform geology (adapt. ALVES et al. 1985), Coordenadas em Hayford-Gauss, em km): FBA - Mértola Fm. Flysch; VSC - Volcano-Sedimentary Complex; PQG - Phyllite-Quartzite Group; T - Tertiary sediments.

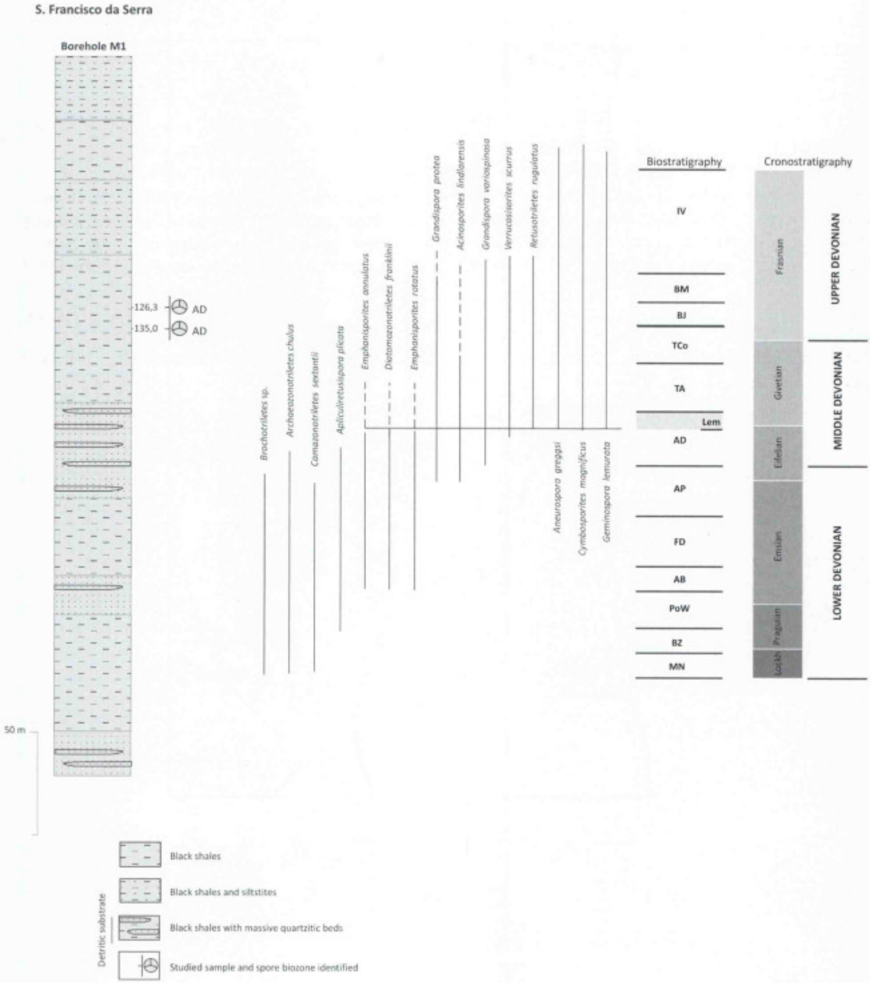

Fig.21 Log from borehole M 1 studied in S. Francisco da Serra and stratigraphic distribution of selected miospore species from the recognised assemblages.

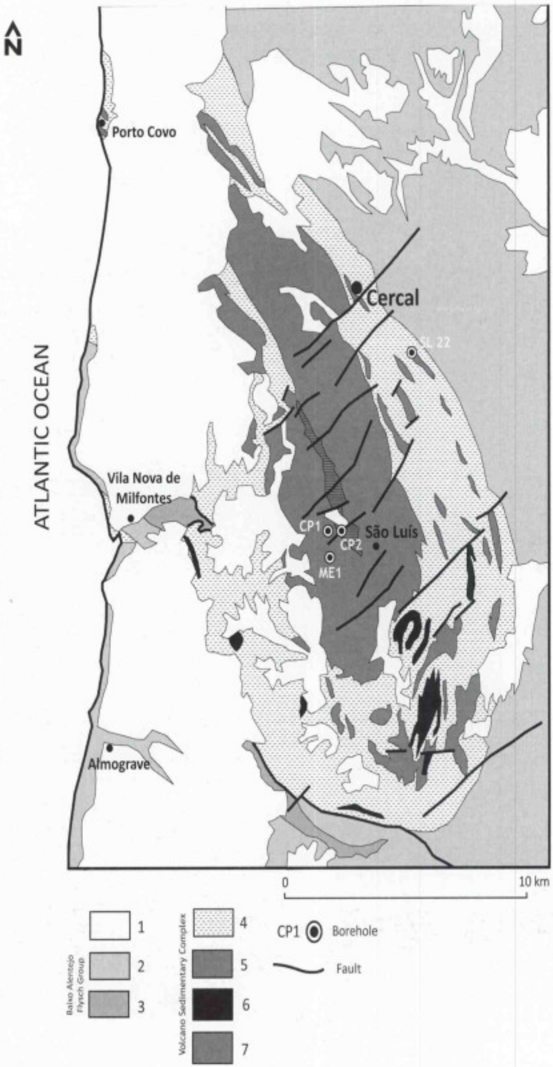

Fig.22 Simplified geology of the Cercal anticline: 1. Cenozoic sedimentary cover; 2. Mira Fm.; 3. Brejeira Fm.; 4. São Luís Shales. 5. Felsic volcanics 6. Mafic volcanics 7. Dark shales and siltstones.

At Salgadinho, about 7 Kms NE of São Luis village, the borehole SL 22 made by the Serviço de Fomento Mineiro was studied (Figure 24, 25). The lithological succession shows felsic, frequently sericitic tuffs and lavas interbedded in dark shales and siltstones. These lithologies are very similar to those identified in São Luis region.

Two main conclusions must be pointed out from the study of these boreholes: i) the enormous thickness of the shales and siltstones below the felsic volcanics in the hinge zone of the anticline (Figure 22) all belonging to the same miospore VH Biozone, a situation that is not common in the Iberian Pyrite Belt. The lithologies are affected by a strong flat cleavage which suggest that the succession is tectonically repeated; ii) the fact that the volcanics apear interbedded in shales dated by the VH miospore Biozone suggest that they have the same age. Volcanics of the this age are also known in other regions, as for instance in Albernôa and São Domingos mine antiforms. Recent U/Pb geochronogical determinations in felsic volcanics of the central area of the anticline gave ages between 369,5±0,85 and 374,3±1,6 My (ROSA et al., 2009) *e.g.* lower Famennian, so older than the age provided by miospores.

Still in the Cercal Anticline, samples collected in road cuts of the national road EN 262, from Cercal to Abertas, in the Espadanal locality, from the Xistos das Abertas Formation, a flysch unit, allow the identification of the KV miospore Biozone of Serpukovian age. This unit corresponds to the basal part of Mira Formation of the Baixo Alentejo Flysch Group.

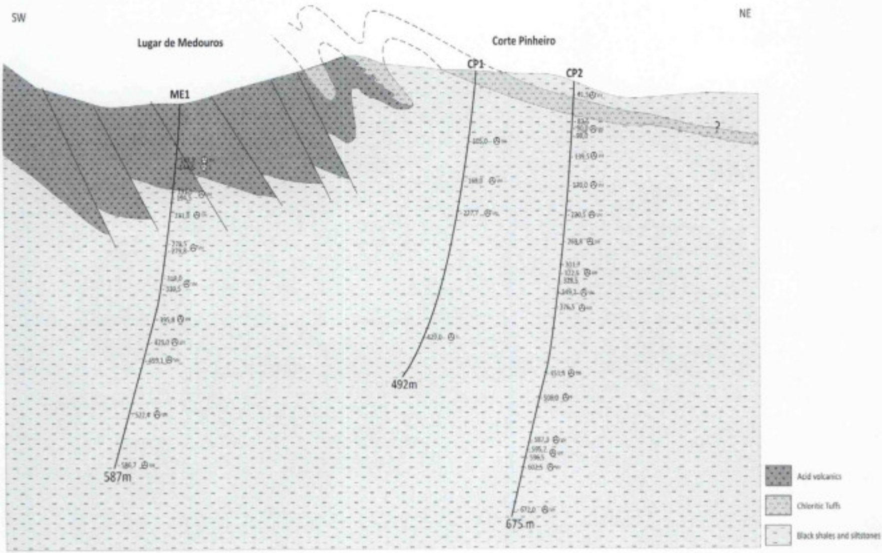

Fig.23 Cross section, from ELf Aquitaine Exploration Report (INETI documentation, 1984), with studied boreholes and positive samples.

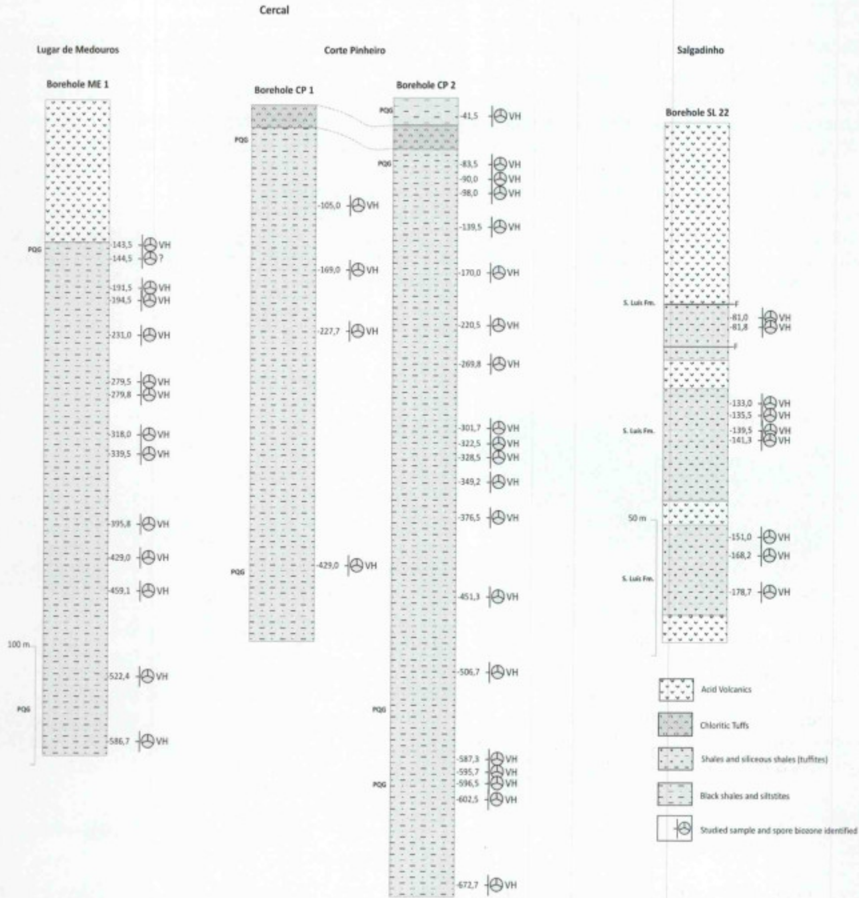

Fig.24 Boreholes studied at the Cercal Anticline, with positive samples illustrated.

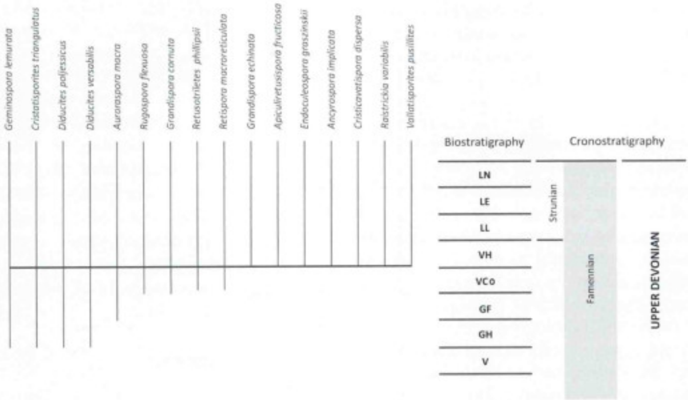

Fig.25 Stratigraphic distribution of selected miospore species from the recognised assemblages in studied samples of Cercal.

Miospore assemblage includes *Crassispora kosankei*, the zonal specie, together with *Bellispores nitidus, Crassispora maculosa, Densosporites* spp., *Lycospora pusilla, Microreticulatisporites concavus, Rotaspora knoxi* and *Tripartites vetustus*.

4.3. The Baixo Alentejo Flysch Group

The stratigraphic palynology of the Baixo Alentejo Flysch Group, although still very incomplete, has been provisionally established. The miospore ages are consistent with ammonoid data recovered from all the BAFG units (KORN, 1997).

Mértola Formation

The Mértola Formation was studied for palynomorphs in several regions, such as the Neves Corvo mine, Mértola town, Azenhas section in Guadiana River, Bens Farm. All the studied samples (mainly shales) gave a upper Viséan age (OLIVEIRA et al., 2007; PEREIRA et al., 2007). Three miospore biozones are identified: the NL and SN Biozones, defined as local miospore biozones (see the details described in the SWP Domain below) based respectively on the first occurrence of the index species *Raistrickia nigra* and *Savitrisporites nux*, and the NC Biozone (recognised only at the Neves Corvo mine region) based on the first appearance of the key species *Bellispores nitidus*.

Mira Formation

The age of Mira Formation is upper Viséan to lower Bashkirian, based on the ammonoids *Dombarites*, *Lyrogoniatites* and *Cravenoceras* (OLIVEIRA et al., 1979; KORN, 1997). Palynostratigraphic data are scarce at the present time and are only restricted to black shale samples obtained in the Castro Marim region. These samples yielded upper Viséan NC miospore Biozone assemblages that contain the key species *Bellispores nitidus*.

Brejeira Formation

The youngest unit of the BFGA is the Brejeira Formation. The palynostratigraphic study of this unit revealed 6 miospore biozones, ranging from the Bashkirian to upper Moscovian (PEREIRA 1997; 1999; Figure 26). These miospore ages are consistent with the local ammonoid biozonation (KORN, 1997).

The base of the Brejeira Formation, in the north part of its outcrop area indicates the FR Miospore Biozone of mid Bashkirian age, which contains the index specie *Reticulatisporites reticulatus* and the *Dyctiotriletes probireticulatus* in the upper part of the zone. Further south, miospore assemblages are successively assigned to the following: SS miospore Biozone characterised by the index specie *Cirratriradites saturni*; Ra Miospore Biozone assemblage containing *Radiizonates aligerens*; Ra/NJ biozonal boundary was only identified in Pincho Road section and is marked by the first occurrence of *Florinites junior*; the SL miospore Biozone was identified based on the first appearance of *Torispora securis*, the presence of *Cadiospora magna* and upper in the the lithological sequence by the incoming of the index taxa *Raistrickia aculeata*; the OT Miospore Biozone is marked by the occurrence of *Thymospora pseudothiessenii*, and the common presence of *T. obscura* and *T. thiessenii*. This distribution of the palynological assemblages confirms the southwestward progradation of the turbidites. The Variscan tectonic deformation in this sector is post-Moscovian in age.

4.4. Southwest Portugal (SWP) Domain, Bordeira and Aljezur Anticlines

Detailed palynostratigraphic research has allowed the establishment of 12 miospore biozones, in which 47 species of upper Devonian age and more than 200 Carboniferous miospore species (PEREIRA et al., 1994; PEREIRA & OLIVEIRA, 1995; PEREIRA, 1997; 1999). These palynostratigraphic results correlate well with the local ammonoids biozonation (OLIVEIRA et al., 1985; KORN, 1997). Sampling was made mostly in coastal cliff sections and also in road cuts.

Tercenas Formation

The palynological study of Tercenas Formation reveals a diverse and well preserved miospore assemblages assignable to the LN Miospore Biozone of upper Strunian age and VI Miospore Biozone of lower Tournaisian age (Figure 27,28). The LN Biozone is characterised by the common presence of *Densosporites spitsbergensis, Dictyotriletes fimbriatus, Knoxisporites concentricus, Retusotriletes crassus, Retispora lepidophyta, Rugospora flexuosa, Vallatisporites pusillites, V. hystricosus, V. verrucosus, Tumulispora rarituberculata* and the key specie *Verrucosisporites nitidus*. All samples suited contain rich assemblages of acritarchs and prasinophytes (*e.g. Cymatiosphaera* sp., *Chomotriletes vedugensis, Duvernaysphaera tessella, D. stellata, D. tenuicingulata, Gorgonisphaeridium ohioense, G. plerispinosum, G. solidum, Hologinella quadrispina, Maranhites brasiliensis, M. britoii, M. gallicus, M. mosesii, M. multioculus, M. perplexus, Multiplicisphaeridium ramusculosum, Navifusa bacillum, Onondagella* sp., *Pterospmella euriptio, Stellinium comptum, S. micropolygonale, Unellium piriforme, Umbellasphaeridium saharicum, U. deflandrei, Veryhachium pannuceum, V. trispinosum* and *Winwaloeusia repagulata.*

Bordalete Formation

Sampling of the Bordalete Formation allowed the identification of the VI, HD and PC Miospore Biozones of Tournaisian age (Figure 27, 28). The VI miospore Biozone (recognised in the Eirinhas-Rizada-Penedo Road section, Monte do Penedo and Pedra Ruiva sections) is marked by the presence of the index specie *Vallatisporites verrucosus* together with the common presence of *Cyrtospora cristifera, Puctatisporites irrasus, Retusotriletes incohatus, Secarisporites remotus* and *Tumulispora rarituberculata*.

The base of HD Biozone, indicated by the first income of the index taxa *Cristatisporites hibernicus*, was identified in the Eirinhas-Rizada-Penedo Road section. It is also characterised by the first appearance of the distinctive species *Umbonatisporites distinctus* and *Neoraistrickia cymosa*.

A typical, diverse and very well preserved PC Miospore Biozone assemblage was recovered from several sections of the Bordalete Formation The zone is defined by the presence of the guide specie *Spelaeotriletes pretiosus* together with *Auroraspora macra, K.* cf. *triradiatus, Granulatisporites microgranifer, Neoraistrickia cymosa, N. logani, Raistri-ckia clavata, Spelaeotriletes balteatus, Vallatisporites microspinosus, V. vallatus, V. verrucosus, Verrucosisporites congestus, V. irregularis* and *V. nitidus* (Figure 27, 28).

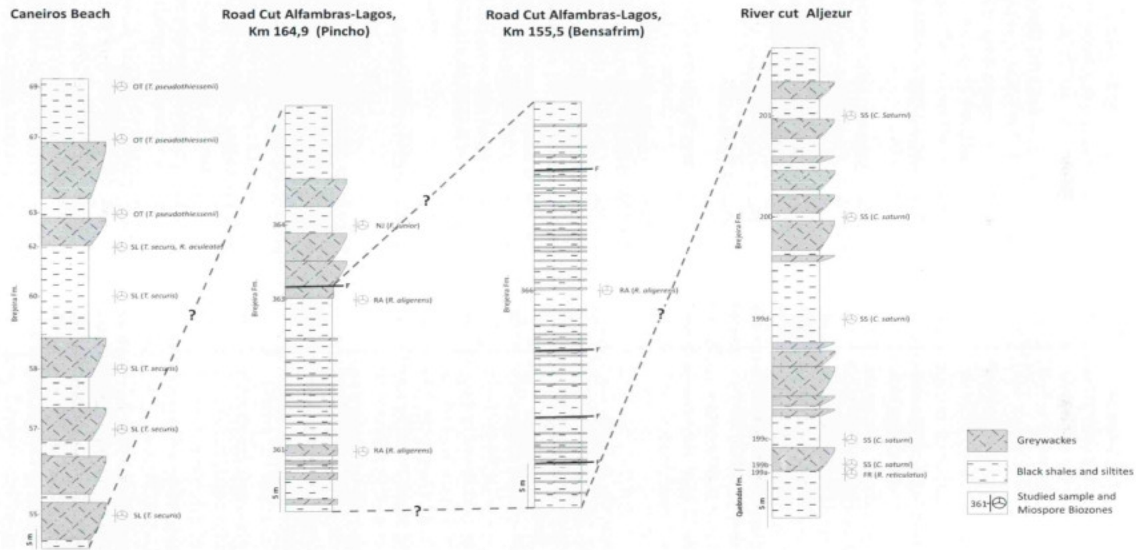

Fig.26 Selected stratigraphic sections from Brejeira Formation (Adapt. PEREIRA, 1999).

At the top of this unit the CM Miospore Biozone of upper Tournaisian age is missing, probably due to the presence of a hiatus. These palynostratigraphics data exclude the existence of a basal hiatus as previously suggested (OLIVEIRA et al., 1985).

Murração Formation

From the Murração Formation 5 miospore biozones of Viséan age have been recognised (PEREIRA, 1999). The study of the Pedra das Safias Member proved to be very difficult due to the strong dolomitization. Only in the Aljezur Anticline, in the Marianos and Corte da Velha sections (Figure 27, 28), where this unit has a more shaly character, it has been possible to identify the base of the Pu miospore Biozone, based in the first appearance of *Lycospora pusilla* and the base of TS Biozone, by the first appearance of *Knoxisporites triradiatus* and *K. stephanephorus*. These two miospore biozones indicate a lower Viséan age for the Pedra das Safias Member.

The Vale Figueira Member, in Praia das Quebradas section (Figure 27, 28) has yielded moderately preserved miospore assemblages assignable to the NL, SN, and NC Biozones of upper Viséan age. Two biozones were defined as local miospore biozones, the NL (*Raistrickia nigra - Proprisporites laevigatus*) and SN (*Savitrisporites nux*) based respectively, on the first occurrence of *Raistrickia nigra* and *Savitrisporites nux* guide taxa (Figure 2). These local biozones were defined due to the absence of stratigraphically useful taxa such as *Rotaspora* spp., *Tripartites* spp. and *Triquitrites* spp. Nevertheless, the NL Biozone can be correlated with the *Raistrickia nigra - Triquitrites marginatus* Miospore Biozone of Western Europe based in the first appearance of *Raistrikia nigra* that occurs at the same level. *Proprisporites laevigatus* appears together with the first *R. nigra* in Southwest Portugal, but in Western Europe the first record of this specie is much higher, at the top of NC Biozone of upper Viséan to lower Serpukhovian age (CLAYTON et al., 1977, CLAYTON, 1996). The SN local Biozone can be correlated with the VF Miospore Biozone of Western Europe, based in the first occurrence of *Savitrisporites nux*. In Western Europe, in addition to *S. nux*, the *Tripartites vetustus* Biozone is defined by the first appearance of a group of new species which includes *Tripartites vetustus, Tripartites nonguerikei, Rotaspora fracta* and *R. knoxi*, which are not represented in the upper Viséan of Southwest Portugal (CLAYTON et al., 1977; CLAYTON 1996).

The basal part of the NC Biozone is marked by the presence of the guide species *Bellispores nitidus*, which was recognised in the Quebradas Beach section. The assemblage also contains the species *Crassispora maculosa, Microreticulatus concavus, Propisporites laevigatus, Raistrickia nigra* and *Savitrisporites nux.*

The palynostratigraphical evidence indicates that the entire Viséan may be represented in the Murração Formation (PEREIRA 1997, 1999) confirming so previous faunal determinations (OLIVEIRA et. al. 1985; KORN, 1997).

Quebradas Formation

The moderately preserved miospore assemblages recovered from Quebradas Formation are assigned to the Bashkirian KV and FR Miospore Biozones. The KV Biozone is marked by the presence of *Crassispora kosankei*. The basal pat of the FR Biozone is defined on the first occurrence of *Reticulatisporites reticulatus* together with comon specimens of *Crassispora kosankei, Raistrickia fulva* and *Savitrisporites nux* (Figure 27, 28). These results fit well, in terms of age, with the local ammonoid biozonation (OLIVEIRA et al., 1985; KORN, 1997).

5. REWORKED PALYNOMORPHS

Reworking results from the transport of palynomorphs from one depositional place to another. It can led to a combination of different age miospore assemblages or, in rare cases, the age of the miospores is completely different from that of the host sediment, in this last case is prefera-bly called recycling. Recycled palynomorphs are mostly recognised by their anomalous biostratigraphic age; differences in the colour of the exines and preservation state are considered less significant. Reworked palynomorphs are commonly preserved in pristine conditions, due to their durability (RAVN & BENSON, 1988; VAN DER LAAR & FERMONT, 1989).

The investigation of reworked palynomorphs can be an important aspect of provenance studies in general. When possible, considerations on the

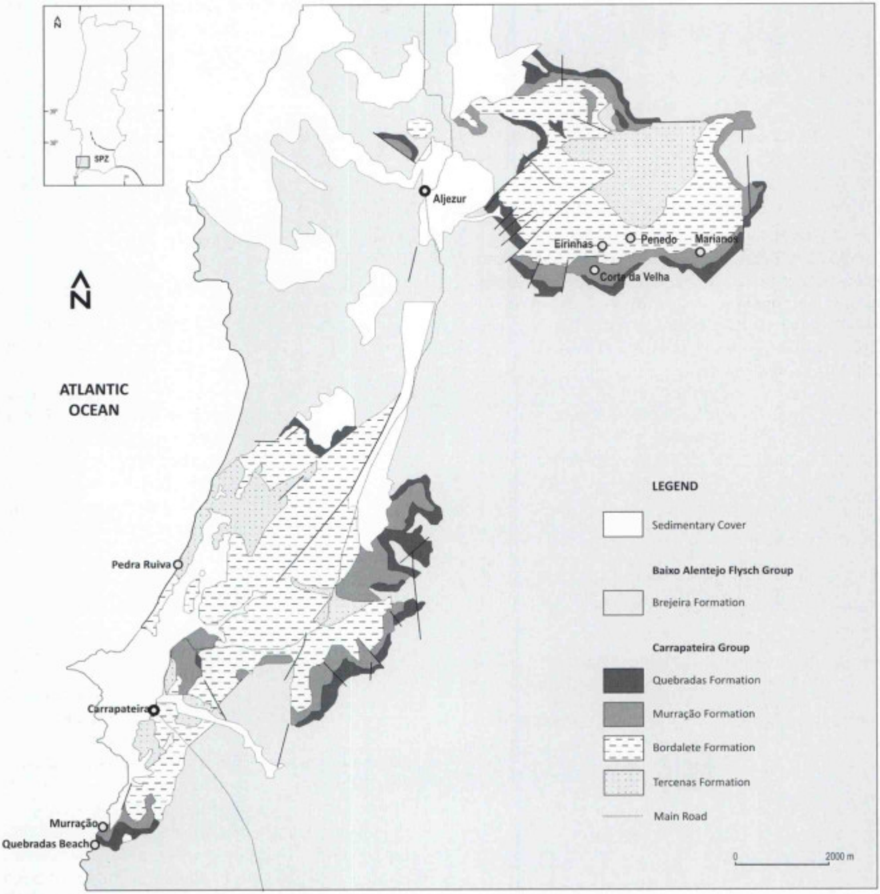

Fig.27 Geological Map of Aljezur and Bordeira Antiforms in the SWP Domain (Adapt. SILVA et al., 1990; OLIVEIRA, 1990).

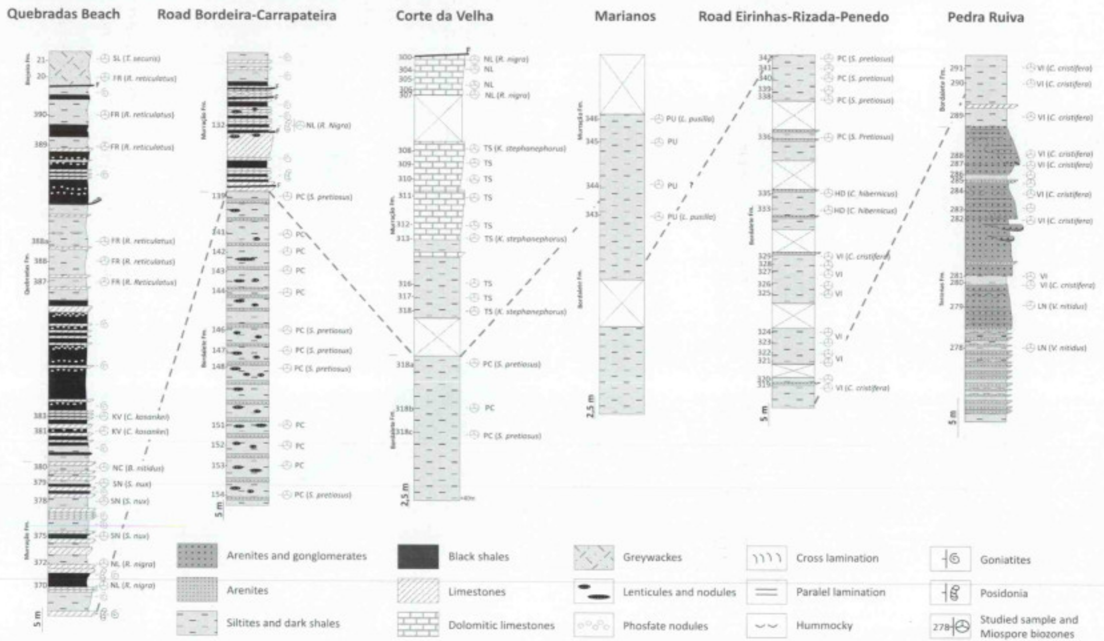

Fig.28 Selected stratigraphic sections from Aljezur and Bordeira Anticlines, SWP Domain.

source area of the reworked palynomorphs must be established.

Palynomorphs reworking is a common feature in SPZ. In general terms, 1% to approximately 30% of the studied palynomorphs are reworked.

5.1. Reworked Palynomorphs in the Devonian units of SPZ

The presence of reworked miospores of Givetian to Frasnian age was commonly found in the upper Strunian Tercenas Formation. Most commonly reworded taxa include: *Ancyrospora* sp., broken processes of *A. longispinosa, Aneurospora greggsii, Cristatisporites triangulatus, Geminospora lemurata* and *Verrucosisporites scurrus*.

Miospores of Emsian ages were also found, although its presence is infrequent (e.g. *Brochotriletes* sp., *Camarozonotriletes* sp. and *Diatomozonotriletes* sp.).

Reworked miospores of the same age were found in the upper units of Pulo do Lobo Domain (particularly in the Represa and Horta da Torre Formations) specifically the taxa *Ancyrospora* sp., *Diatomozonotriletes franklinii, Cristatisporites triangularis, Cristatisporites* sp., *Verrucosisporites premnus* and *V. scurrus*. The possible source areas for the reworked taxa may be units of Frasnian age, such as the lower units of the Pulo do Lobo Antiform and the PQG of the Pyrite Belt. Extrabasinal rocks of Lower Devonian rocks are found in units of the Ossa Morena Zone and these could also be visuali-sed as a possible source.

In the PQG of the Iberian Pyrite Belt several episodes of reworking were documented:

- in the upper PQG of upper Famennian to upper Strunian age, Givetian to Frasnian reworked miospores and acritarchs(?) were frequently found (*Ancyrospora* sp., *Aneurospora greggsii, Contagisporites optivus, Cristatisporites triangulatus, Cristatisporites* sp., *Geminospora lemurata, Verrucosisporites premnus* and *V. scurrus*);

- in the lower Givetian PQG sediments of São Francisco da Serra Antiform and Caveira mine region, Emsian reworked miospores were regularly found (for instance: *Archaeozonotriletes chulus* (Plate 7, Fig. 14), *Brochotriletes* sp., *Camarozonotriletes sextantii* (Plate 8, Fig. 2) and also *Diatomozonotriletes franklinii* (Plate 5, Fig. 14) *Emphanisporites annulatus* and *E. rotatus*. The reworked specimens are, in general, moderately preserved indicating small depositional corrosion or abrasion. This situation would indicate a relative short transport meaning so that the source area was not distant and could well has been the proper PQG sediments admitting that their age can reach the lower Devonian (the base of the PQG sedimentary pile is unknown).

It is noteworthy that several of these reworked species were recognised, in the Terena Formation, a flysch unit of the Barrancos area, Ossa Morena Zone, which was dated of Lockhovian to Emsian based on miospores (PEREIRA et al., 1999).

5.2.Reworked palynomorphs in the Carboniferous units of SPZ

Reworked miospores were noticed in all the studied units of the SPZ.

In the Bordalete Formation (dated of Tournaisian age, VI to PC Miospore Biozones), it is frequently observed the presence of reworked miospores and more rarely acritarchs of Strunian age (in particular the species: *Emphanisporites annulatus, Geminospora lemurata, Retispora lepidophyta, Rugospora flexuosa* and *Vallatisporites pusillites*). The origin of these materials could be the Tercenas Formation, or the Pyrite Belt, where Strunian sediments are accurately dated.

In Murração Formation (of lower Viséan age, Pu to TS miospore Biozones), Tournaisian miospores are widespread (*Cyrtospora cristifera, Densosporites* sp., *D. spitsbergensis, Neoraistrickia cymosa, Tumulispora rarituberculata, Vallatisporites vallatus* and *V. verrucosus*).

Same situation was observed in the Graça Formation of the Neves Corvo mine region (dated of lower Viséan age, TS Miospore Biozone), where reworked miospores of Tournaisian age are present, as for instance *Cyrtospora cristifera, Densosporites spitsbergensis, Knoxisporites concentricus, Rugospora polyptycha, Spelaeotriletes* spp., *Tumulispora rarituberculata, Verrucosisporites oppressus* and *Verrucosisporites* sp.. The reworked palynomorphs are remarkably well preserved. The source area, in this case, could be the Pyrite Belt. In fact, a major erosive event, probably related to submarine gravity slumping and sliding generated in response to extensional tectonism was suggested by OLIVEIRA et al. (2004).

In the upper part of Murração Formation, in situ assemblages of mid upper Viséan (NM to NC Miospore Biozones) includes several reworked species assigned to the upper Tournaisian, PC and CM miospore Biozones (*Auroraspora macra, Schopfites clavinger, Spelaeotriletes balteatus, S. pretiosus* and *Tumulispora rarituberculata*). It is important to notice that CM Miospore Biozone is lacking in the SWP Domain, corresponding to a lacune or an erosive event. The source area, in this case, could be the Bordalete Formation or, also the Iberian Pyrite Belt.

In the Quebradas Formation (Bashkirian age, KV and FR Miospore Biozones), reworked miospores are rare and moderately preserved. Present are the species *Knoxisporites literatus, K.* cf. *triradiatus* and *K. triangularis* of Upper Devonian to Lower Carboniferous age. The source of the reworked miospores could be the Tercenas and Bordalete Formations.

In the Baixo Alentejo Flysch Group reworked palynomorphs were also determined. In the Mértola Formation (mid upper Viséan age) it is frequent to recover reworked Tournaisian miospores. The Brejeira Formation (lower Bashkirian to upper Moscovian age, KV to OT Miospore Biozones) showed the most important assortment on reworked palynomorphs. Present are recycled acritarchs of Cambrian to Silurian age, and miospores of Devonian and Lower Carboniferous. Regarding the provenance and source of the reworked miospores, possible origins are from the Pulo do Lobo Domain and from Iberian Pyrite Belt. The Ossa Morena Zone could possibly be the source area for the acritarchs of Lower Paleozoic age.

It should be pointed out also that Upper Tounaisian an Lower Viséan miospore assemblages recoverd from the Toca da Moura-Cabrela Volcano Sedimentary Complex, in the west border of the Ossa Morena Zone (OMZ), in Portugal, and in shales of the La Codocera - Escusa belt, Serra de São Mamede sincline (RODRIGUEZ, et al., 2007), Central Iberian Zone (CIZ), are quite similar to those obtained in the sediments of the same age in the SPZ. This would suggest that the SPZ, OMZ and the south border of the CIZ were close to each other at this time.

6. CORRELATION WITH EUROPE

A number of palynological events recognised in the Western Europe were identified in the SPZ. These events, generally defined as the appearance or disappearance of a single genus or whole complexes of forms, provide important indicators in the establishment of global zonations (CLAYTON, 1985; CLAYTON, 1996; CLAYTON et al., 2003; OWENS, 1996; OWENS at al., 2004; STREEL, 1996).

One event has local importance at the scale of SPZ (in Portugal and Spain) and two events are locally distinct and are correlated with goniatites control points in the BAGF and SPS (see figures 2).

The most important events identified in the Western Europe and recognised in SPZ are:

1. The first appearance of *Geminospora lemura*. In SPZ the assemblages also typically contains *Aneurospora greggsii, Cymbosporites magnificus, Grandispora protea, Retusotriletes rugulatus, Verrucosisporites premnus* and *V. scurrus*. This event marks the base of the Lem subzone of AD Biozone of lower Givetian age (STREEL et al., 1987). According to LOBOZIAK & STREEL (1980;1988;1989), STREEL & LOBOZIAK (1987), *G. lemurata* first occurs not far from the proposed base of the Givetian stage.

2. The first appearance of *Grandispora cornuta*, together with other taxa that typically occur at this level in SPZ, that includes *Retusotriletes phillipsii, Diducites versabilis* and *Rugospora flexuosa*. This event, with the same type assemblage is recognised in Western Europe and marks the basal part of the VCo Biozone of upper Famennian age (MAZIANE et al., 1999).

3. First appearance of *Grandispora echinata*. Assemblages in the SPZ also typically contain consistently *Ancyrospora? andevalensis, Cristicavatispora dispersa, Rugospora explicata* and *Teichertospora iberica* at this level. It is worth noting that this assemblage is currently only documented in the SPZ and could represent a local event. In addition, the appearance of *Grandispora echinata* occurs immediately before the first inception of *Retispora lepidophyta* in SPZ and Western Europe, at the upper Famennian age.

4. Extinction of *Retispora lepidophyta*. In Western Europe this event is approximately at the Devonian/Carboniferous boundary (PAPROTH & STREEL, 1972; HIGGS & STREEL, 1984);

5. First appearance of *Spelaeotriletes pretiosus*, marking the middle Tournaisian age, in Western Europe;

6. First appearance of *Lycospora pusilla*. In Western Europe it is approximately coincident with the Tournaisian/Viséan boundary;

7. First appearance of *Raistrickia nigra*, together with other taxa that typically occur at this level in the SPZ, *Propisporites laevigatus* and *Densosporites* spp. This event marks the mid upper Viséan in SPZ. This data is confirmed with goniatites;

8. First appearance of *Savitrisporites nux*. This local event is equivalent to the Western Europe first appearance of *Tripartites vetustus*. In the SPZ, the other taxa that typically occur with the *S. nux* are *Rotaspora* spp. and *Grandispora spinosa* of upper Viséan age;

9. Extinction of the characteristic Viséan miospore species, *Raistrickia nigra, Grandispora spinosa, Rotaspora* spp. and *Crassispora maculosa,* analogous to the Viséan /Serpukovian boundary of the Western Europe;

10. Appearance of the distinctive Bashkirian genus *Reinschospora* and increase on *Crassispora kosankei*, representative of the lower Bashkirian assemblages, similar to Western Europe;

11. First appearance of *Radiizonates aligerens*, a type event for the upper Westphalian A in Western Europe. It is also characterised by the increase of *Laevigatosporites* and *Cirratriradites saturni*;

12. First appearance of *Torispora* genus, marking the basal Wesphalian C, as documented for Western Europe;

13. First appearance of *Thymospora* spp. which in Western Europe marks the basal part of the Wesphalian D.

7. SYNOPSIS OF THE SOUTH PORTUGUESE ZONE PALYNOSTRATIGRAPHY

Devonian and Carboniferous palynomorphs are documented from all the geological domains recognised in the SPZ. For the first time, assessments of all of the palynostratigraphic records obtained in the SPZ are compared. Twenty three miospore biozones are identified in the SPZ comprising the identification of more than 150 Devonian miospores and acritarchs species and more than 200 Carboniferous miospore species (PEREIRA et al., 2007). Selection of the index species used for the SPZ is based upon the consistent occurrence of each taxon in several sections and boreholes.

The synopsis of the SPZ palynostratigraphy obtained from all the geological domains recognised allow the following conclusions. The general chronostratigraphic correlation chart for all the domains of the SPZ is represented in Figure 2.

1. Lower Givetian miospores assemblages were recovered from the PQG in the Caveira and São Francisco da Serra Anticlines.

2. Lower Frasnian miospore assemblages were obtained from the PQG of the IPB, in Valverde del Camino Anticline, SW Spain (LAKE, 1991; GONZALEZ et al., 2004; GONZALEZ, 2005) and appear as reworked assemblages at the top of this same group. These Frasnian assemblages are also comparable to those found in the Ribeira de Limas and Gafo Fms. of the Pulo do Lobo Antiform (PEREIRA et al., 2006 a,b).

3. Upper Famennian assemblages in SPZ have a consistent presence of the miospore species *Ancyrospora* sp., *Cristicavatispora dispersa, Rugospora explicata* and *Teichertospora iberica*. These assemblages were recovered from the PQG and the VSC (IPB) (GONZALEZ et al., 2004; PEREIRA et al., 2004; 2007) and from the upper units of the Pulo do Lobo Antiform (Horta da Torre, Santa Iria and Represa Fms; PEREIRA et al., 2006 a,b).

4. Analogous late Strunian miospore assemblages were determined from the IPB, the upper part of the PQG (CUNHA & OLIVEIRA, 1989; OLIVEIRA et al., 2004; OLIVEIRA et al., 2005; MATOS et al., 2006), and the VSC in Spain (GONZALEZ, 2005) and also from the Tercenas Formation in

Southwest Portugal (Bordeira and Aljezur Anticlines).

5. Similarities in Upper Devonian miospore assemblages, strongly suggest that the Pulo do Lobo basin, the IPB basin and Southwest Portugal shallow siliciclastic basin were part of the same palaeogeographic realm during the late Devonian.

6. Records of Tournaisian palynomorphs from the Bordalete Formation in Southwest Portugal and reworked Tournaisian associations in the VSC of the IPB show the presence of the same taxa.

7. The VSC of the IPB yield miospores of late Famennian to mid/late Viséan age (OLIVEIRA et al., 1986; OLIVEIRA et al., 2004; 2005; 2006; PEREIRA et al., 2006; 2007). Mid/late Viséan assemblages appear to be very consistent along the SPZ as the same assemblages are recorded from the BAFG.

8. IMPLICATIONS ON THE SPZ TECTONOSTRATIGRAPHIC AND GEODYNAMIC INTERPRETATION

Our comments are mostly centered on the Pulo do Lobo Antiform and the Iberian Pyrite Belt domains whose tectonstratigraphic and geodynamic interpretation still remains doubtfull in some aspects.

As seen above (chapter 4.1) the Pulo do Lobo Domain was considered as a true anticline (PFEFFERKORN, 1968; SHERMERHORN, 1971; CARVALHO et al., 1976), based on the assumption that the lithostratigraphic units of both the north limb (Ferreira-Ficalho Group) and the south limb (now Chança Group) show strong lithological affinities and similar Tournaisian to Viséan ages. SHERMERHORN (1971) also suggested that the Gafo Formation is a lateral equivalent of the Culm sediments (present Mértola Formation) and CARVALHO et al. (1976) admit the stratigraphic equivalence, although diachronic, with the IPB. A distinct interpretation has been given by OLIVEIRA et al. (1986) who consider that the pairs Horta da Torre/Santa Iria Formations (north limb) and Gafo/Atalaia Formations (south limb) are older than the Pyrite Belt succession (however age equivalence between the Represa Formation and the PQG has been suggested).

Our recent plynostratigraphic results (PEREIRA et al., 2006 a,b) show that: the age of the Pulo do Lobo and Atalaia Formations remains unknown; the lower Frasnian and upper Fammennian ages of the Ribeira de Limas/Gafo and Santa Iria/Horta da Torre/Represa Formations, respectively, indicate that they are separated by a hiatus of ca 14 My. This fact reinforces previous structural interpretations that suggested the existence of an unconformity between the Santa Iria/Horta da Torre Formations and the underlying Ribeira de Limas Formation. The similar lithologies and ages of the units on both limbs of this antiform allow stratigraphic correlations among them which lead to the conclusion that all are part of the same sedimentary basin. Furthermore, the PQG sediments yielded miospore assemblages of upper Famennian age (the most common) complemented with the less common lower Givetian age obtained in São Francisco da Serra and Caveira regions (OLIVEIRA et al. 2008), and lower Frasnian age in Spain (LAKE, 1991; GONZÁLEZ et al., 2004; GONZÁLEZ, 2005). In spite of the superimposed Variscan tectonism, all these data should permit the conclusion that the units of the Pulo do Lobo Antiform and the PQG were part of the same palaeogeographic realm during the Upper Devonian.

The units of the Pulo do Lobo Antiform were also interpreted as an accretionary prism related to a northward dipping subduction (MUNHÁ et al., 1986; SILVA et al., 1990; FONSECA et al., 1993; QUESADA et al., 1994). Although not denying the existence of a northward subduction, PEREIRA et al. (2006) have argued that only the Pulo do Lobo Formation and the interbedded MORB-N basalts were involved in the subduction process and that the overlying units were laid down in a superimposed and discordant sedimentary basin develloped after the subduction processes have ceased. In this case, the oceanic basin in which the Pulo do Lobo Formation sediments and basalts were laid down was closed in pre-Lower Frasnian time. If this suggestion is correct, the Pulo do Lobo suspected terrain (RIBEIRO et al., 1990) should be restricted to the Pulo do Lobo Formation.

The tectonostratigraphy and structure of the Iberian Pyrite Belt has been the aim of varied interpretations, both in Portugal and Spain. In the present work comments are mostly concentrated

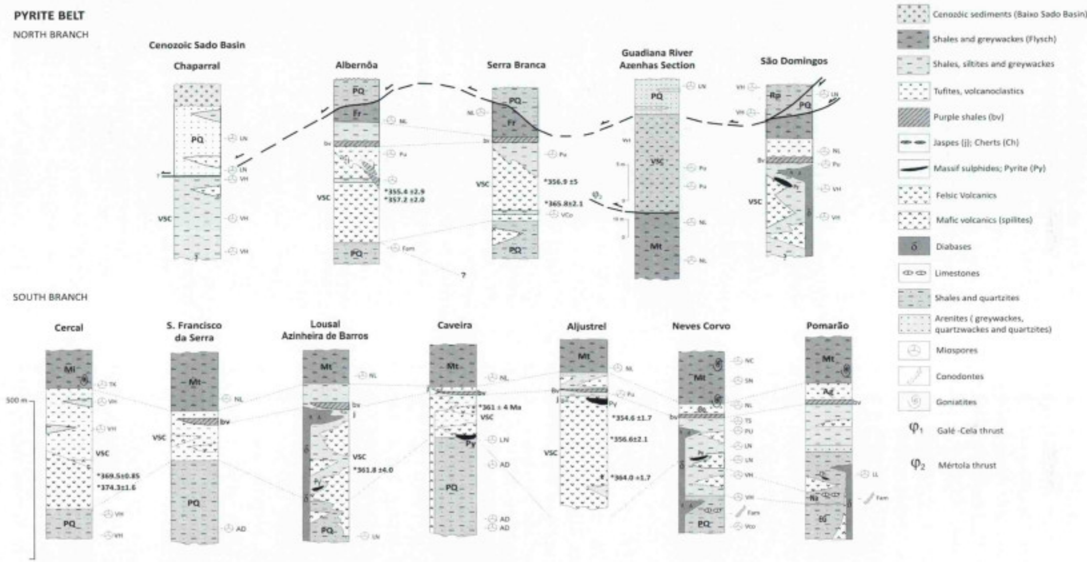

Fig. 29 Synthetic stratigraphic columns selected from the portuguese part of the Iberian Pyrite Belt (adapt. OLIVEIRA et al., 2006).

in the Portuguese part of the Belt. Until the work of SCHERMERHORN (1971), the IPB was seen as a succession of anticlines where the PQG appear conformably overlain by the VSC and this by the Culm sediments. This interpretation is still acceped by many of the geologists working in the IPB (see, for instance CARVALHO et al., 1999).

However SCHERMERHORN & STANTON (1969) were the first to recognise folded overthrusts at Aljustrel, an interpretation that they did not extend to other areas of the IPB. FANTINET (1971), working in the Mértola region identified Variscan thrusts in the Guadiana River valley. It was only with the work by RIBEIRO et al., (1983), SILVA & RIBEIRO (1983) later complemented by SILVA (1989), SILVA et al. (1990) and OLIVEIRA & SILVA (1990) that the IPB was interpreted as a thrust sheet complex. At that time, OLIVEIRA (1990), OLIVEIRA et al. (2005, 2006), divided the Iberian Pyrite Belt in two main branches, north and south, and this division is adopted in the present work.

The studied boreholes at the North Branch (Chaparral, Albernoa, Serra Branca, Guadiana River and São Domingos mine) and their structural interpretation in the light of the palynological age determinations, all show that the PQG sediments tectonically overlay the VSC lithological successions, confirming so previous structural interpretations. This tectonic boundary is called the Galé-Cela overthrust (SILVA et al. 1990; OLIVEIRA & SILVA, 1990). It is worth noting that in most of the studied boreholes the stratigraphic succession is up side down and affected by late faults. This indicates that below the overthrust plane the lithological sequence develops large recumbent folds vergent to southwest. The case of the Guadiana River section is important because the tectonic boundary between the Mértola turbidites and the VSC volcanogenic sediments (Mértola overthrust) is supported by sedimentary (way up), palynostratigraphic and structural criteria.

In the South Branch, dozens of boreholes were studied in the Neves Corvo mine (OLIVEIRA et al., 2004) and several at Aljustrel (still in progress), Caveira mine, São Francisco da Serra and Cercal. In all these boreholes, the stratigraphic succession appears, as a whole, in normal stratigraphic order, locally disrupted by Variscan reverse faults. The case of the Neves Corvo mine is emblematic because the extensional tectonism followed by thrusting has been demonstrated with the support of a very detailed palynostratigraphic research (Figure 17).

Having the data derived from the boreholes study in mind and also the regional geology it is possible to establish stratigraphic columns covering a big part of the Portuguese IPB (Figure 29). The chronostratigrafic ages of the North Branch units, based on miospores, range from upper Famennian to the mid upper Visean, with a generalized gap of Tournaisian ages. In the South Branch the PQG age spans from the lower Givetian to the Strunian, but mid and upper Frasnian and lower Famennian ages were not found, as well a Tournaisian ages. The origin of the Devonian gaps is not yet clearly understood. The absence of units of Tournaisian age has been ascribed to a generalized submarine erosion in the IPB (OLIVEIRA et al., 2004).

Recent U/Pb age determinations in zircons of the felsic volcanics by ROSA et al. (2009) are ploted in the corresponding stratigraphic columns (Figure 29). Comparing the absolute ages and the palynostratigraphic ages it can be concluded that they do not fit so well: in some cases (Cercal, Caveira) the absolute ages are older than the palynostratigraphic ages; in the case of Albernôa, they are younger. The progressive younging of the IPB volcanism towards NE, as suggested by ROSA et al. (2009) is not supported by the palynostratigraphic data.

From these columns it seems clear that the North branch is dominated by a complex tectonism where two major overthrusts are dominant. SILVA (1989) has argued that the tectonic transport was from NE, at least along 20 kms, but the root zone of these overthrusts was not localized (nowadays this author admit that the overthrusts are indeed true gravity nappes, SILVA in OLIVEIRA & SILVA, 2007). The boundary between the Pulo do Lobo Formation and the Gafo Formation has been refered to be the root zone of the tectonic overthrusts, a suggestion that is not in agreement with the available stratigraphic and palynological data. As far as we are concerned the root zone must be situated elsewhere between the Represa Formation and the PQG.

The IPB structure in the South branch is less complex. The stratigraphic units are arranged in normal order forming anticlines which in turn show internal tectonic complications, most related to the occurrence of reverse faults. The difference in the tectonic styles between the North and the South branches is related to the attenuated progression of the orogenic wave towards SW.

Current work being developed in severeal sectors and mining areas will follow up the presented data. This systemathic and detailed survey, based in the logging and mapping of the most important IPB sectors is essential for a better understanding of the palaeogeographic and geodynamic development of the South Portuguese Zone.

PART 2

SYSTEMATIC PALYNOLOGY

This part presents a systematic description of the taxa recorded. Miospores are systematically organised under the supragenetic classification is that proposed by NEVES & OWENS (1966) and SMITH & BUTTERWORTH (1967). Morphological terminology adopted here accords with the glossaries by DETTMANN (1963), KREMP (1965), SMITH & BUTTERWORTH (1967), and PLAYFORD & DETTMANN (1996). Micron is abbreviated to μm.

Acritarchs are listed alphabetically under genus in the absence of any widely accepted suprageneric classificatory scheme. The majority of the taxa are allocated to the incertae sedis "group" Acritarcha Evitt, 1963, but others are considered attributable to the green-algal class Prasinophyceae (following TAPPAN,1980; NORRIS, 1980).

The miospore, prasinophytes and acritarch species described are listed in Appendix 1. Stratigraphically important and typical taxa are illustrated in Plates 1-17.

1. MIOSPORES

Anteturma SPORITES H. Potonié 1893

Turma TRILETES (Reinsch) Dettmann 1963

Suprasubturma ACAMERATITRILETES Neves & Owens 1966

Subturma AZONOTRILETES (Luber) Dettmann, 1963

Infraturma LAEVIGATI Bennie & Kidston emend R. Potonié 1956

Genus CALAMOSPORA Schopf, Wilson & Bentall 1944

Type species: *Calamospora hartungiana* Schopf in Schopf, Wilson & Bentall 1944, by original designation.

Calamospora liquida Kosanke, 1950

Plate 1, Fig. 1

1950 *Calamospora liquida* Kosanke, p. 54, pl. 9, fig.5-6.

Dimensions: 55-88 μm; 12 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas and Bordalete Formations of SWP Domain (LN to PC Miospore Biozone, of Strunian to Tournaisian age).

Genus LEIOTRILETES Naumova ex Ishchenko 1952

Type species: *Leiotriletes sphaerotriangulatus* (Loose) R. Potonié & Kremp, 1954; by subsequent designation of Potonié & Kremp (1954, p. 120).

Leiotriletes sp.

Plate 1, Figs. 2, 3

1980 *Leiotriletes* sp. A of Attar, Fournier, Candiller & Coquel, pl. 1, fig. 17.

Description: Miospores radial, trilete. Amb subtriangular with slightly concave to straight sides and rounded apices. Laesurae distinct, straight, almost reaching equatorial margin, simple or with narrow labra 1-3 μm high. Exine 1-1.5 μm thick, laevigate.

Dimension: 50-60 μm; 15 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas, Bordalete and Murração Formations of SWP Domain (LN to NL Miospore Biozone, of Strunian to Viséan age).

Leiotriletes struniensis Moreau-Benoit, 1979

Plate 1, Fig. 4

1979 *Leiotriletes struniensis* Moreau-Benoit, pp. 16-17; pl. 1, figs. 2, 3.

Description: Miospores radial, trilete. Amb trilobate with barely concave interradii. Laesurae distinct, straight, almost reaching equatorial margin, simple. Exine 1 μm thick, laevigate.

Dimension: 90-105 μm; 15 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt (LN Miospore Biozone).

Previous records: From upper Strunian (MOREAU-BENOIT, 1979, ATTAR et al., 1980; ABDESSELAM-ROUIGHI, 1996; LOBOZIAK et al., 1997; 2002).

Genus PLICATISPORA Higgs, Clayton & Keegan, 1988

Type species *Plicatispora scolecophora* (Neves & Ioannides) Higgs, Clayton & Keegan, 1988

Plicatispora quasilabrata (Higgs) Higgs, Clayton & Keegan, 1988

Plate 1, Fig. 5

1973 *Cyclogranisporites* sp. Warg & Traverse, pl. 1, fig.11.

1975 *Pulvinispora quasilabrata* Higgs, p.394, pl. 1, fig.5,6 e 8.

1988 *Plicatispora quasilabrata* (Higgs) Higgs, Clayton & Keegan, p.1, fig.11-12.

Description: Miospores radial, trilete. Amb subcircular to subtriangular. Suturae straight, extending almost to equatorial margin. Distinct by its large and sparse distal folds.

Dimension: 40-75 μm; 11 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas and Bordalete Formations of the SWP Domain (LN to PC Miospore Biozones of Strunian - Tournaisian age).

Previous records: From the uppermost Devonian to lower Viséan (LL to Pu Miospore Biozones) of Scotland and Ireland (NEVES et al., 1973; NEVES & IOANNIDES, 1974; HIGGS et al., 1988) and Poland (FILIPIAK, 2004). From Upper Devonian in Spain (GONZÁLEZ et al., 2005) and Portugal (PEREIRA, 1997, CLAYTON et al., 2002).

Plicatispora scolecophora (Neves & Ioannides) Higgs, Clayton & Keegan, 1988

Plate 1, Fig. 6

1974 *Pulvinispora scolecophora Neves & Ioannides*, p. 74; pl. 1, figs. 9, 10.

1988 *Plicatispora scolecophora* (Neves & Ioannides) Higgs, Clayton & Keegan, p. 51; pl. 1, figs. 10, 14.

Description: Miospores radial, trilete. Amb subcircular to subtriangular. Laesurae distinct, straight, extending almost to equatorial margin, simple or accompanied by low (1.5 μm high), narrow labra. Contact areas bounded by curvaturae perfectae, frequently invaginated in radial position. Exine, laevigate to infrapunctate with 2-2.5 μm thick, with narrow straight to sinuous, irregularly disposed, commonly branching, distal folds 2-8 μm long.

Dimensions: 42.5-55.5 μm; 16 specimens.

Occurrence: Tercenas, Bordalete and Murração Formations of SWP Domain (LN to PC Miospore Biozones of Tournaisian age and TK, NL of Viséan age).

Previous records: From the uppermost Devonian to lower Viséan (LL to Pu Miospore Biozones) of Scotland and Ireland (NEVES et al., 1973; NEVES & IOANNIDES, 1974; HIGGS et al., 1988) and Poland (FILIPIAK, 2004). From Upper Devonian of Spain (GONZÁLEZ et al., 2005) and Portugal (PEREIRA, 1997, CLAYTON et al., 2002).

Genus PUNCTATISPORITES Ibrahim emend. R. Potonié & Kremp, 1954

Type species: *Punctatisporites punctatus* (Ibrahim) Ibrahim, 1933; by original designation.

Punctatisporites minutus Kosanke, 1950

Plate 1, Figs. 8, 9

1950 *Punctatisporites minutus* Kosanke, p. 32.

Description:Miospores radial, trilete. Amb circular to subcircular. Suturae simple, straight, length one-half to three-quarters of spore radius in length. Exine laevigate, 1.0-2.0 μm thick.

Dimensions: 24-32 μm; 32 specimens.

Occurrence: Tercenas and Bordalete Formations of SWP Domain (LN to PC Miospores biozones of Tournaisian age).

Previous records: From the uppermost Devonian-Tournaisian (LL-Pu Miospore Biozones) of Ireland (HIGGS et al., 1988). From Lower Carboniferous of Illinois Basin (KOSANKE, 1950), from the Michigan Basin, USA (RICHARDSON, 2006). From Serpukhovian-Bashkirian of the Upper Silesian Basin, Czech Republic (BEK, 2008).

Punctatisporites planus Hacquebard, 1957

Plate 1, Fig. 7

1957 *Punctatisporites planus* Hacquebard, p. 308; p. 1, figs. 7, 8.

Description: Miospores radial, trilete. Amb subcircular. Suturae distinct, simple, straight, length one-half to three-quarters of spore radius. Exine laevigate to slightly scabrate, about 2.0 μm thick, with occasional equatorial folds.

Dimensions: 40-72 μm; 26 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas and Bordalete Formations of SWP Domain (VH to PC Miospore Biozones).

Previous records: From Upper Devonian to Lower Carboniferous of Ireland and Great Britain(PHILLIPS & CLAYTON, 1980; CLAYTON et al., 1982; CLAYTON, 1986; HIGGS, 1975; HIGGS & CLAYTON, 1984; HIGGS et al., 1988), Canada (HACQUEBARD, 1957; PLAYFORD & MCGREGOR, 1993), Germany (HIGGS & STREEL, 1984), Portugal (PEREIRA, 1999), Spain (GONZÁLEZ et al., 2005), Algeria (COQUEL & LATRECHE, 1989) and Lower Carboniferous (Tournaisian) of Belgium (HIGGS, 1996), eastern U.S.A. (CLAYTON et al., 1998) and Saudi Arabia (CLAYTON, 1995).

Punctatisporites irrasus Hacquebard, 1957

Plate 1, Fig. 11

1970 *Punctatisporites* cf. *irrasus* Dolby & Neves, p.635, pl. 1, fig.1.

Description: Miospores radial, trilete. Amb subcircular, suturae distinct, straight, simple often accompanied by narrow labra which are normally gaping and darken along its length. Exine thick (1-2 μm), laevigate to infrapunctate and large compression folds common.

Dimensions: 45 - 72 μm; 23 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt, Tercenas and Bordalete Formation of SWP Domain (LE to PC Miospore Biozones).

Previous records: Lower Carboniferous of Canada (HACQUEBARD, 1957; PLAYFORD & MCGREGOR, 1993; UTTING, 1987) and Colombia (DUEÑAS & CÉSARI, 2006). From upper Strunian to upper Tournaisian of Ireland and Great Britain (CLAYTON et al., 1982; CLAYTON, 1986; HIGGS, 1975; HIGGS & CLAYTON, 1984; HIGGS et al., 1988).

Infraturma RETUSOTRILETI Streel in Becker, Bless, Streel & Thorez, 1974

Genus RETUSOTRILETES Naumova emend. Streel, 1964

Type species: *Retusotriletes simplex* Naumova,1953; by subsequent designation of Potonié (1958, p. 13).

Retusotriletes crassus Clayton, Johnston, Sevastopulo & Smith, 1980

Plate 1, Fig. 17

1969 *Phyllothecotriletes* sp. nº 840 of Lanzoni &

Magloire, pl. 1, figs. 3, 4. [no description]

1975 *Retusotriletes* sp. A of Higgs, p. 395; pl. 1, figs. 9-13.

1980 *Retusotriletes crassus* Clayton, Johnston, Sevastopulo & Smith, p. 97; pl. 3, figs. D-H.

Description: Miospores radial, trilete, amb subcircular to oval, suturae distinct, straight, simple, extending aproximatly three-quarters of spore radius. Curvaturae perfectae well-defined, delimiting the contact areas, exine 2- 2.5 μm thick, laevigate to slightly granulate. Contact areas thickened, extending three-quarters to four-fifths of spore radius.

Dimensions: 47.5 - 60 μm; 15 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas Formation (LN spore Biozone).

Previous records: From the Upper Devonian-Lower Carboniferous of Germany (HIGGS & STREEL, 1984), Tournaisian of Belgium (HIGGS, 1996), Saudi Arabia (CLAYTON, 1995), and Ghana (ATTA-PETERS & ANAN-YORKE, 2003). From the LN-CM Miospore Biozones (Strunian-Tournaisian) of England and Ireland (HIGGS, 1975; HIGGS & CLAYTON, 1984; HIGGS et al., 1988). Very common in the upper Strunian (PEREIRA, 1997) of Portugal.

Retusotriletes incohatus Sullivan, 1964

Plate 1, Fig. 16

1964 *Retusotriletes incohatus* (Sullivan) pl. 1, fig.5-7, in Becker et al p.24.

1971 *Retusotriletes incohatus* (Sullivan) Paproth & Streel, p.26, pl. 5.

1974 *Aneurospora incohata* (Sullivan) Streel in Becker et al p.24.

Description: Miospores radial, trilete. Amb subcircular to convexly subtriangular. Suturae distinct, straight to slightly sinuous, simple, extending almost to equatorial margin and terminating in curvaturae perfectae. Exine 1.0-2.5 μm thick, laevigate, contact areas laevigate, bounded by a darker narrow equatorial region.

Dimensions: 42.5-67.5 μm; 252 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas and Bordalete Formation (LN to PC Miospore Biozones).

Previous records: From the Upper Devonian to Lower Carboniferous (lower Viséan) rocks, from the northern hemisphere. In Portugal this species is very common in the Tournaisian of the Bordalete Formation (PEREIRA, 1997; 1999; PEREIRA et al., 2007).

Retusotriletes phillipsii Clendening, Eames &Wood, 1980

Plate 1, Figs. 18, 19

1974 *Retusotriletes* sp. A of Streel in Becker et al., p. 24; pl. 15, figs. 11, 12.

1980 *Retusotriletes phillipsii* Clendening, Eames & Wood, pp. 15-20, pl. 1, figs. 1-9.

Description: Miospores radial, trilete. Amb subcircular to rounded-triangular. Suturae distinct, straight, almost three quarters of spore radius in length, bordered by narrow labra terminating in curvaturae perfectae. Exine 2.5-3 μm thick, laevigate. Contact areas sculptured with spread grana and striae, straight to sinuous, in a radial distribution. Proximal polar area triangular in outline, relatively thin and bounded by a darkened band up to 3.0-3.5 μm in width.

Dimension: 45-55 μm; 28 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt (VCo to LN Miospore Biozones).

Previous records: *Retusotriletes phillipsii* has been previously recorded from Famennian sediments in the United States (CLENDENING et al., 1980) and Famennian strata in Belgium (BECKER et al., 1974 and CLAYTON et al., 1977). From Upper Devonian of IIberian Pyrite Belt in Spain (GONZÁLEZ et al., 2005) and Portugal (PEREIRA et al., 2006).

Retusotriletes planus Dolby & Neves, 1970

Plate 1, Figs. 12-14

1966 *Punctatisporites irrasus* Hacquebard, Streel, p.81,pl. 2, fig.26.

1969 *Punctatisporites irrasus* Hacquebard, Streel em Bouckaert et al., pl. 93, fig.5.

1970 *Retusotriletes planus* Dolby & Neves, p.365, pl. 1, fig.2.

Dimension: 42.5- 52.5 μm; 56 specimens.

Remarks and Comparison: The specimens recorded are similar to *Punctatisporites irrasus* Haquebard, and Dolby & Neves (1970, p.635) regarded *R. planus* as "*P. irrasus* with curvaturae".

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas and Bordalete Formations (VCo-LN and VI-PC Miospore Biozones).

Previous records: From Strunian to Tournaisian of Ireland (HIGGS, 1975; HIGGS & CLAYTON, 1984; HIGGS et al., 1988), and Portugal (PEREIRA, 1997; 1999) and Lower Carboniferous of Canada (HACQUEBARD, 1957; PLAYFORD & MCGREGOR, 1993; UTTING, 1987).

Retusotriletes rugulatus Riegel, 1973

Plate 1, Fig. 15

1973 *Retusotriletes rugulatus* Riegel, p. 82; pl. 10, figs. 2-5.

1974 *Stenozonotriletes extensus* Naumova, Hamid, pl. 10, fig.3.

For complete list see Mcgregor & Camfield 1982, p.58.

Description: Miospores radial, trilete. Amb circular to subcircular. Suturae distinct, simple, straight, length almost one-half to three-quarters of spore radius. Contact areas bounded by well defined curvaturae perfectae. Exine 1.5-3.5 μm thick, laevigate, proximal radial rugulate sculpture with ribs or folds, less than 1.0. μm wide and high.

Dimensions: 40 - 65 μm; 8 specimens.

Occurrence: Phyllite-Quartzite Group (LN Miospore Biozone).

Previous records: Devonian of Germany (RIEGEL, 1973), Canada (MCGREGOR, 1979; MCGREGOR & CAMFIELD 1982; MCGREGOR & PLAYFORD, 1992) and Midle Devonian of Saudi Arabia (BREUER et al., 2007, MARSHALL, 2007).

Retusotriletes triangulatus (Streel) Streel, 1964

Plate 1, Fig. 10

1964 *Phyllothecotriletes triangulatus* Streel, p.237, pl. 1, fig.3-5.

1967 *Retusotriletes triangulatus* (Streel), p.24-25.

1976 *Retusotriletes piperatus* Playford, p.10-11, pl1,fig.14,17.

Description: Miospores radial, trilete. Amb subcircular to rounded-triangular. Suturae distinct, simple, straight in the apical area, defined near the equator, length aproximatly four-fifths of spore radius and terminate in curvaturae perfectae. Exine thin, laevigate, with darkened thicked apical zone in the proximal pole. Large compression folds common.

Dimensions: 42.5-65 μm; 16 specimens.

Occurrence: Phyllite-Quartzite Group and Tercenas Formation (LN Miospore Biozone).

Infraturma APICULATI Bennie & Kidston emend R. Potonié 1956

Genus ACANTHOTRILETES Naumova emend Potonié & Kremp 1954

Type species: *Acanthotriletes ciliatus*(?) (Knox) Potonié & Kremp 1955

Acanthotriletes echinatus (Knox) Potonié & Kremp, 1955

Plate 2, Fig. 1

1950 *Spinoso-sporites echinatus* (Knox), p.313, pl. 17, fig.208.

1955 *Acanthotriletes echinatus* (Knox) Potonié & Kremp, p.84.

Description: Miospores radial, trilete. Amb subcircular to rounded-triangular. Suturae indistinct to distinct, simple, straight, length approximately two-thirds of spore radius. Exine thin, ornamented with spines (2-5 μm long and 1 μm diameter), discrete (3.0-5.0 μm apart), projecting in number 30-40 from the equatorial margin.

Dimensions: 20-38 μm; 21 specimens.

Occurrence: Quebradas and Brejeira Formations of SWP Domain (NC to NJ Miospore Biozones, Serpukovian to Moscovian).

Acanthotriletes persibus Higgs, 1975

Plate 2, Fig. 2

1975 *Acanthotriletes persibus* Higgs, p.359, pl. 1, fig.14-16, 21.

Remarks: The specimens recorded conform with those described by Higgs (1975). The species is described by a subcircular amb with distinct compression folds and bulbous based fine spinae.

Dimensions: 33-48 μm; 63 specimens.

Occurrence: Bordalete Formation of Tournaisian age (PC Miospore Biozone).

Previous records: From Strunian to Tournaisian of Ireland (HIGGS et al., 1988).

Genus ANAPICULATISPORITES (Potonié & Kremp) emend. Smith & Butterworth 1967

Type species: *Anapiculatisporites isselburgensis* Potonié & Kremp 1954

Anapiculatisporites concinnus Playford, 1962

Plate 2, Fig. 3

Description: Miospores radial, trilete. Amb triangular with ronded apices and convex to almost straight sides. Suturae distinct, simple, more or less straight, length three-quarters to four-fifths of spore radius. Proximal surface laevigate, distal surface bearing small uniform coni, 1.0-2.0 μmin length and 1.0-1.5 μm in basal diameter. Exine 1 μm in thickness, rarely folded.

Dimensions: 24-35.5 μm; 6 specimens.

Occurrence: Murração Formation of Viséan age (NL to NC Miospore Biozones).

Genus ANAPLANISPORITES Jansonius 1962

Type species: *Anaplanisporites telephorus* (Klaus) Jansonius 1962

Anaplanisporites baccatus (Hoffmeister, Staplin & Malloy) Smith & Butterworth, 1967

Plate 2, Fig. 4

1955 *Punctatisporites ? baccatus* Hoffmeister, Staplin & Malloy, p.392, pl. 16, fig.2.

1958 *Apiculatisporites baccatus* (Hoffmeister, Staplin & Malloy) Butterworth & Williams, p.363, pl. 1, fig.25.

1967 *Anaplanisporites baccatus* (Hoffmeister, Staplin & Malloy) Smith & Butterworth, p.166-167, pl. 7, fig.2.

Description: Miospores radial, trilete. Amb circular to rounded triangular with slightly convex sides. Suturae distinct, length about the equator, bordered by low ray folds and ending in curvaturae. Distal surface ornamented with closely spaced, coni of 2 μm height. Exine folded.

Dimensions:25-36 μm; 12 specimens.

Occurrence: Bordalete Formation of Tournaisian age (VI to PC Miospores Biozone), Murração, Quebradas and Brejeira Formation. Very common in the Bashkirian (Ra Miospore Biozone).

Genus APICULIRETUSISPORA Streel emend Streel 1967

Type species: *Apiculiretusispora brandtii* Streel 1964; by original designation.

Apiculiretusispora brandtii Streel, 1964

Plate 2, Fig. 9

Description: Miospores radial, trilete. Amb subcircular to rounded subtriangular. Suturae sinuous, equal spore radius, accompanied by labra 0.8-1.2 μm high ending in curvaturae perfectae coincident with the equator. Contact areas laevigate, but with a triangular thickening centered on the proximal pole (observed as a darker area). Exine laevigate, 0.5-1.2 μm in thickness. Exine distally covered by short spines and microconi, 0.5-1.0 μm in height. Dimensions: 45-60 μm; 17 specimens.

Occurrence: Phyllite-Quartzite Group in S. Francisco da Serra (AD Miospore Biozone, subzone Lem).

Apiculiretusispora fructicosa Higgs, 1975

Plate 2, Figs. 5-8

1962 *Retusotriletes verrucosus* Caro-Moniez, pl. 1, fig.1-2.

1974 *Apiculiretusispora verrucosa* (Caro-Moniez) Streel in Becker et al., p.24.

1975 *Apiculiretusispora fructicosa* Higgs, p.395, pl. 1, fig.23-25.

Description: Miospores radial, trilete. Amb subcircular to rounded subtriangular. Suturae distinct, simple, straight, length three-quarters to four-fifths of spore radius, ending in curvaturae perfectae. Exine, 2 μm thick, densely sculptured with coni, pila and short bacula, elements discrete with rounded or flattened tops, 1.5-3.5 μm in width.

Dimensions: 55-78.5 μm; 32 specimens.

Occurrence: Tercenas Formation of SWP Domain of Strunian age (LN Miospore Biozone).

Previous records:From Strunian to Tournaisian of Ireland (HIGGS, 1975; HIGGS et al., 1988), of Great Britain (HIGGS & CLAYTON, 1984) and of Belgium (MAZIANE et al., 1999).

Genus CADIOSPORA (Kosanke) Venkatachala & Bharadwaj 1964

Type species: *Cadiospora magna* Kosanke 1950

Cadiospora magna Kosanke, 1950

Plate 2, Fig. 13

1950 *Cadiopora magna* Kosanke, p.50, pl. 16, fig.1.

Description: Miospores radial, trilete. Amb circular to subtriangular, crenulate margin. Suturae with prominent dark thickenings, straight, extending almost to the equator, ending in a interradial curvaturae. Exine 5.0-10.0 μm in thickness, laevigate to punctate to finely granulose, ornamented with small closely spaced grana of variable size, less than 0.5 μm in height. A single compression fold occurs in the region of the curvaturae.

Dimensions: 68-72.5 μm; 7 specimens.

Occurrence: Brejeira Formation of BAFG, guide specie for the base of OT, Miospore Biozone.

Genus CAMPTOTRILETES Naumova emend Potonié & Kremp 1954

Type species: *Camptotriletes corrugatus* (Ibrahim) Potonié & Kremp 1954

Camptotriletes paprothii Higgs & Streel, 1984

Plate 2, Fig. 11

1984 *Camptotriletes paprothii* Higgs & Streel, p.169, pl. 1, fig.9-16.

Description: Miospores radial, trilete. Amb subcircular to rounded subtriangular. Suturae simple, straight, extending almost to the equator. Exine 1.0-2.0 μm in thickness, ornamented with small irregular cristae and discrete wide based spinae, 1-2.5 μm in height and variable length, densely distributed over the distal surface, proeminent at the equator and reduced on the proximal surface.

Dimensions: 45-58 μm. 18 specimens.

Occurrence: Bordalete Formation of Tournaisian age (VI to PC Miospore Biozones).

Genus CRASSISPORA Bharadwaj emend Sullivan 1964

Type species: *Crassispora ovalis* Bhardwaj, 1956; by original designation.

Crassispora catenata Higgs, 1975

Plate 2, Fig. 12

1975 *Crassispora catenata* Higgs, p.396, pl. 2, fig1-3.

Description: Miospores radial, trilete. Amb subcircular to rounded subtriangular. Suturae distinct, straight, extending almost to equator, bordered by narrow labra (1 μm wide). Exine two layered. Intexine perceptible, thin (0.5-0.8 μm thick), laevigate, occupying 90-95% of overall spore diameter, outline, in polar aspect, conformable with amb. Exoexine 2.0-2.5 μm thick, proximal surface laevigate, distal surface and equator sculptured with small, densely packed, mostly rounded coni and spines 1.0-2.5 μm high, with rounded bases (0.5-1.5 μm in diameter).

Dimensions: 45-72.5 μm; 5 specimens.

Occurrence: Represa Formation of Pulo do Lobo Formation and Tercenas Formation (LN Miospore Biozone).

Crassispora kosankei Potonié & Kremp emend Bharadwaj, 1957

Plate 2, Fig. 14

1955 *Planisporites kosankei* Potonié & Kremp, p.71, pl. 13, fig.208-213.

1957 *Planisporites ovalis* Bharadwaj, p.86, pl. 23, fig.9-10.

1957 *Crassispora ovalis* Bharadwaj, p.126, pl. 25, fig.73-76.

1957 *Crassispora kosankei* Potonié & Kremp emend Bharadwaj, p.127.

1957 *Apiculatisporites apiculatus* (Ibrahim) Dybová & Jachowicz, p.87, pl. 15, fig.1-4.

Description: Miospores radial, trilete. Amb subcircular to rounded subtriangular. Suturae indistinct, straight, extending almost to equator, generally with folds, gape open in a distinctive triangular aperture in the polar region. Exine, finely ornamented with grana with equatorial crassitude of 5-10 μm thinckness. Distal surface ornamented with coni, up to 2 μm high irregularly distributed and discrete (5 μm).

Dimensions: 48-62.5 μm; 39 specimens.

Occurrence: Quebradas Formation of SWP Domain and Xistos das Abertas Formation in Cercal Anticline, of Bashkirian age. Guide species for the KV Miospore Biozone.

Crassispora maculosa (Knox) Sullivan, 1964

Plate 2, Figs. 15-16

1950 *Verruco-sisporites maculosus* Knox, p.318.

1955 *Apiculatisporis maculosus* (Knox) Potonié & Kremp, p.78.

1964 *Crassispora maculosa* (Knox) Sullivan, p.376, pl. 60, fig.14-15.

Description: Miospores radial, trilete. Amb subcircular to rounded subtriangular. Suturae straight, simple, extending at least four-fifths of spore radius, terminating in curvaturae perfecta. The equator surface are thickened relative to the proximal surface. Combination of curvaturae with equatorial thickening often produces a dark zone at equator, up to 10 μm in width. Distal surface sculptured with small discrete coni and rare verrucae, up to 2.5 μm high.

Dimensions: 67.5-100 μm; 8 specimens.

Occurrence: Bordalete Formation of SWP Domain-Sector, Mértola Formation of BAFG. In SWP Domain occurs in the Brejeira Formation in Miospore Biozone Ra, interpreted as a reworked element.

Genus GRANULATISPORITES Ibrahim emend Potonié & Kremp 1954

Type species: *Granulatisporites granulatus* Ibrahim 1933

Granulatisporites micrograniifer Ibrahim, 1933

Plate 2, Fig. 10

1933 *Granulati-sporites microgranifer* Ibrahim, p. 22, pl. 5, fig.32.

1938 *Azonotriletes microgranifer* (Ibrahim) Luber in Luber & Waltz, p.7, fig.92.

Description: Miospores radial, trilete. Amb rounded to concave triangular. Suturae straight, simple, often gapping, extending at least three-quarters of spore radius. Exine 1μm thick sculptured with grana which are less that 1μm in size. Grana of even distribution and variable density.

Dimensions: 32.5-40 μm; 63 specimens.

Occurrence: Bordalete Formation, PC Miospore Biozone.

Genus LOPHOTRILETES (Naumova) Potonié & Kremp 1954

Type species: *Lophotriletes gibbosus* (Ibrahim) Potonié & Kremp 1954

Lophotriletes commissuralis (Kosanke) Potonié & Kremp, 1955

Plate 3, Fig. 1

1950 *Granulatisporites comminsuralis* Kosanke, p.20, pl. 3, fig.1.

1955 *Lophotriletes commissuralis* (Kosanke) Potonié & Kremp, p.73, pl. 12, fig.222-223.

Description: Miospores radial, trilete. Amb rounded triangular, angles rounded, sides concave. Suturae distinct, extending for three-quarters of spore radius, margin slightly raised in part broken by granulations. Exine 1.0-2.0 μm thick, coarsely granulate, with closely separated grana and small spines of 2.0 μm in basal diameter.

Dimensions: 24-35 μm; 13 specimens.

Occurrence: Quebradas and Brejeira Formations of SWP Domain (NC to NJ Miospore Biozones, Serpukovian to Moscovian).

Lophotriletes gibbosus (Ibrahim) Potonié & Kremp, 1954

Plate 3, Figs. 2, 3

1933 *Verrucosi-sporites gibbosus* Ibrahim, p.25, pl. 6, fig.49.

1938 *Azonotriletes gibbosus* (Ibrahim) Luber & Waltz, pl. 7, fig.91.

1944 *Granulati-sporites gibbosus* (Ibrahim) Schopf, Wilson & Bentall, p.33.

1950 *Verrucosi-sporites gibbosus* (Ibrahim) Knox, p.317, pl. 17, fig.232.

1954 *Lophotriletes gibbosus* (Ibrahim) Potonié & Kremp, p.129, pl. 14, fig.220.

Description: Miospores radial, trilete. Amb rounded triangular, sides concave, angles markedly rounded. Suturae distinct, extending for two-thirds of spore radius, margin slightly raised in part broken by granulations. Exine 1.0-2.0 μm thick, sculptured with coni (3-4.5 μm high and 2-4 μm basal diameter) rounded apices, about 40 projecting from the equator. The narrow spaces between the coni give rise to a negative reticulum.

Dimensions: 40-50 μm; 7 specimens.

Occurrence: Brejeira Formation (SS to OT Miospore Biozones).

Genus NEORAISTRICKIA Potonié 1956

Type species: *Neoraistrickia truncatus* (Cookson) Potonié 1956

Neoraistrickia cymosa Higgs, Clayton & Keegan, 1988

Plate 3, Figs. 4, 5

1966 *Raistrickia* sp. Doubinger & Raucher, p. 337, pl 4, fig 4.

1969 *Raistrickia* sp Nº 2928 Lanzoni & Magloire, pl. 4, fig 17-18.

1975 *Schopfites* sp A Higgs, p. 397, pl. 2, fig 8

1979 *Ceratosporites* sp. A Van der Zwan, pl. 4, figs 6-8, pl. 5, figs 7-8

1988 *Neoraistrickia cymosa* Higgs, Clayton & Keegan, p. 55, pl. 4, fig.3-5.

Description: Miospores radial, trilete. Amb convexly triangular. Suturae distinct to unclear, simple, often gaping, straight, extending at least three-quarters of spore radius Exine 1.0-1.5 μm thick. Distal surface sculptured with irregular shaped bacula few verrucae and coni. Elements subcircular to irregular in basal outline, often coalescent, with parallel sides and flattened, rounded or pointed tops of 2-6 μm length and 2.5-4.5 μm basal diameter.

Dimensions: 34-52.5 μm; 12 specimens.

Occurrence: Bordalete Formation (HD to PC Miospore Biozones).

Neoraistrickia logani (Winslow) Coleman &

Clayton, 1987

Plate 3, Figs. 6,7

1962 *Granulatisporites logani* Winslow p.62-63, pl. 22, fig 10-11.

1987 *Neoraistrickia logani* (Winslow) Coleman & Clayton pl. 1, fig. 5-8.

Description: Miospores radial, trilete. Amb triangular with straight, slightly concave or convex rounded sides. Suturae bordered by narrow labra 2.0-3.0 μm in widht and extending three-quarters of spore radius. Exine 2.0-3.0 μm thick bearing well spaced discrete biformed elements and conate elements. These have generally 1.0-2.2 μm height and 2.0-5.0 μm diameter, surmounted by conus or baculum of 1.5-3.5 μm in height, with convex or straight sides and rounded terminations. Coni with 2.5-3.5 μm in width. Ornaments mainly distributed on the distal surface and equator, rare on proximal surface.

Dimensions: 55-80 μm; 12 specimens.

Occurrence: Bordalete Formation (PC Miospore Biozone).

Genus PUSTULATISPORITES R. Potonié & Kremp emend Imgrund 1960

Type species: *Pustulatisporites pustulatus* R. Potonié & Kremp, 1954; by original designation.

Pustulatisporites dolbii Higgs, Clayton & Keegan, 1988

Plate 3, Fig. 8

1970 *Pustulatisporites* cf. *gibberosus* (Hacquebard) Playford; Combaz & Streel, p. 230; pl. 3, fig. 2.

1975 *Pustulatisporites* sp. A of Higgs, p. 396; pl. 2, fig. 4.

1988 *Pustulatisporites dolbii* Higgs, Clayton & Keegan, p. 56; pl. 4, figs. 6, 9, 10.

Description: Miospores radial, trilete. Amb rounded subtriangular to subcircular. Suturae distinct, straight, length at least three-quarters of spore radius, simple or with narrow labra. Exine 1.0-2.5 μm thick. Proximo-equatorial and distal exine sculptured with irregular, discrete or rarely coalescent verrucae and spinae. Elements 1.5-3.0 μm in height, with subcircular to irregularly polygonal bases 2.0-7.0 μm in basal diameter and spaced up to 5.0 μm apart.

Dimensions: 45-60 μm; 26 specimens.

Occurrence: Tercenas and Bordalete Formation (LN to PC Miospore Biozone).

Previous records: From the Upper Devonian of France (COMBAZ & STREEL, 1970) and Belgium (HIGGS, 1996); and Upper Devonian to Lower Carboniferous of Ireland (HIGGS et al., 1988); Germany (HIGGS & STREEL, 1984), Poland (FILIPIAK, 2004), and Canada (PLAYFORD & MCGREGOR, 1993), Upper Devonian Spain (GONZÁLEZ et al., 2005).

Genus RAISTRICKIA Schopf, Wilson & Bentall emend. R. Potonié & Kremp 1954

Type species: *Raistrickia grovensis* Schopf in Schopf, Wilson & Bentall 1944

Raistrickia aculeata Kosanke, 1950

Plate 3, Fig. 9

1950 *Raistrickia aculeata* Kosanke, p.46, pl. 10, fig.9

Description: Miospores radial, trilete. Amb rounded subtriangular to subcircular. Suturae distinct, to obscure, extending two-thirds of spore radius. Exine thickness of 2 μm, totally covered by non pointed elements such as bacula or pila processes. Ornamentation is composed of elements 7.0-10.0 μm in length and 2.0-2.5 μm in height, with parallel sides.

Dimensions: 37.5-47.5 μm; 4 specimens.

Occurrence: Brejeira Formation, of BAFG (OT Miospore Biozone).

Raistrickia clavata Hacquebard emend. Playford, 1964

Plate 3, Fig. 10

1957 *R. clavata* Hacquebard, p.310, pl1, fig 25

1957 *R. pistillata* Hacquebard, p.310-311, pl2, fig 2

1964 R. clavata Hacquebard, emend Playford, p.24-25, pl6, fig 5-10

Description: Miospores radial, trilete. Amb rounded to convexly triangular. Suturae distinct or obscure by ornamentation, extending three-quarters of the spore radius. Exine thickness of 2.0-3.0 μm, and densely ornamented, with discrete mainly short club shaped processes and bacula, 5.0-10.0 μm in height, 2.0-4.0 μm, wide at base, usually widening into bulbous or flattened tops 3.5 -6.0 μm width.

Dimensions: 55-85 μm; 27 specimens.

Occurrence: Bordalete Formation (PC Miospore Biozones).

Raistrickia variabilis Dolby & Neves, 1970

Plate 3, Fig. 11

1967 *Raistrickia* sp. Neves & Dolby, pl. 1, fig. 4.

1970 *Raistrickia variabilis* Dolby & Neves, p. 636, pl. 1, fig.6.

Description: Miospores radial, trilete. Amb subcircular. Suturae distinct or obscure by ornamentation, simple or labrate, extending three-quarters of the spore radius. Exine thickness of 2.0-3.0 μm, densely ornamented, with dense and prominent ornament of bacula (8.0-18.0 μm in height, 2.0-6.5 μm in width). Bases of bacula wide and generally coalescent. Processes parallel sided and often tapering, occasionally constricted near the tops. Bacula terminate in truncate, rounded pointed or multifurcate tops.

Dimensions: 62-80 μm; 5 specimens.

Occurrence: Phyllite-Quartzite Group (LN Miospore Biozones). Very common in the Neves Formation of Neves Corvo mine.

Raistrickia fulva Artuz, 1957

Plate 3, Fig. 12

1957 *Raistrickia fulva* Artuz, pl. 3, fig.19.

Description: Miospores radial, trilete. Amb subcircular to subtriangular. Suturae distinct or obscure by ornamentation, extending two-thirds to three--quarters of the spore radius. Exine thickness of 5.0-6.0 μm, ornamented with dispersed bacula and coni and verrucae (2.5-5.0 μm in height, 5.0-10.0 μm in width).

Dimensions: 35-57.5, 35 specimens.

Occurrence: Brejeira Formation of BAFG (FR to Ra Miospore Biozones).

Raistrickia nigra Love, 1960

Plate 3, Fig. 13-14

1960 *Raistrickia nigra* Love, p. 54.

Description: Miospores radial, trilete. Amb subcircular to subtriangular. Suturae distinct or obscure by ornamentation, simple, extending two-thirds to three-quarters of the spore radius. Exine thickness of 1.0-3.0 μm, ornamented with disperse and important bacula elements with rounded edges, plane tops, and sporadically with coni as biform spines (2.0-5.5 μm in height and evenly spaced, 3.0-5.5 μm in the distal surface and around 5.0-7.0 μm at the equator).

Dimensions: 35-57 μm; 47 specimens.

Occurrence: Volcano Sedimentary Complex of the Iberian Pyrite Belt, Mértola Formation of BAFG and Murração Formation of the SSW (Key species of NL Miospore Biozone of lower mid Viséan age).

Genus SCHOPFITES Kosanke 1950

Type species: *Schopfites dimorphus* Kosanke 1950

Schopfites claviger Sullivan emend. Higgs, Clayton & Keegan, 1988

Plate 4, Fig. 1

1968 *Schopfites claviger* Sullivan, p.121, pl. 25, fig.1-10.

1988 *Schopfites claviger* Sullivan emend. Higgs, Clayton & Keegan, p. 59, pl. 5, fig.6-8, 13.

Description: Miospores radial, trilete. Amb subcircular to circular. Suturae indistinct to distinct extending almost to equator. Intexine thickness of 1.0-1.5 μm, indistinct to distinct conformable with the amb. Distal surface and equator ornamented with pila, rounded bacula and rare coni and verrucae (1.0-4.5 μm in height and 0.5-3.0 μm in width). Exoexine 1.0-2.0 in thickness, ocasionally folded. Intexine and proximal surface laevigate.

Dimensions: 40-52 μm; 11 specimens.

Occurrence: Murração Formation of SWP Domain, interpreted as reworked.

Previous records: From Tournaisian of Ireland (CLAYTON, 1971; HIGGS, 1975; HIGGS et al., 1988). From Viséan of Portugal (PEREIRA, 1997, 1999).

Schopfites delicatus Higgs, 1975

Plate 4, Fig. 2

1975a *Schopfites delicatus* Higgs, p.24, pl. 2, fig.6.

Description: Miospores radial, trilete. Amb subcircular to circular. Suturae indistinct to distinct, straight, extending almost to equator, with ray folds up to 3.5-4.0 μm in height. Exoexine 1.0-2.0 μm in thickness and folded. Intexine thickness of 1.0-1.5 μm, indistinct to distinct more or less conformable with the amb. Distal surface and equator sculptured with a fine ornamentation of pila and rare rounded bacula (0.5-3.5 μm in height and 0.5-1.0 μm in width). Intexine and proximal surface laevigate.

Dimensions: 40-60 μm; 9 specimens.

Occurrence: Bordalete Formation of SWP Domain of Tournaisian age (PC Miospore Biozone).

Genus UMBONATISPORITES Hibbert & Lacey 1969

Type species: Umbonatisporites variabilis Hibbert & Lacey 1969

Umbonatisporites distinctus Clayton, 1971

Plate 4, Fig. 4

1960 *Apiculatisporites* sp. Balme, p.28, pl. 4, fig.10-11.

1971 *Umbonatisporites distinctus* Clayton, p.591, pl. 4, fig.4-6.

1971 *Acanthotriletes turriculaeformis* Kremp & Playford in Playford, p.20, pl. 6, fig. 7-15.

Description: Miospores radial, trilete. Amb subcircular to circular. Suturae indistinct to distinct, simple, straight, extending almost to equator. Exine thin, ornamented distally with processes of basal diameter 0.5-1.5 μm and 3-7.5 μm in lenght. Processes have a characteristic shape and regular distrubution. Proximal surface laevigate.

Dimensions: 60-98 μm; 6 specimens.

Occurrence: Bordalete Formation of SWP Domain, (HD to PC Miospore Biozones). In SWP Domain the specimens evidenced in HD Miospore Biozone showed higher dimensions (85-98 μm) as compared with the specimens recovered from the PC Miospore Biozone (60-75 μm).

Genus VERRUCIRETUSISPORA Owens 1971

Type species:*Verruciretusispora robusta* Owens, 1971

Verruciretusispora loboziakii Higgs & Finucane, 2002

Plate 4, Fig. 3

1980 *Verruciretusispora famenensis* (Kedo, 1963) Massa, Coquel, Loboziak and Taugourdau-Lantz, p.144, pl. IV, figs14-15.

2002 *Verruciretusispora loboziakii* Higgs & Finucane, pl. 1, figs. 1-5, 9, 11.

Description: Miospores radial, trilete. Amb subcircular to subtraingular. Suturae distinct, straight, bordered by labra (1.0-2.0 μm in width, extending almost to equator were terminates in well defined curvaturae. Exine 2.0 μm thick and darker at the equator due concentration of the ornament. Contact area laevigate. Distal surface and proximal surface outside the contact area ornamented with small verrucae (1.0-2.5 μm) and rugulae (1.5-3.0 μm), ornament discrete, closely spaced and ocassionally coalescent.

Dimensions:25-45 μm; 7 specimens.

Occurrence: Ribeira de Limas and Gafo Formations of Pulo do Lobo domain (BJ Miospore Biozone).

Previous records: Upper Famennian of Western Lybia (MASSA et al., 1980; COQUEL & MOREAU-BENOIT, 1986), Algerian Sahara (ATTAR et al., 1980; COQUEL & LATRECHE, 1989; ABDESSELAM-ROUIGHI & COQUEL, 1997), Iran (COQUEL et al., 1977) and Saudi Arabia (CLAYTON et al., 2000), Turkey (HIGGS et al., 2002), Portugal (PEREIRA et al., 2006) and Argentina (NOETINGER & PASQUO, 2007).

Genus VERRUCOSISPORITES Ibrahim emend. Smith & Butterworth, 1967

Type species: *Verrucosisporites verrucosus* (Ibrahim) Ibrahim, 1933; by original designation.

Verrucosisporites bulliferus Richardson & McGregor, 1986

Plate 4, Fig. 5

Description: Miospores radial, trilete. Amb subcircular to convexly subtriangular. Suturae straight, simple, distinct or obscured by sculpture, length of three-quarters of spore radius. Exine 2.5-3.0 μm in thickness, ornamented with verrucae flat topped or rounded topped (2.0-3.5 μm in basal diameter, 0.5-1.5 μm in height) irregularly distributed. In plan view range from circular to polygonal in shape.

Dimensions: 35-48 μm; 19 specimens.

Occurrence: Ribeira de Limas Formation of Pulo do Lobo domain.

Verrucosisporites congestus Playford, 1964

Plate 4, Figs. 6, 7

1964 *Verrucosisporites congestus* Playford, p.13, pl. 2, fig.11-13.

1980 *Verrucosisporites congestus* Playford; Van der Zwan, p.215-216, pl. 25, fig.1-5.

1988 *Verrucosisporites nitidus* (Naumova) Playford; Higgs et al., p.62, pl. 6, fig1.

Description: Miospores radial, trilete. Amb subcircular. Suturae simple, straight, distinct, lenght three-quarters of spore radius, frequently obscured by ornament. Exine 3.0-5.5 μm in thickness. Distal surface ornamented with large verrucae (more than 8 μm in basal diameter), irregularly distributed on both surfaces distal and proximal.

Dimensions: 55-65 μm; 46 specimens.

Occurrence: Bordalete Formation of SWP Domain (PC Miospore Biozone).

Verrucosisporites irregularis Phillips & Clayton, 1980

Plate 4, Fig. 8

1980 *Verrucosisporites irregularis* Phillips & Clayton, pl. 3, Figs.

Description: Miospores radial, trilete. Amb subcircular. Suturae simple, straight, distinct, lenght one-half to three-quarters of spore radius. Exine 2.0-4.0 μm in thickness. Distal surface ornamented with verrucae (1-9 μm in basal diameter, around 3 μm height and spaced 1-6 μm). Verrucae subcircular to irregular in shape and rounded in outline. Short ridges formed by the fusion of adjacent verrucae are very frequent.

Dimensions: 40-78 μm; 28 specimens.

Occurrence: Bordalete Formation of SWP Domain (PC Miospore Biozone).

Verrucosisporites nitidus Playford, 1964

Plate 4, Figs. 9, 10

1953 *Lophotriletes grumosus* Naumova, p.57, pl. 7, fig.14-15.

1964 *V. grumosus* (Naumova) Sullivan p.1252-1253, pl. 1, fig.9-15.

1980 *Verrucosisporites nitidus* (Naumova) Playford; Van der Zwan, p.126, pl. 24, fig.1-5.

1988 *Verrucosisporites nitidus* (Naumova) Playford; Higgs et al., p. 62, pl. 6, fig.2-4.

1988 *Verrucosisporites nitidus* (Naumova) Playford; Avchimovitch et al., p.175, pl. 2,fig.5,6.

1990 *Verrucosisporites mesogrumosus* (Kedo) Byvscheva; Clayton &Turnau, pl. 2, fig.4,6.

Description: Miospores radial, trilete. Amb subcircular. Suturae simple, straight, distinct or obscured by ornament, reaching at least three-quarters of the spore radius. Exine thick (1.5-4.5 μm), ornamented with dense to sparsely verrucae. Verrucae discrete subcircular to irregular polygonal in basal outline often dense forming negative reticulum with rounded flat tops (2.0-12.0 μm in basal diameter; 2.0-7.0 μm in height).

Dimensions: 35-70 μm; 68 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt, Tercenas and Bordalete Formations of SWP Domain (LN to PC Miospore Biozones).

Previous records: From upper Frasnian to Viséan worldwide deposits (BERTELSEN, 1972, PLAYFORD, 1991, CLAYTON, COQUEL et al., 1977, HIGGS & STREEL, 1984, HIGGS et al., 1988, PEREIRA, 1997, 1999; GONZÁLEZ et al., 2005, PEREIRA et al., 2006; 2007).

Verrucosisporites premnus Richardson, 1965

Plate 4, Fig. 11

1965 *Verrucosisporites premnus* Richardson, p. 572, Pl. 90, figs. 1,2.

1965 *Raistrickia* sp. A, Richardson, p. 572, Pl. 90, fig. 3.

1965 *Raistrickia* cf. *clavata*, Hacquebard, Richardson, p. 575, Pl. 90, fig. 5.

Description: Miospores radial, trilete. Amb subcircular to rounded subtriangular. Suturae simple, straight, distinct or obscured by ornament, reaching at least three-quarters of the spore radius. Exine thick (3-5.5 μm), ornamented, in distal and equatorial regions, with proeminent bacula, verrucae and spatulate elements, with flatted or less commonly rounded tops, greatly varied in size and shape on each specimen, 3.0-16.0 μm high and 3.0-15.0 μm wide at base. Verrucae discrete subcircular to irregular polygonal in basal outline often forming negative reticulum with rounded flat tops (2.0-12.0 μm in basal diameter; 2.0-7.0 μm in height). The largest elements commonly occur at the equator, and asymmetrically distributed in polar view. Elements widely or closed spaced, discrete or joined in small groups.

Dimensions:31-65 μm; 23 specimens.

Occurrence: Ribeira de Limas Formation of Pulo do Lobo Domain, Phyllite-Quartzite Group of Iberian Pyrite Belt (BM and VCo-VH Miospore Biozones).

Previous records: From Middle to lower Upper Devonian strata (NAUMOVA, 1953; RICHARDSON, 1965; ALLEN, 1965; SMITH, 1971; MCGREGOR & CAMFIELD, 1982; RICHARDSON & MCGREGOR, 1986; PEREIRA et al., 2006).

Verrucosisporites scurrus (Naumova) McGregor & Camfield, 1982

Plate 4, Figs. 12, 13

1982 *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, pp. 61- 62; pl. 18, figs. 10-17, 22.

For further synonymy see McGregor & Camfield (1982, pp. 61-62).

Description: Miospores radial, trilete. Amb subcircular to convexly subtriangular. Suturae straight, simple, distinct or obscured by sculpture, length of three-quarters of spore radius. Exine 2.0-3.0 μm in thickness, ornamented systematically with verrucae (2.5-6.5 μm in basal diameter, 2.5-6.5 μm in height) irregularly distributed. Verrucae discrete (up to 9 μm apart) or fused, sometimes overlapping, variable in shape and size on a given specimen, rounded or rounded-conical in profile, but sometimes almost parallel-sided with rounded tops, basal outline circular, elongate, or polygonal. Sculpture reduced in contact areas.

Dimensions: 35- 65 μm; 23 specimens.

Occurrence: Phyllite-Quartzite Group and Volcano Sedimentary Complex (VCo, VH and LN Miospore Biozones).

Previous records: From Middle to lower Upper Devonian strata (NAUMOVA, 1953; MCGREGOR & CAMFIELD, 1982; RICHARDSON & MCGREGOR, 1986; TURNAU & RACKI, 1999; OTTONE, 1996; RUBINSTEIN, 1999; LOBOZIAK et al., 1988, 1992; DINO, 1999; MELO & LOBOZIAK, 2003; GONZÁLEZ et al., 2005; PEREIRA et al., 2006; 2007), Uppermost Devonian to Lower Carbonifeous (Tournaisian) of Ireland (HIGGS et al., 1988), Portugal in SWP Domain (PEREIRA 1997, 1999) and Ghana (ATTA-PETERS & ANAN-YORKE, 2003).

Genus WALTZISPORA Staplin 1960

Type species: *Waltzispora lobophora* (Waltz) Staplin 1960

Waltzispora polita (Hoffmeister, Staplin & Malloy) Smith & Butterworth, 1967

Plate 4, Figs. 14, 15

1955 *Granulati-sporites politus* Hoffmeister, Staplin & Malloy,p.389, pl. 36, fig.13.

1960 *Leiotriletes politus* (Hoffmeister, Staplin & Malloy) Love, p.111, pl. 1, fig.1.

1967 *Waltzispora polita* (Hoffmeister, Staplin & Malloy) Smith & Butterworth, p. 159, pl. 6, fig.14.

Description:Trilete spore, Amb triangular with rounded apicae and cancave sides. Suturae distinct, simple, straight, three-quarters to fourth-fifth of the spore radius. Proximal surface lavigatae. Distal surface with small and uniform coni with 1 - 2 μm in length and 1 - 1.5 μm in basal diameter. Distance between coni 2 to 3 μm, regular distribution but in small numbers in the equatorial margin, particurlaly in the inter-radial areas. Exine 1 μm in thickness seldom folded. Smooth equatorial margins with coni concentrated near the apicae.

Dimensions:24-35 μm; 12 specimens.

Occurrence: Murração and Mértola Formations.

Infraturma MURORNATI R. Potonié & Kremp1954

Genus ACINOSPORITES Richardson 1965

Type species: *Acinosporites acanthomammillatus* Richardson 1965

Acinosporites lindlarensis Riegel, 1968

Plate 4, Fig. 16

1968 *Acinosporites lindlarensis* Riegel, p.89, Pl. 19, figs. 11-16.

For additional synonymy see McGregor & Camfield, 1976, p.6.

Description: Miospores radial, trilete. Amb subcircular to rounded subtriangular. Suturae, simple, distinct with narrow labra, reaching almost the equator. Exoexine proximally laevigate or with small coni, 0.5-1.5 μm at base, about 1.0 μm high. Ornamentation at the equator and distal regions biform, with roundly expanded or conical bases 1.5-6.0 μm wide, up to 7.0-8.0 μm long, tapering gradually or abruptly to a spine or baculum 1.0-4.0 μm long, or rounded apex, surmounted by a granule or cone, rounded or polygonal in plan view, discrete and closely spaced, or jointed at base to adjacent elements forming ridges.

Dimensions: 58-87 μm; 18 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt in S. Francisco da Serra region (AD Miospore Biozone).

Previous records: From Middle Devonian of Canada (MCGREGOR & CAMFIELD, 1976; MCGREGOR & CAMFIELD, 1982; RICHARDSON & MCGREGOR, 1986) and Australia (MCGREGOR & PLAYFORD, 1992). From Lower Devonian of Argentina (LE HÉRISSÉ et al., 1997), Brazil (LOBOZIAK et al., 1988; DINO, 1999; LOBOZIAK AND MELO, 2002; MELO & LOBOZIAK, 2003; GRHAM et al., 2006) and Bolivia (PÉREZ LEYTON, 1990; MCGREGOR, 1984).

Genus CONVOLUTISPORA Hoffmeister, Staplin & Malloy, 1955

Type species: *Convolutispora florida* Hoffmeister, Staplin & Malloy, 1955; by original designation.

Convolutispora cerebra Butterworth & Williams, 1958

Plate 4, Fig. 18

1958 *Convolutispora cerebra* Butterworth & Williams, p. 371.

Description: Spore radial, trilete. Amb circular. Suturae distinct or indistinct, length approximately three-quarters of spore radius. Exine thick, 4.0-6.0 μm densely ornamented by sinuous muri of several dimensions (2.0-5.0 μm in width 2 μm in height) separated by small lumina.

Dimensions:55-72.5 μm; 31 specimens.

Occurrence: Quebradas Formation of SWP Domain and Brejeira Formation of BAFG (FR Miospore Bizone).

Convolutispora florida Hoffmeister, Staplin & Malloy, 1955

Plate 4, Fig. 19

1955 *Convolutispora florida* Hoffmeister, Staplin & Malloy, p.87, pl. 38, fig.6.

Description: Spore radial, trilete. Amb circular to subcircular. Suturae indistinct, length approximately three-quarters of spore radius. Exine thick, densely ornamented by rugulae (3-6 μm in width). The rugulae possess rounded to flat tops, with 5.0 μm in height and 7.0 μm in basal diameter.

Dimensions: 34-50 μm; 26 specimens.

Occurrence: Quebradas Formation of SWP Domain and Brejeira Formation of BAFG (FR Miospore Bizone).

Convolutispora major (Kedo) Turnau, 1978

Plate 4, Fig. 17

1963 *Dictyotriletes major* Kedo, p.55, pl. 4, fig.97.

1978 *Convolutispora major* (Kedo) Turnau, p.8, pl. 2, fig.18-19.

Description: Spore radial, trilete. Amb circular. Suturae disctint to partially obscured, straight, length aproximatly one-half of spore radius, bordered by labra (4.0-5.0 μm). Exine 9.0-10.0 μm thick, densely ornamented with broad, rounded muri (5.0-10.0 μm in width and 4.0-6.0 μm in height) irregular, convoluted and anastomosing forming an imperfect reticulum. Lumina irregular in shape 8-18 μm in width.

Dimensions: 90-100 μm; 6 specimens.

Occurrence: Bordalete Formation of SWP Domain (PC Miospore Biozone).

Genus CORBULISPORA Bharadwaj & Venkatachala 1961

Type species: *Corbulispora retiformis* Bharadwaj & Venkatachala, 1962; by original designation.

Corbulispora sp.

Plate 5, Fig. 1

Description: Miospores radial, trilete, amb circular to subcircular. Suturae distinct, straight, reaching three-quarters to four-fifths of distance to equator, bounded by labra 6.0-10.0 μm in width. Exine thick, sculptured with crenulate rugulae, 4.0-6.0 μm in width and height. Rugulae coalescent, enclosing lumina of 10-13 μm in diameter, or freely terminating. Non-rugulate exine laevigate to scabrate.

Dimensions: 50-65 μm; 4 specimens.

Occurrence: Tercenas Formation (LN Miospore Biozone).

Genus DICTYOTRILETES Naumova emend Smith & Butherworth 1967

Type species: *Dictyotriletes bireticulatus* (Ibrahim) Potonié & Kremp 1954

Dictyotriletes fimbriatus (Winslow) Kaiser, 1970

Plate 5, Fig. 2

1962 *Reticulatisporites? fimbriatus* Winslow, p.58-59, pl. 14, fig.1-3; pl. 22, fig.21.

1970 *Dictyotriletes fimbriatus* (Winslow) Kaiser, p.95, pl. 19, fig. 4-6.

Description: Spore radial, trilete, amb circular to subcircular or broadly rounded. Suturae indistinct and irregular in outline. Exine reticulate, reticulum more or less uniformly developed over the proximal and distal surfaces. Muri sinuous, smooth, fringered and often papillate forming an irregular reticulum.

Dimensions:75-115 μm; 42 specimens.

Occurrence: Tercenas Formation (LN Miospore Biozone).

Previous records: From Upper Devonian of Ireland (HIGGS et al., 1988), Portugal (PEREIRA, 1999), Russia (BYVSCHEVA, 1976).

Dictyotriletes probireticulatus (Ibrahim) Butterworth & Mahdi, 1981

Plate 5, Fig. 3

1967 *Dictyotriletes bireticulatus* (Ibrahim) Smith &

Butterworth, p. 194.

1981 *Dictyotriletes probireticulatus* (Ibrahim) Butterworth & Mahdi, p. 490, pl. 1, fig.11-13.

Description: Spore radial, trilete, amb triangular to subtriangular. Suturae indistinct, simple, straight, reaching three-quarters of spore radius. Exine of 1.5 μm thickness, reticulate, reticulum more or less uniformly developed over proximal and distal surfaces. Muri sinuous, about 1.5 μm in width and in height. Lumina 18-22, irregularly polygonal, maximum diameter range 2.5-12.0 μm. Aproximatly 14-18 muri project from equator.

Dimensions:45.5-60 μm; 8 specimens.

Occurrence: Brejeira Formation (SS Miospore Biozone).

Dictyotriletes proprius Playford, 1978

Plate 5, Fig. 4

1977 *Dictyotriletes* sp. Playford, p. 79, pl. 12, figs.1,2.

1978 *Dictyotriletes proprius* Playford, p. 127, pl. 7, figs.13-19.

Description: Spore radial, trilete, amb circular to subcircular or broadly rounded. Suturae distinct, simple, straight, reaching one-half to three-quarters of spore radius. Exine reticulate, reticulum more or less uniformly developed over the proximal and distal surfaces. Muri sinuous, smooth, frequently anastomosed, 0.5-3.0 μm in width, mural crests rounded to acute, 0.5-3.0 μm height. Lumina irregularly polygonal, maximum diameters range 2.5-12.0 μm. Non-murolate exine laevigate 1.2-2.5 μm thickeness.

Dimensions:45-82 μm; 8 specimens.

Occurrence: Volcano sedimentary Complex of Iberian Pyrite Belt (TS Miospore Biozone).

Genus EMPHANISPORITES McGregor, 1961

Type species: *Emphanisporites rotatus* McGregor emend. McGregor, 1973; by original designation.

Emphanisporites annulatus McGregor, 1961

Plate 5, Figs5

1961 *Emphanisporites annulatus* MacGregor, p.3, pl. 1, fig.5-6.

1962 *Radiaspora* sp. Balme, p.6, pl. 1, fig.13.

1963 *Emphanisporites erraticus* (Eisenack) McGregor in Chaloner, p.103, fig.1.

1967 *Emphanisporites* cf. *erraticus* (Eisenack) McGregor, p.106, pl. 1,fig.10.

For additional synonymy see McGregor (1973, p. 45).

Description: Miospores radial, trilete. Amb subtriangular to subcircular. Suturae distinct, straight, simple or associated with narrow labra (up to 3 μm high), reaching almost to equator. Proximal surface showing 3-6 radial ridges in each interradial sector, their width increasingly from 2 μm in proximal polar area to 3.5-4.0 μm at equatorial margin. The latter is marked by a continuous thickening, 2-4 μm wide, a second concentric ring, located aproximatly one-half to two-thirds of distance towards the distal pole.

Dimensions: 45-57,5 μm; 37 specimens.

Occurrence: Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt, Tercenas Formation (LN Miospore Biozone).

Previous records: From Lower and Middle Devonian worldwide rocks. From Upper Devonian (upper Famennian) deposits of Ireland (CLAYTON et al., 1977; HIGGS et al., 1988), Portugal (PEREIRA et al., 1994; 2007; PEREIRA, 1997, 1999), Spain (GONZÁLEZ, 2005) and Libya (MASSA & MOREAU-BENOIT, 1976). This apparently reports a second abundance peak of *Emphanisporites* spp. during uppermost Devonian lowermost Carboniferous time (PLAYFORD & MCGREGOR, 1993).

Emphanisporites hibernicus Clayton, Higgs & Keegan, 1977

Plate 5, Fig. 6

1977 *Emphanisporites hibernicus* Clayton, Higgs & Keegan, p. 421; pl. 1, figs. 10-15.

Description: Miospores radial, trilete. Amb rounded subtriangular to subcircular. Suturae distinct, straight, extending almost to equator, with narrow labra 1.0-1.5 μm in overall width. Exine 1.5-3.0 μm thick, laevigate, sculptured proximally with straight, thickened ridges (6-8 in each interradial sector), disposed in a chevron organization. Ridges 2-3.5 μm wide. Exine laevigate distally, equatorial crassitude 2.0-4.0 μm wide.

Dimensions: 5-54 μm; 12 specimens.

Occurrence: Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt, Tercenas Formation (LN Miospore Biozone).

Previous records: From the uppermost Devonian-Lower Carboniferous of Ireland (CLAYTON, HIGGS & KEEGAN, 1977; HIGGS et al., 1988); Portugal (PEREIRA, 1999; PEREIRA et al., 1994).

Emphanisporites rotatus McGregor emend McGregor, 1973

Plate 5, Figs. 7,8

1961 *Emphanisporites rotatus* McGregor, p. 3; pl. 1, figs. 1-4.

1973 *Emphanisporites rotatus* McGregor emend. McGregor, pp. 46-47; pl. 6, figs. 9-13.

For further synonymies see McGregor (1973, pp. 46-47), McGregor & Camfield (1982, p. 39), Balme (1988, p. 131), and Steemans (1989, p. 142).

Description: Miospores radial, trilete. Amb convexly subtriangular to subcircular. Suturae distinct, straight, simple or with narrow labra, attaining equator. Exine 2.0-3.0 μm thick, distal face laevigate, proximal face bearing 15-30, radially arranged, spoke-like ridges, extending from distal polar region to equator. Ridges frequently branching towards equator attaining the maximum of 2.5-4.0 μm in width.

Dimensions: 32.5-65 μm; 26 specimens.

Occurrence: Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt, Tercenas and Bordalete Formations and (LN to PC Miospore Biozones).

Previous records: Reported worldwide throughout the Devonian system, *Emphanisporites rotatus* extends also into the lowermost Carboniferous (PLAYFORD & MCGREGOR, 1993).

Genus MICRORETICULATISPORITES Knox emend. Potonié & Kremp 1954

Type species: *Microreticulatisporites lacunosus* (Ibrahim) Knox 1950

Microreticulatisporites concavus Butterworth & Williams, 1958

Plate 5, Figs. 9,10

1958 *Microreticulatisporites concavus* Butterworth & Williams, p. 367, pl. 1, fig.56.

Description: Miospores radial, trilete. Amb subtriangular, with straight, slightly concave or convex rounded sides. Suturae distinct, straight, simple, open, reaching three-quarters of spore radius. Exine thin, microreticulate with 2 μm diameter lumina. Muri 3 μm in height, 30-40 muri projecting along the equatorial margin.

Dimensions: 30-52 μm; 16 specimens.

Occurrence: Volcano Sedimentary Complex of Iberian Pyrite Belt, Mértola Formation of BAFG and Murração Formation of SWP Domain (NL Miospore Biozone).

Subturma ZONOTRILETES Waltz, 1935

Infraturma AURICULATI Smith & Butterworth, 1967

Genus TRIPARTITES (Schemel) Potonié & Kremp 1954

Type species: *Tripartites vetustus* Schemel 1950

Tripartites vetustus Schemel 1950

Plate 5, Fig.11

Description: Miospores radial, trilete, amb triangular, slightly to strongly concave, apices rounded or truncate. Suturae distinct, straight, simple or accompanied by narrow labra extending almost to equator margin. Exine laevigate, 2.5 μm in thickness, extended laterally in the equatorial plane to form a well developed auriculae in radial positions, inter-radial connections reduced. Distal surface of auriculae plicated.

Dimensions: 37-50 μm; 9 specimens.

Occurrence: Mértola Formation of BAFG and Murração, Quebradas and more infrequently in Brejeira Formations of SWP Domain (VF to SS Miospore Biozones). The studied specimens are poorly preserved, normally occurring as eroded specimens.

Genus TRIQUITRITES (Wilson & Coe) Potonié & Kremp 1954

Type species: *Triquitrites arculatus* Wilson & Coe 1954

Triquitrites bransonii Wilson & Hoffmeister, 1956

Plate 5, Fig. 12

1956 *Triquitrites bransonii* Wilson & Hoffmeister, p.24, pl. 3, fig.1.

Description: Miospores radial, trilete, amb triangular, sides slightly to strongly concave. Suturae distinct, straight, simple or accompanied by narrow labra extending from two-thirds radius to polar margin of radial crassitudes. Extent and development of radial crassitudes dense thicknings which protrude from equator and are smooth and rounded truncate, or sometimes lobed. Maximum dimension of crassitudes from 13.0 μm in width and 7.0 μm in length.

Dimensions: 30-40 μm; 18 specimens.

Occurrence: Brejeira Formation.

Triquitrites tribullatus (Ibrahim) Schopf, Wilson & Bentall, 1944

Plate 5, Fig. 13

1932 *Sporonites tribullatus* (Ibrahim) Potonié, Ibrahim & Loose, p.448, pl. 15, fig.13.

1933 *Laevigati-sporites tribullatus* Ibrahim, p.20, pl. 2, fig.13.

1934 *Valvi-sporites tribullatus* (Ibrahim) Loose, p.152, pl. 7, fig.21.

1938 *Azonotriletes tribullatus* (Ibrahim) Luber & Waltz, pl. 7, fig.88.

1944 *Triquitrites tribullatus* (Ibrahim) Schopf, Wilson & Bentall, p.47.

Description: Miospores radial, trilete, amb triangular, with well rounded or flatted angles, sides straight to slightly convex or concave. Suturae distinct, straight, simple extending from two-thirds radius to inner margin of spore body. The radial crassitudes vary from slight equatorial thickenings, which do not modify the outline of the spore to rounded truncate, or sometimes lobed and which may project slightly beyond the margin. Maximum dimension of crassitudes from 18.0 μm in width and 11.0 μm in length, more developed in the distal pole. Exine scabrate to weakly granulate and up to 2.5 μm in thickness.

Dimensions: 40-70 μm; 6 specimens.

Occurrence: Brejeira Formations (Bashkirian age).

Infraturma TRICRASSATI Dettmann 1963

Genus DIATOMOZONOTRILETES (Naumova) Playford 1963

Type species: *Diatomozonotriletes saetosus* (Hacquebard & Barss) Hugues & Playford 1961

Diatomozonotriletes cervicornutus (Staplin) Playford, 1963

Plate 5, Fig. 15

1960 *Reinschospora cervicornuta* Staplin, p.24, pl. 5, fig.1-3.

Description: Miospores radial, trilete, amb triangular with straight to slightly convex sides and rounded to truncate apices. Suturae distinct, simple, straight, open, reaching equator margin. Interadial areas ornamented with small setae (17-23), basal diameter 5 μm and up to 15 μm long in the central interradial region. Distal surface bears sharply tapered coni on the distal surface, coni in variable number around the distal pole. Exine 1.5-3.0 μm thicness.

Dimensions: 40-50 μm; 5 specimens.

Occurrence: Murração Formation (NL Miospore Biozone).

Diatomozonotriletes franklinii McGregor & Camfield, 1982

Plate 5, Fig. 14

1966 *Diatomozonotriletes devonicus* Naumova, Mikhailova, pl. 1, fig.2.

1966 *Diatomozonotriletes devonicus* Naumova, McGregor & Uyeno, Pl. 2, fig.6.

1982 *Diatomozonotriletes franklinii* McGregor & Camfield, Pl. 7, Figs. 10-13.

Description: Miospores radial, trilete, amb subtriangular with convex, straight to slightly concave sides and rounded apices. Suturae distinct, simple, straight, almost reaching equator margin. Exine 1.0-1.5 μm in thickness, proximal surface scabrate to laevigate, or with scattered grana. Sculpture at interradial equator consists of closely spaced spinae (0.5-1.0 μm wide at base and 2.5-4.0 μm long in the middle of the interradial margins, increasing in length toward the radial angles. Distal surface bears small grana and coni less that 2.0 μm wide and high, polygonal or subcircular in plan view.

Dimensions: 25-37 μm; 9 specimens.

Occurrence: Reworked species recovered in Phyllite-Quartzite Group (AD Miospore Biozone, subzone lem).

Diatomozonotriletes rarus Playford, 1962

Plate 5, Figs. 16, 17

1962 *Diatomozonotriletes rarus* Playford, p.649, pl. 93, fig.15-16.

Description: Miospores radial, trilete, amb subtriangular with straight to slightly concave sides and rouded to truncate apices. Suturae distinct, simple, straight, almost reaching equator margin. From the sides of the spore, small saetae (17-23), pointed, basal diameter 1.0-1.5 μm, longest in central interradial region . Distal surface bearing sharped tapered spinae 2.0-4.0 μm long, 1.5-2.5 μm broad at base. Exine 1.0-2.5 μm thicness.

Dimensions: 35-43 μm; 3 specimens.

Occurrence: Volcano Sedimentary Complex of Iberian Pyrite Belt, Mértola Formation and Murração Formation (NL Miospore Biozone).

Infraturma CINGULATI Potonié & Klaus emend Dettmann, 1963

Genus ANEUROSPORA Streel, 1964

Type species: *Aneurospora goensis* Streel 1964, by original designation.

Aneurospora greggsii (McGregor) Streel in Becker, Bless, Streel & Thorez, 1974

Plate 5, Figs. 18-20

1964 *Retusotriletes greggsii* McGregor, p. 10; pl. 1, figs. 1-12.

1974 *Aneurospora greggsii* (McGregor) Streel in Becker, Bless, Streel & Thorez, p. 24; pl. 16, figs. 6-15.

Description: Miospores radial, trilete, amb subtriangular to subcircular, suturae distinct, straight, reaching at least three-quarters of distance to equator, accompanied by labra 1-3 μm wide, and terminating in curvaturae perfectae. Exine thick, proximo-equatorially forming a darkened band (2-6 μm wide) commonly associated with the curvaturae. Contact areas laevigate, distal surface densely sculptured with coni and spinae (up to 1 μm high). Large folds common.

Dimensions: 40 - 55 μm;17 specimens.

Occurrence: Ribeira de Limas and Gafo, and Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo Domain, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt (AD, BM, VH and LN Miospore Biozones).

Previous records: From Givetian through upper Famennian of Portugal (CUNHA & OLIVEIRA, 1989; OLIVEIRA et al., 1986; PEREIRA et al., 2006, 2007), Spain (GONZÁLEZ et al., 2005), Belgium (BECKER et al., 1974; STREEL, 1967, 1999), France (LOBOZIAK & STREEL, 1980), Germany (HIGGS & STREEL, 1984), Scotland (MARSHALL & ALLEN, 1982), Canada (MCGREGOR, 1964), Poland (TURNAU, 1996; TURNAU & RACKI, 1999) and northeastern U.S.A (STREEL & TRAVERSE, 1978).

Genus BELLISPORES (Artuz) Sullivan 1964

Type species: *Bellispores nitidus* (Horst) Sullivan 1964

Bellispores nitidus (Horst) Sullivan, 1964

Plate 6, Figs. 1, 2

1957 *Simizonotriletes trilinearis* Artuz, p.251, pl. 5, fig. 36.

1964 *Bellispores nitidus* (Horst) Sullivan, p. 375.

Description: Miospores radial, trilete, acamerate, cingulate. Amb triangular with concave or straight sides and rounded apices. Outline crenulate. Suturae distinct, straight, to sinuous, bordered by narrow labra, almost reaching equator margin. Intexine thin forming wall of spore body. Exoexine sculptured distally and equatorially to form an irregular narrow cingulum, 2.5-5.0 μm wide, with irregular crenulate margin, uniformly broad. Distal surface ornamented with Y-thickened ribs. Margins of distal thickened ribs crenulate in the same style as the cingulum, individual ribs up to 10.0 μm wide. Proximal surface laevigate, distal surface including distal ribs and cingulum foveolate (foveolae less than 2.0 μm diameter).

Dimensions: 28-45 μm; 27 specimens.

Occurrence: Murração, Quebradas of SWP Domain and Mértola and Brejeira Formations of GFBA (upper Viséan to Bashkirian, NC to NJ Miospore Biozones).

Genus KNOXISPORITES R. Potonié & Kremp emend Neves 1961

Type species: *Knoxisporites hagenii* Potonié & Kremp, 1954, by original designation.

Knoxisporites concentricus (Byvscheva) Playford & McGregor, 1993

Plate 6, Figs. 3, 4

1976 *Concentrisporites concentricus* Byvscheva, p.83-85, pl. 17, fig.1-5.

1977 *Lophozonotriletes* sp. Keegan, pl. 3, fig. 9.

1980 *Lophozonotriletes* sp. in Naylor & Higgs, tab.1, p.383.

1981 *Tumulispora* sp. Van Veen, pl. 4, fig. 1-2.

1988 *Lophozonotriletes concentricus* (Byvscheva) Higgs, Clayton & Keegan, p.67, pl. 8, fig. 7-10.

1993 *Knoxisporites concentricus* (Byvscheva) Playford & McGregor, Pl. 13, Figs. 1-8.

Description: Miospores radial, trilete. Amb roundly subtriangular to subcircular, edge entire to occasionally undulant to dentate. Suturae distinct to perceptible, simple, straight, extending to inner margin of cingulum. Cingulum width uniform, about 5.0-12.0 μm. Well defined rugulae, sometimes associated with verrucae, developed on distal surface, often arranged almost symmetricaly in a polar centered spiral or concentric pattern. The murornate elements maybe tightly or separated up to 10 μm apart. Verrucae when present, often occur centrally in distal polar region. Two to four whorls or concentric sets of rugulae/verrucae may occur where sculpture patterns show this disposition. Proximal surface laevigate or bearing one or two rugulae or verrucae.

Dimensions: 45-65 μm; 24 specimens.

Occurrence: Tercenas and Bordalete Formations (LN to PC Miospore Biozones).

Previous records: From the uppermost Devonian and possibly Lower Carboniferous (Tournaisian) of Russia (BYVSHEVA, 1976; 1985), Ireland (VAN VEEN, 1981; HIGGS et al., 1988), England (TURNER et al., 1991) and USA (COLEMAN & CLAYTON, 1987) and Portugal (PEREIRA, 1997; 1999).

Knoxisporites literatus (Waltz) Playford, 1963

Plate 6, Fig. 5

1938 *Zonotriletes literatus* Waltz em Luber & Waltz, p. 18, pl. A, fig.11.

1956 *Euryzonotriletes literatus* (Waltz) Ishchenko, p. 52-53, pl. 9,fig.108.

1956 *Anulatisporites literatus* (Waltz) Potonié & Kremp,p.111.

1957 *Cincturasporites literatus* (Waltz) Hacquebard & Barss, p. 23-34, pl. 3, fig. 2-5.

1963 *Archaeozonotriletes literatus* (Waltz) Kedo, pl. 8, fig. 188-190.

1963 *Knoxisporites literatus* (Waltz) Playford, p. 63, pl. 90, fig. 7-8.

Description: Miospores radial, trilete. Amb subcircular to convexly subtriangular. Suturae distinct, straight, extending almost to the cingulum and bordered by low labra 4.0 -10.0 μm in overall width. Distal ornament consist of a subcircular to polygonal ring shaped thickening surrounding the distal pole and linked to the cingulum by variable number of muri (1-4). The equatorial cingulum 5.0-10.0 μm in width. Exine smoth.

Dimensions: 55-102 μm; 26 specimens.

Occurrence: Phyllite-Quartzite Group and Tercenas and Bordalete Formations (LN to PC Miospore Biozones).

Previous records: Extensively recorded from the uppermost Devonian to upper Viséan/lower Namurian of the northern hemisphere and Eastern Gondwana (Australia), as summarized by PLAYFORD (1971), VAN DER ZWAN (1980), PLAYFORD & SATTERTHWAIT (1986), HIGGS et al (1988) and PLAYFORD (1991).

Knoxisporites hederatus (Ishchenko) Playford, 1962

Plate 6, Figs. 6, 7

1956 *Euryzonotriletes hederatus* Ishchenko, pl. 10, fig. 121.

1962 *Knoxisporites hederatus* Playford, pl. 90, figs. 9-12.

Description: Miospores radial, trilete. Amb circular to subcircular, surrounded by more or less conformable cingulum. Suturae distinct, straight, extending almost to the margin of spore body. Exoexine extended in the equatorial plane to form an undifferentiated cingulum 5.0-16.0 μm in width. Distal surface bears widely spaced, rounded muri, that are connected in several places to each other and to the cingulum. Muri slightly sinuous, irregular in pattern, 10-18 μm wide and 5.0-8.0 high.

Dimensions: 75-110 μm; 12 specimens.

Occurrence: Graça Formation of Neves Corvo mine region (TS Miospore Biozone of Viséan age).

Knoxisporites stephanephorus Love, 1960

Plate 6, Figs. 14, 15

1960 *Knoxisporites stephanephorus* Love, p. 567.

Description: Miospores radial, trilete. Amb circular, subcircular to rounded triangular. Suturae distinct, straight, extending almost to the cingulum simple or bordered by low narrow labra which tpically become expanded equatorially to form a tringular thickened areas that fuse to the proximal surface of the cingulum. Exine laevigate. Intexine forming all(?) body rarely discernible. Exoexine closely adpressed to intexine but extended in the equatorial plane to form ticknened cingulum 5.0-12.0 μm. Exoexine possesses a second ring of thickning with irregular, radially oriented, thick ribs in the inter-radial positions. A distal polar thickening, circular in shape, 5.0-10.0 μm in diameter is also developed in the exoexine.

Dimensions: 30-62 μm; 47 specimens.

Occurrence: Murração and Graça Formations (TS Miospore Biozone of Viséan age).

Koxisporites ruhlandii Doubinger & Rauscher, 1966

Plate 6, Figs. 8, 9

Remarks: *Koxisporites ruhlandii* resembles *K. stephanephorus* Love 1960, but has roundly triangular amb in contrast to circular amb of *K. stephanephorus*. Dimensions: 45-90 μm; 15 specimens.

Occurrence: Graça Formation (TS Miospore Biozone of Viséan age).

Knoxisporites triradiatus Hoffmeister, Staplin & Malloy, 1955

Plate 6, Figs. 10, 11

1955 *Knoxisporites triradiatus* Hoffmeister, Staplin & Malloy, p1. 1, fig. 3.

Description: Miospores radial, trilete. Amb subcircular to rounded triangular. Suturae distinct, straight, extending almost to, the equatorial margin of the spore, bordered by low, broad, thickened labra. Intexine probably thin, forms inner spore body conformable in outline with the equatorial margin. Exoexine closely adpressed to intexine over proximal and distal surfaces but extended in the equatorial plane to form thick undifferentiated relatively narrow cingulum. Distal surface of exoexine bears thickened Y-shaped structure with ribs of uniform thickness, extending from distal pole to fuse with the cingulum in the inter-radial position (6-10 μm width).

Dimensions: 48-75 μm; 24 specimens.

Occurrence: Murração and Quebradas Formations of SWP Domain and Mértola Formation of BAFG (Viséan to Serpukovian). Very common in Quebradas Formation (FR Miospore Biozone of Bashkirian age), in an assemblage dominated by *Knoxisporites* spp, it is interpreted as reworked from the Tournaisian.

Knoxisporites cf. *triradiatus* Hoffmeister, Staplin & Malloy sensu Sullivan, 1964

Plate 6, Figs. 12, 13

1964 *Knoxisporites* cf. *triradiatus* Hoffmeister, Staplin & Malloy sensu Sullivan, pl. 8, fig.4.

Description: Miospores radial, trilete. Amb subcircular to rounded triangular. Suturae distinct, straight, bordered by thickned labra up to 7.0-8.0 μm; extending to the margin of the cingulum. Distal surface bears three broad muri 8.0-15.0 μm in width, which radiate from distal pole to the cingulum in inter-radial positions. Cingulum laevigate and 9.0-16.0 μm in thickness.

Dimensions: 74-100 μm; 42 specimens.

Occurrence: Tercenas and Bordalete Formations of SWP Domain (LN to PC Miospore Biozones). Higher dimensions specimens are observed in PC Biozone.

Genus ROTASPORA Schemel emend. Smith & Butterworth 1967

Type species: *Rotaspora fracta* Schemel emend Smith & Butterworth 1967

Rotaspora fracta (Schemel) Smith & Butterworth, 1967

Plate 6, Figs. 16

1950 *Rotaspora fracta* Schemel, p. 241.

1967 *Rotaspora fracta* Schemel emend Smith & Butterworth, p. 227, pl. 15, fig. 8-11.

Description: Miospores radial, trilete. Amb circular to subcircular to rounded triangular, spore body triangular with slightly concave sides and rounded apices. Suturae distinct, straight, simple or bordered by narrow labra extending to the spore margin. Width of zona constant, with narrow thickening in the margin forming an equatorial zona.

Exine of body and zona laevigate.

Dimensions: 35 μm; 3 especimens.

Occurrence: Murração and Mértola Formations (VF to NC Miospore Biozones of upper Viséan to Serpukovian).

Rotaspora knoxi Butterworth & Williams, 1958

Plate 6, Figs. 17

1958 *Rotaspora knoxi* Butterworth & Williams, p. 378, pl. 3, fig.21-23.

Description: Miospores radial, trilete. Amb subtriangular, with broadly rounded apices, outline of the body more triangular. Suturae distinct, straight, simple or surrounded by narrow labra extending to the spore margin. Exine laevigate. Zona widest (up to 6.0 μm) in the inter-radial position, but significantly reduced in the apices. Zona normally bizonate.

Dimensions: 26-38 μm; 14 specimens.

Occurrence: Murração and Mértola Formations (VF to TK Miospore Biozones of late Viséan to Serpukovian).

Genus RETICULATISPORITES (Ibrahim) Neves 1964

Type species: *Reticulatisporites reticulatus* Ibrahim 1932

Reticulatisporites peltatus Playford, 1962

Plate 7, Fig. 3

1962 *Reticulatisporites peltatus* Playford, p. 599, pl. 84, fig. 1-4.

Description: Miospores radial, trilete. Amb circular to subcircular. Suturae, straight, simple extending to the spore margin often obscured by sculpture. Exine thick (3.5-4.5 μm), sculptured with coarse reticulum formed by smooth, rounded muri 2.0-5.5 μm wide and 2-3 μm high, enclosing irregularly polygonal lumina 6.0-25.0 μm in diameter. Numerous peltate processes (6.0-10.0 μm, long, 4.0-6.5 μm broad at base, apices 5.0-13.0 μm in diameter), are developed on the junctions of the muri.

Dimensions: 42.5-105.0 μm, 26 specimens. The Bashkirian specimens of Quebradas Formation (FR Miospore Biozone) are of lower dimensions 42.5-77.5 μm, compared to the specimens recovered from the Brejeira Formation (Ra Miospore Biozone) of 95.0-105.0 μm.

Occurrence: Quebradas and Brejeira Formations.

Reticulatisporites polygonalis (Ibrahim) Smith & Butterworth, 1967

Plate 7, Fig. 2

1932 *Sporonites polygonalis* Ibrahim in Potonié, Ibrahim & Loose, p. 447, pl. 14, fig. 8.

1933 *Laevigati-sporites polygonalis* Ibrahim, p. 19, pl. 1, fig. 8.

1934 *Reticulati-sporites polygonalis* Ibrahim, Loose, p. 155, pl. 7,fig. 16.

1955 *Knoxisporites polygonalis* (Ibrahim) Potonié & Kremp, p. 117, pl. 16, fig. 318.

1967 *Reticulatisporites polygonalis* (Ibrahim) Smith & Butterworth, p. 221, pl. 14, fig. 13.

Description: Miospores radial, trilete. Amb circular to polygonal. Suturae, straight, simple extending to the spore margin often obscured by sculpture. Cingulum 10.0-15.0 μm, with three zones, an internal zone of 3.5-7.0 μm thickness, separated of the exterior zone 2.0-4.0 μm, in thickness, by a thin membrane. Exine ornament on distal surface prominent, but reduced proximally, pattern varies in detail, but distally consists of a single triangle, or a, more or less, polygonal structure formed by the bands which connect to the cingulum at the inter-radial positions by three prominent muri. Exine laevigate.

Dimensions: 75-97.5 μm; 18 specimens.

Occurrence: Brejeira Formation (FR Miospore Bizone).

Reticulatisporites reticulatus (Ibrahim) Ibrahim, 1933

Plate 6, Fig. 18

1932 *Sporonites reticulatus* Ibrahim in Potonié, Ibrahim & Loose, p. 447, pl. 14, fig. 3.

1933 *Reticulati-sporites reticulatus* Ibrahim, p. 33, pl. 1, fig. 3.

1938 *Azonotriletes reticulatus* (Ibrahim) Luber in Luber & Waltz, pl. 7, fig. 99.

Description: Miospores radial, trilete. Amb subcircular. Suturae, straight, simple extending to the spore margin. Three zones of cingulum clearly defined, inner thickened zone 2.5-5.0 μm in width, separated by narrower marginal zone by a thinner region of 2.0-4.0 μm in width. The distal pattern is variable, from a muri that delimit a central polygonal area and six or seven surrounding marginal areas to a complex pattern with several polygonal lumina and a corresponding number of marginal lumina.

Dimensions: 50.5-60.0 μm; 12 specimens.

Occurrence: Brejeira Formation (FR to OT Miospore Biozones, Bashkirian age).

Genus SAVITRISPORITES Bharadwaj 1955

Type species: *Savitrisporites triangulus* Bharadwaj 1955

Savitrisporites nux (Butterworth & Williams) Sullivan emend Smith & Butterworth, 1967

Plate 7, Figs. 4-6

1958 *Callitisporites nux* Butterworth & Williams, p.377, pl. 3, fig.24-25.

1964 *Savitrisporites nux* (Butterworth & Williams) Sullivan, p. 373, pl. 60, fig. 1-5.

1967 *Savitrisporites nux* (Butterworth & Williams) Sullivan emend Smith & Butterworth, p. 223, pl. 15, fig.1-3.

Description: Miospores radial, trilete. Amb triangular with slightly convex to concave sides and broad rounded angles. Outline smooth to irregularly crenulated. Suturae, simple, straight, extending to the inner margin of cingulum. Proximal ornament confined to a broad, low band of thickening on either side of each commissure. Distal ornament comprises coni and verrucae, or ridges of irregular height, formed by the coalescence of the bases of of the individual elements.

Dimensions: 45-62.5 μm; 106 specimens.

Occurrence: Murração and Mértola Formations (VF to TK Miospore Biozones of late Viséan to Serpukovian).

Savitrisporites concavus Marshall & Smith, 1964

Plate 7, Fig. 7

1964 *Savitrisporites concavus* Marshall & Smith, p.661, pl. 99, fig.9-12.

Description: Miospores radial, trilete. Amb triangular with straight to concave sides, margin crenulated to smooth, apices pointed to narrowly rounded. Suturae simple, straight, reaching inner margin of cingulum. Proximal ornament of ridges bordering suturae prominent (height 2.0-4.0 μm) mainly around distal pole and radiating towards each apex. Distal ornament of irregular thickenings. Apical swellings developed from ornament on each surface. Cingulum widest in radial position and irregular in profile, possibly corroded.

Dimensions: 55-70 μm; 10 specimens.

Occurrence: Brejeira Formation (NJ Miospore Biozone).

Savitrisporites sp. A

Plate 7, Figs. 8, 9

Description: Miospores radial, trilete. Amb circular to subcircular, external margin irregular due to ornamentation. Suturae simple, straight, reaching the equatorial margin of the spore. Proximal ornament of irregularly ridges parallel to suturae (height 1.0-2.5 μm) and along the equatorial channel, separating the contact areas sculptured with small verrucae and spinae. Distal ornament of coni, spinae and rare verrucae of 1.0-2.5 μm high and 2.0-2.5 μm basal diameter, forming small cristae by fusion of the bases.

Dimensions: 30-38 μm; 28 specimens.

Occurrence: Quebradas and Brejeira Formation (frequent in FR Miospore Biozone).

Genus SECARISPORITES Neves 1961

Type species: *Secarisporites lobatus* Neves 1961

Secarisporites remotus Neves, 1961

Plate 7, Fig. 1

1961 *Secarisporites remotus* Neves, p. 262, pl. 32, fig. 8-9.

Description: Miospore trilete, circular to subcircular. Suturae thin, straight, obscure by ornamentation. Ornamentation of rugulae. Peripheral rugulate lobes of varying dimensions extend up to 10 μm beyond wall and are up to 20 μm in witdth, lobes sometimes overlap and are deeply incised. Body distinct, about 20-30 μm in diameter.

Dimensions: 35-50 μm; 39 specimens.

Occurrence: Quebradas and Brejeira Formations (FR Miospore Biozone).

Genus TUMULISPORA Staplin & Jansonius, 1964

Type species: *Tumulispora variverrucata* (Playford) Staplin & Jansonious, 1964; by original designation.

Tumulispora rarituberculata (Luber) Playford, 1991

Plate 7, Fig. 10-13

For synonymy see Playford, 1991, p.101.

Description: Miospores radial, trilete. Amb convexly subtriangular to subcircular, periphery entire to occasionally undulant or partly crenulate to dentate. Suturae distinct, simple, straight, extending about two-thrids to four-fifths of distance to inner margin of cingulum. Cingulum width about 10-20% of total equatorial diameter. Distal surface verrucate, normally on central area, but a few, infrequently, smaller verrucae, also occur on the inner cingulum margin. Verrucae (2.5-5.0 μm in height and in basal size 2.0-20.0 μm) with roun-ded to flattened crests, circular to irregular rounded polygonal basal outline, discrete (up to 10.0 μm apart) to coalescent basally, less common. Generally a large verrucus occupies the distal polar region, encircled by a series of smaller verrucae, with irregular disposition. Proximal exine and inter-verrucae distal exine with laevigate surface.

Dimensions: 35-48 μm; 62 specimens.

Occurrence: Tercenas and Bordalete Formation (LN to PC Miospore Biozone).

Previous records: From upper Devonian to Lower Carboniferous (Tournaisian) sequences of Northern Hemisphere and Australia (HIGGS et al., 1988; PLAYFORD, 1991; PLAYFORD & MCGREGOR, 1993). In Portugal this taxon was reported as *T. malevkensis* (PEREIRA, 1997; PEREIRA,1999; PEREIRA et al., 2007).

Suprasubturma LAMINATITRILETES Smith & Butterworth, 1967

Subturma ZONOLAMINATITRILETES Smith & Butterworth, 1967

Infraturma PATINATI Butterworth & Williams, 1958

Genus ARCHAEOZONOTRILETES (Naumova) Allen 1965

Type species: *Archaeozonotriletes variabilis* Allen 1965

Archaeozonotriletes chulus (Cramer) Richardson & Lister, 1969

Plate 7, Fig. 14

1966 *Retusotrilete chulus* Cramer, p.74, pl. 2, fig.14.

1969 *Archaeozonotriletes chulus* (Cramer) Richardson & Lister, pl. 43, figs.1-6.

Description: These miospores are atributed to A. chulus, for its cingulate/patinate character, thin proximal exine and absence of ornamentation.

Dimensions: 36-58 μm; 5 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt (AD Miospore Biozone, subzone lem).

Previous records: Lower to Middle Devonian worldwide, from England (RICHARDSON & LISTER, 1969; WELLMAN, 2006; 2007), Spain (RODRIGUEZ, 1983), Portugal (PEREIRA et al., 1999), Saudi Arabia (AL-GHAZI, 2007), Brazil (MELO & LOBOZIAK, 2003; RUBINSTEIN et al., 2005), Argentina (AMENABAR, 2004), Bolivia (MCGREGOR, 1984) and Paraguai (MAULLER et al., 2004).

Genus CHELINOSPORA Allen 1965

Type species: *Chelinospora concinna* Allen 1965

Chelinospora concinna Allen, 1965

Plate 7, Fig. 15

1965 *Chelinospora concinna* Allen, pl. 101, figs. 12-20.

Description: Miospores radial, trilete. Amb circular to subcircular. Suturae distinct, simple, straight, with small labra (less than 1μm), reaching the equatorial margin of the spores. Exine scabrate, thickened 2.0-10.0 μm distally, covered with prominent muri (1.0-6.0 μm height and 1.0-2.0 μm width), forming an irregular reticulum, containing polygonal to irregular lumina of about 5.0-12.0 μm dimension.

Dimensions: 47-56 μm; 11 specimens.

Occurrence: Ribeira de Limas Formation of Pulo do Lobo Domain and Phyllite-Quartzite Group of Iberian Pyrite Belt.

Previous records: From Givetian to Frasnian from Northern Hemisphere (ALLEN, 1965; 1967; 1973; LOBOZIAK & STREEL, 1980; MCGREGOR, 1981; MARSHALL & ALLEN, 1982; RICHARDSON & MCGREGOR, 1986; GONZÁLEZ et al., 2004; PEREIRA et al., 2006).

Genus CYRTOSPORA Winslow 1962

Type species: *Cyrtospora cristifer* (Luber) emend. Van der Zwan 1979

Cyrtospora cristifera (Luber) emend. Van der Zwan, 1979

Plate 7, Figs. 18-20

1941 *Azonotriletes cristifer* Luber in Luber & Waltz, pl. 1,fig.10.

1957 *Lophozonotriletes cristifer* (Luber) Kedo, pl. 4, fig.15.

1962 *Cyrtospora clavigera* Winslow, pl. 22, fig.18-20.

1966 *Tholisporites cristifer* (Luber) Luber.

1979 *Cyrtospora cristifera* (Luber) emend. Van der Zwan, p.5-7, pl. 1, fig.1-5; pl. 2, fig.1-8; pl. 3, fig.1-3.

Description: Miospores radial, acamerate, trilete. Amb convexly subtriangular to subcircular. Suturae distinct, simple, straight, extending about three-fourths of spore radius. Exine 1.0-2.5 μm in thickness. Proximal surface laevigat. Distal surface bears an elongated thicknening, concentrated in apical zone, 10.0-35.0 μm lenght and 8.0-22.0 μm in width. Thickening variable in shape, and sparcely to densly ornamented with bacula, verucae and coni, of 2.0-6.5 μm height and 1.0-4.0 μm in width. Elements discrete or fused, with convex, concave or parallel sides and rounded tops.

Dimensions: 28-43 μm; 45 specimens.

Occurrence: Bordalete Formation (VI to PC Miospore Biozones).

Previous records: From uppermost Frasnian to mid Tournaisian of Western Canada (BRAMAN, 1981; VAN DER ZWAN & WALTON, 1981), upper Frasnian to Lower Viséan of Russia (RASKATOVA, 1974; BYVSHEVA, 1985), upper Famennian to mid Tournaisian of North America (WINSLOW, 1962) and Western Europe (CLAYTON et al., 1977; HIGGS et al., 1988; PEREIRA, 1999; PEREIRA et al., 2007), Poland (TURNAU, 1978; 1990) and Iran (COQUEL et al., 1977) and North Africa (ATTAR et al., 1980; COQUEL & MOREAU-BENOIT, 1986; VACHARD et al., 1991).

Genus CYMBOSPORITES Allen 1962

Type species: *Cymbosporites magnificus* (McGregor) McGregor & Camfield 1982

Cymbosporites magnificus (McGregor) McGregor & Camfield, 1982

Plate 7, Figs. 16, 17

1960 *Lycospora magnifica* McGregor, p. 35, pl. 13, fig.2-4.

1960 *Lycospora magnifica* McGregor, p. 36, pl. 12, fig.9-10.

1965 *Cymbosporites cyathus* Allen, p. 725, pl. 110, fig. 8-11.

1971 *Verruciretusispora magnifica* (McGregor) Owens var *magnifica* McGregor emend Owens, p. 22, pl. 5, fig. 1-6.

1971 *Verruciretusispora magnifica* var *endoformis* (McGregor) emend Owens, p. 24, pl. 5, fig. 7.

1982 *Cymbosporites magnificus* (McGregor) McGregor & Camfield, p. 32, pl. 6, fig. 4-5.

Description: Miospores radial, acamerate, trilete. Amb convexly subtriangular to subcircular. Suturae distinct, straight, to sinuous, extending about three-fourths of spore radius, bordered by narrow labra and terminating in curvature perfectae. Inner margin of curvature distinct, delimiting contact areas from a thick equatorial region of about 4.0-8.0 μm in width. Contact areas laevigate. Distal surface and equatorial regions solidly sculptured with verrucae and rugulae. Elements of verrucae discrete and/or fused to give rugulae, subcircular in outline with round tops (but occasionally mamillate), up to 10 μm in length. Small grana and coni regularly dispersed between the verrucae.

Dimensions: 58-63 μm; 8 specimens.

Occurrence: Ribeira de Limas Formation of Pulo fo Lobo Domain and Phyllite-Quartzite Group of Iberian Pyrite Belt (respectively from Frasnian and lower Givetian age, BM and AD (subzone lem) Miospore Biozones) and Tercenas and Bordalete Formations of SWP Domain (LN to PC Miospore Biozones).

Infraturma CINGULICAVATI Smith & Butterworth, 1967

Genus CAMAROZONOTRILETES Naumova 1953

Type species: *Camarozonotriletes devonicus* Naumova 1953

Camarozonotriletes sextantii McGregor & Camfield, 1976

Plate 8, Fig. 2

1968 *Apiculatisporites* sp. 1, in Jardine and Yapaudjian, pl. 1, figs. 15, 18.

1970 *Proconaspora* sp., McGregor, Sanford and Norris, Pl. 2, Figs 1, 2.

1976 McGregor & Camfield, p. 12, pl. 4, figs. 13, 14, 16-18.

Description: Miospores radial, acamerate, trilete. Amb subtriangular with convex, straight or concave sides. Suturae distinct, straight, extending about one-half of spore radius, frequently open. Exoexine thin. Intexine 1.5-2.0 μm thick at equator opposite the rays, up to 5.0 μm thick at the equator interradially. Contact areas laevigate or with fine grana less than 0.5 μm wide, curvaturae commonly defined by proximal limit of distal and equatorial sculpture. Sculpture composed of grana, pointed or rounded cones, spines and biform ornaments, 0.5-5.0 μm high, 0.5-2.0 μm wide at their base and about 0.5-3.5 μm apart. The largest ornament occurs in the interradial equatorial regions. Maybe present or reduced in size at the apices.

Dimensions: 35-58 μm; 9 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt (AD Miospore Biozone).

Genus CINGULIZONATES (Dybová & Jachowicz) Butterworth, Jansonius, Smith & Staplin 1964

Type species: *Cingulizonates bialatus* (Waltz) Smith

& Butterworth 1967

Cingulizonates loricatus (Loose) Butterworth & Smith, 1964

Plate 8, Fig. 3

1932 *Sporonites loricatus* Loose in Potonié, Ibrahim & Loose, p.450, pl. 18, fig.42.

1934 *Zonales-sporites loricatus* Loose, p.151.

1944 *Densosporites loicatus* (Loose) Schopf, Wilson & Bentall, p.40.

1964 *Cingulizonates loricatus* (Loose) Butterworth & Smith in Butterworth et al., p.1053, pl. 2, fig.4.

Description: Miospores radial, trilete. Amb subtriangular to subcircular. Suturae distinct, straight, extending to inner margin of cingulum. Cingulum aproximatly 40% of total spore diameter. Central body of intexine thin and laevigate. Central proximal area of exoexine slightly rugose, central distal area granulate, or with small verrucae. Outer margin of cingulum minutely crenulate, outer thin part of cingulum granulate, sometimes slightly plicated. Margin of spore modified by grana and plications.

Dimensions: 37-48 μm; 7 specimens.

Occurrence: Brejeira Formation (Ra Miospore Biozone).

Genus CIRRATRIRADITES Wilson & Coe 1940

Type species: *Cirratriradites saturni* (Ibrahim) Schopf, Wilson & Bentall 1944

Cirratriradites saturni (Ibrahim) Schopf, Wilson & Bentall, 1944

Plate 8, Fig. 4

1932 *Sporonites saturni* Ibrahim in Potonié , Ibrahim & Loose, p.448, pl. 15, fig.14.

1933 *Zonales-sporites saturni* Ibrahim, p.30, pl. 2, fig.14.

1944 *Cirratriradites saturni* (Ibrahim) Schopf, Wilson & Bentall, p.44.

Description: Miospores radial, trilete. Amb subtriangular, outline irregular and serrate. Suturae distinct, flexuous, extended to equator. Exine of body coarsely granulate, or verrucate. Zona with radial striations and concentric thickenings, wider at angles. Body moderately thick, zona thin. Characteristic circular, polar, fovea, which through constriction may give the appearance of two.

Dimensions: 70-82.5 μm; 3 specimens.

Occurrence: Brejeira Formation (SS Miospore Biozone).

Genus CRISTATISPORITES Potonié & Kremp emend Butterworth, Jansonius, Smith & Staplin 1964

Type species: *Cristatisporites indignabundus* (Loose) R. Potonié & Kremp, 1954, by original designation.

Cristatisporites indignabundus (Loose) Potonié & Kremp emend Staplin & Jansonius, 1964

Plate 8, Fig. 5

1932 *Sporonites indignabundus* Loose in Potonié, Ibrahim & Potonié, p.451, pl. 19, fig.51.

1934 *Apiculati-sporites indignabundus* Loose, p.153.

1944 *Densosporites indignabundus* (Loose) Schopf, Wilson & Bentall, p. 40.

1954 *Cristatisporites indignabundus* (Loose) Potonié & Kremp, p.142.

1964 *Cristatisporites indignabundus* (Loose) Potonié & Kremp emend Staplin & Jansonius, p. 108.

Description: Miospores radial, trilete. Amb subtriangular to subcircular. Suturae often indistinct, narrow terminating to the row of spines. Exine two layered. Intexine rarely observed. Central proximal area of exoexine coarsened to finely granulose, bounded by an irregular ring of hooked setose spines up to 1.0-2.5 μm long and 1.0-1.5 μm wide at their bases. Zona, not clearly marked, width generally less than half spore radius, beyond the setae, almost laevigate or bears a scattered small granules or conical apiculae. Distal surface sculptured with prominent verrucae that in part connect at their bases, individual verrucae up to 6.0 μm de high and 4.0 μm wide. Sculpture become less significant and well separated towards the equatorial margin and are combined with small coni, the warts also become smaller in central distal area. Spore margin irregular.

Dimensions: 47.5-58 μm; 8 specimens.

Occurrence: Brejeira Formation (SS Miospore Biozone).

Cristatisporites sp. cf. *C. inusitatus* (Allen) McGregor & Camfield, 1982

Plate 8, Fig. 1

cf. 1965 *Samarisporites inusitatus* Allen, p. 717; pl. 99, figs. 7–9.

cf. 1982 *Cristatisporites inusitatus* (Allen) McGregor & Camfield, p. 29.

Description: Miospores radial, trilete. Amb subtriangular to subcircular. Suturae distinct to unclear, with narrow labra up to 2.0 μm, extending to the equatorial margin of zona. Exine two layered. Exoexine extended equatorially to form a zona of irregular margin, of 8.0 μm high. Exoexine proximally laevigate to scabrate. Distal exoexine covered by a dense sculpture of cristae, in a concentric shape, formed by the coalencence of spines. Intexine thin (0.5-1.0 μm). Zona generally absent due to poorly preserved condition of the miospores. Rare observed specimens are sculptured with small spinae, highly variable in size.

Dimensions: 38-62.5μm; 13 specimens.

Remarks: The specimens recovered are poorly preserved.

Occurrence: Ribeira de Limas Formation of Pulo do Lobo domain (BM Miospore Biozone).

Cristatisporites triangulatus (Allen) McGregor & Camfield, 1982

Plate 8, Figs. 6-8

1965 *Samarisporites triangulatus* Allen, p. 716; pl. 99, figs. 1-6.

1982 *Cristatisporites triangulatus* (Allen) McGregor & Camfield, p. 29.

For further synonymy see Allen (1982, pp. 158-159) and Balme (1988, p. 136).

Description: Miospores radial, trilete. Amb triangular to subtriangular, periphery irregular to dentate, spore cavity outline circular to rounded, subtriangular in polar view. Suturae distinct to obscure, extending to equatorial margin, normally with smooth, narrow, straight to sinuous labra (up to 4 μm high). Exine two-layered. Intexine distinct or indistinct, closely appressed to exoexine, laevigate, 1.5-2.0 μm wide. Exoexine extended equatorially to form a zona, proximally laevigate, distally sculptured with grana, spinae, rounded coni, and biform elements (verrucae with minute apical coni and spinae), 1.0-4.0 μm wide and high, discrete or fused at bases to form an irregular, weakly defined rugulae. Zona sculptured with spinae, highly variable in size (2.0-12.0 μm high), discrete or fused to form cristae. Zona is widest at the apices and interradially the zona is relatively narrow or even absent.

Dimensions: 40-65 μm; 47 specimens.

Occurrence: Ribeira de Limas, Gafo Formations, Sta Iria, Horta da Torre and Represa Formations of Pulo do Lobo domain, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (BM to LN miopore Biozones).

Previous records: From upper Givetian to middle Frasnian deposits worldwide (ALLEN, 1982; BALME, 1988). However, in the SPZ *C. triangulatus* it occurs from the Frasnian to the upper Famennian age (BM to LN Miospore Biozones). The occurrence in the upper Famennian of South Portugal is interpreted as reworked miospores.

Genus DENSOSPORITES Berry emend Butterworth, Jansonius, Smith & Staplin 1964

Type species: *Densosporites covensis* Berry, 1937; by original designation.

Densosporites annulatus (Loose) Schopf, Wilson & Bentall emend Smith & Butterworth, 1967

Plate 8, Fig. 9

1932 *Sporonites annulatus* Loose in Potonié , Ibrahim & Loose, p.451, pl. 18, fig.44.

1934 *Zonales-sporites (Anulati-sporites) anulatus*, Loose, p.151.

1944 *Densosporites annulatus* (Loose) Schopf, Wilson & Bentall, p.40.

1950 *Denso-sporites reynoldsburgensis* Kosanke, p.33, pl. 6,fig.9-11.

1956 *Anulatisporites annulatus* (Loose) Potonié & Kremp, p.112, pl. 17, fig.365-372.

1967 *Densosporites annulatus* (Loose) Schopf, Wilson & Bentall emend Smith & Butterworth, p. 239, pl. 19, fig.5-6.

Description: Miospores radial, trilete. Amb subtriangular. Suturae distinct, straight, simple, extending to inner margin of the cingulum. Intexine thin, laevigate. Central area of the exoexine thin, laevigate. Cingulum narrow, tapering very slightly towards the equator, laevigate, occupying about two-fifths of the total spore diameter.

Dimensions: 32-56 μm; 26 specimens.

Occurrence: Murração, Quebradas and Brejeira Formations (NL to SS Miospore Biozones).

Densosporites rarispinosum Playford, 1962

Plate 8, Fig. 10-12

1962 *Densosporites rarispinosum* Playford, p. 630, pl. 89, figs.18-21.

Description: Miospores radial, trilete. Amb more or less conformable with the convexly subtriangular spore body outline. Suturae simple, perceptible to distinct, straight or sinuous, extending equatorially 2.0-4.0 μm beyond body magin. Distal sculpture composed of sparcely and irregularly distributed simple spines (1.0-3.0 μm in height, bases circular to subcircular in about 0.5-1.5 μm in diameter), which also project from the equatorial margin. Apart from this sculputure, spore body and cingulum laevigate to finely punctate. Cingulum non tapering and much darker in colour than spore body.

Dimensions: 40-50 μm; 8 specimens.

Occurrence: Murração Formation of SWP Domain and Mértola Formation of BAFG (Viséan age).

Densosporites spitsbergensis Playford, 1963

Plate 8, Fig. 13

Description: Miospores radial, trilete. Amb subtriangular conformable with the spore body outline. Suturae simple, perceptible to distinct, straight or sinuous, extending on to the cingulum as thicknened, elevated ridges which often reach the equatorial margin. Cingulum darker in colour than body, small and gradual equatorial decrease in thickness. Distal exoexine and cingulum, sculptured with proeminent spinae (1.5-5.0 μm in length and 1.0-4.0 μm in basal diameter) packed and frequently coalescent at their bases forming cristae around inner margin of cingulum, reduced in size and density in equatorial region. Intexine generally indistinct, laevigate.

Dimensions: 40-62 μm; 41 specimens.

Occurrence: Tercenas and Bordalete Formations (LN to PC miospores Biozones).

Previous records: From the uppermost Famennian to Tournaisian of Portugal (PEREIRA, 1999; PEREIRA et al., 1994, 1996), uppermost Famennian toTournaisian of Ireland (KEEGAN, 1977; HIGGS et al., 1988), Tournaisian of South Wales (MCNESTRY, 1988) and Tournaisian to upper Viséan of Spitsbergen (PLAYFORD, 1962).

Genus INDOTRIRADIATES Tiwari emend. Foster, 1979

Type species: *Indotriradiates korbaensis* Tiwari, 1964; by original designation.

Indotriradiates explanatus (Luber) Playford, 1991

Plate 8, Fig. 14

1941 *Zonotriletes explanatus* Luber in Luber & Waltz, p.10, pl. 1, fig.4.

1963 *Hymenozonotriletes explanatus* (Luber) Kedo, p.67, pl. 6, fig.144-147.

1974 *Hymenozonotriletes tenuicostatus* Kedo, p. 45-46, pl. 11, fig.8-10.

1977 *Samarisporites* sp. cf. *Hymenozonotriletes explanatus* (Luber) Kedo, Streel, p.404, pl. 2, fig.1.

1978 *Hymenozonotriletes explanatus* (Luber) Kedo morphological type ii; Turnau, p.13, pl. 5, fig.18.

1991 *Indotriradiates explanatus* (Luber) Playford, pl. 103, pl. 3, figs. 17, 18.

Description: Miospores radial, trilete. Amb convexly to rounded subtriangular. Suturae distinct, straight, accompanied by labra of 1.0-2.5 μm in height and extending to the inner margin of zona. Exine two-layered. Intexine thin, laevigate, radius two-thirds to three-quarters of total spore radius, outline conformable with amb. Exoexine extended equatorially to form a zona 7.0-13.5 μm wide, its inner margin relatively thick, dark-coloured band 3.0-8.0 μm. Distal and equatorial sculpture of exoexine (including zona) consisting mainly of discrete (2-8 μm apart) coni, spinae, and rare verrucae, 1.0-3.5 μm in basal diameter and height. Proximal exoexine laevigate to infrapunctate. Occasional compression folds are present.

Dimension: Exoexine 50-87 μm; intexine 35-70 μm; 16 specimens.

Occurrence: Tercenas and Bordalete Formations (LE to PC miospores Biozones).

Previous records: From uppermost Devonian to Lower Carboniferous strata, it is a cosmopolitan specie reported worldwide (HIGGS et al., 1988; PLAYFORD, 1991). In SPZ was documented by PEREIRA (1999), GONZÁLEZ et al. (2005) and PEREIRA et al. (2007).

Indotriradites mitratus (Higgs) Higgs, 1996

Plate 8, Fig. 16

1975 *Kraeuselisporites mitratus* Higgs, p. 401, pl. 7, fig.13.

1996 *Indotriradites mitratus* (Higgs) Higgs, p. 274.

Description: Miospores radial, trilete. Amb rounded to convexly triangular. Suturae distinct, straight, accompanied by labra of 1.0-3.0 μm in height and extending to the spore margin. Exine two-layered. Exoexine extended equatorially to form a zona, 6.0-12.0 in width. The zona is thicker along the inner margin forming a darkened band, the outer margin of the zona is thinner and fibrous. Distal exoexine and zona ornamented with closely spaced spinae and galea which are wide, broad and bulbous based, about 2.0-5.0 μm in diameter and tapering uniformly to pointed apices, in overall height about 4.0-10.5 μm. Elements discrete to fused at bases. Intexine distinct to obscure, laevigate, outline comformable with the amb. Exine infragranulate.

Dimensions: 5-76 μm; 21 specimens.

Occurrence: Bordalete Formation of SWP Domain (PC Miospore Biozone).

Genus KRAEUSELISPORITES Leschik emend Jansonius 1962

Type specie *Kraeuselisporites dentatus* Leschik 1956

Kraeuselisporites fasciatus Higgs, 1975

Plate 8, Fig. 15

1975 *Kraeuselisporites fasciatus* Higgs, p.400-401, pl. 6, fig.13-14.

Description: Miospores radial, trilete. Amb subtriangular. Suturae distinct, straight to sinuous, accompanied by labra of 2.5-6.0 μm in height and extending to the spore margin finishing in curvatura perfectae. Exoexine extended equatorially to form a thinner zona, 3.0-15.0 in width. The zona is darker in internal margin, forming a band of about 3.0-5.0 μm in size. Intexina distinct, laevigate, outline more triangular than the spore equatorial shape, laevigate and frequently folded.

Dimensions: 60-120 μm; 33 specimens.

Occurrence: Bordalete Formation of SWP Domain (PC Miospore Biozone).

Genus LYCOSPORA Schopf, Wilson & Bentall emend R. Potonié & Kremp, 1954

Type specie *Lycospora micropapillata* (Wilson & Coe) Schopf, Wilson & Bentall, 1944; by original designation.

Lycospora pusilla (Ibrahim) Schopf, Wilson & Bentall, 1944

Plate 8, Figs. 18, 19

1932 *Sporonites pusillus* Ibrahim in Potonié, Ibrahim & Loose, p.448, pl. 15, fig.19.

1933 *Zonales-sporites pusillus* Ibrahim, p.32, pl. 2, fig.20.

1938 *Zonotriletes pusillus* (Ibrahim) Waltz in Luber & Waltz, p.33, pl. 3, fig. 105.

1944 *Lycospora pusilla* (Ibrahim) Schopf, Wilson & Bentall, p.54.

Description: Miospores radial, trilete. Amb rounded to triangular, smooth to indented margin. Suturae distinct, straight, and extending to the spore equator. Exine, often rupture along suturae, laevigate to sculptured with fine granulate ornaments. Cingulum with or without flange like extension. In polar compression inner darker zone of cingulum narrow, about 1.5 μm in width. Total thickness of cingulum up to 3.0 μm. Folds of very narrow, taper-pointed type are present normally located pa-rallel to inner margin of cingulum. Exine, including cingulum, finely granulate and thin.

Dimensions: 30-40 μm; 63 specimens.

Occurrence: Murração and Quebradas Formations of SWP Domain, Mértola, Mira and Brejeira Formations of BAFG (Viséan to Moscovian).

Genus RADIIZONATES Staplin & Jansonius 1964

Type specie *Radiizonates aligerens* (Knox) Staplin & Jansonius 1964

Radiizonates aligerens (Knox) Staplin & Jansonius, 1964

Plate 8, Fig. 17

1950 *Cirratriradites aligerens* Knox, p.329, pl. 19, fig.288.

1964 *Radiizonates aligerens* (Knox) Staplin & Jansonius, p. 106, pl. 18, fig.23-28.

Description: Miospores radial, trilete. Amb circular to subtriangular. Suturae distinct, straight, and extending to the spore equator. Exine two layered. Intexine not visible. Central proximal area of exoexine frequently lost, but when preserved, show fine sutural features and extending to inner edge of zona. Zona variable in size, with irregular radial ribs and gouge structure that extends to the equatorial margin on both proximal and distal surfaces.

Dimensions: 70-90 μm; 8 specimens.

Occurrence: Brejeira Formation (Ra Miospore Biozone).

Genus VALLATISPORITES Hacquebard 1957 emend Sullivan 1964

Type species: *Vallatisporites vallatus* Hacquebard, 1957; by original designation.

Vallatisporites verrucosus Hacquebard, 1957

Plate 8, Figs. 21-22

1957 *Vallatisporites verrucosus* Hacquebard, p. 313; pl. 2, fig. 13.

Description: Miospores radial, trilete. Amb rounded subtriangular to subcircular. Suturae distinct or indistinct, extending to intexinal margin and bordered by labra of about 1-3 μm width. Exine two-layered. Intexine 0.5 μm thick, laevigate, outline conformable with amb. Exoexine extended equatorially as a zona of about 6.0-10.0 μm wide, proximal inner margin of zona bearing elongate vacuoles, 1.0-2.5 μm in dimension. Outside vacuolate inner margin, zona bearing small (0.5-1.0 μm in basal diameter and height), distinct spinae, rarely projecting equatorially. Non-zonate distal exoexine sculptured with discrete or basally fused verrucae of about 1.5-3.0 μm in basal diameter, some of them biform, with superposed minute spinose projections up to 1 μm high. Sculptural elements somewhat larger and more densely distributed in distal polar region, rarely coalescing to form rugulae. Proximal face laevigate to scabrate.

Dimensions: 55-64 μm; 52 specimens.

Occurrence: Tercenas and Bordalete Formations of SWP Domain (LN to PC Miospore Biozones).

Previous records: Widely recorded from the upper Famenian and Tournaisian of Euramerica (HIGGS et al., 1988; PLAYFORD & MCGREGOR, 1993). In Iberia was reported by PEREIRA et al. (1994), (1996), (2007); PEREIRA (1997), (1999) and by GONZÁLEZ et al. (2002), (2005) and MORENO et al. (2003).

Vallatisporites microspinosus Clayton , Higgs & Keegan, 1988

Plate 12, Fig. 20

1975 *Vallatisporites* sp. A Higgs, p.404, pl. 7, fig.7, 11.

Description: Miospores radial, trilete. Amb convex triangular to subcircular with pointed apices and serrate margin. Suturae distinct, straight, bordered by labra of about 1.0-4.0 μm width and extending to spore margin. Exoexine extended equatorial to form a zona of about 5.0-10.0 μm wide, proximal inner margin of zona bearing vacuoles, of about 1.0-2.0 μm in dimension. Distal and equatorial exoexine sculptured with sparse to evently distributed, discrete spinae and grana (1.0-4.0 μm in height and 0.5-2.0 μm in basal diameter). Intexine 0.5 μm thick, outline conformable with amb, laevigate and sometimes bearing reduced ornament of fine spinae.

Dimensions: 33-45 μm; 57 specimens.

Occurrence: Bordalete Formation of SWP Domain (PC Miospore Biozone).

Vallatisporites pusillites (Kedo) Dolby & Neves, 1970

Plate 9, Figs. 1-2

1957 *Hymenozonotriletes pusillites* Kedo,p.22,pl 1, fig 1

1962 *Cirratriradites hystricosus* Winslow, p. 41, pl 18, fig 5

1962 *Cirratriradites* sp. A Winslow, p. 42, pl 18, fig 1-2

1970 *Vallatisporites pussilites* (Kedo) Dolby & Neves, p. 639, pl 2, fig 1-4

Description: Miospores radial, trilete. Amb convexly triangular. Suturae distinct to obscure, straight, bordered by labra of about 1.0-5.0 μm width and extending to spore margin. Intexine distinct, laevigate to infragranulate, outline conformable with amb. Exoexine extendended equatorial to form a zona of about 5.0-12.0 μm wide, proximal inner margin of zona bearing radially aligned vacuoles, of about 3.0-10.0 μm in lenght. Distal and equatorial exoexine sculptured with discrete spinae and galea (1.0-3.0 μm in height and up to 7.0 μm in basal diameter), aproximatly 6.0 apart in groups of two or three.

Dimensions: 50-78 μm; 53 specimens.

Occurrence: Phyllite-Quartzite Group and Tercenas Formation (LN Miospore Biozone).

Vallatisporites hystricosus (Winslow) Byvscheva, 1985,

Plate 9, Fig. 3

1962 *Cirratriradites hystricosus* Winslow, p. 40, 41, pl 18, fig 5

1962 *Cirratriradites* sp. A Winslow, p. 41, pl 18, figs 1-2.

1963 *Hymenozonotriletes pusillites* Kedo, Kedo, pl. 6, fig. 141, non. fig. 138-140, 142.

1970 *Vallatisporites pussilites* (Kedo) Dolby & Neves, p. 639, pl 2, fig 1-4

1985 *Vallatisporites hystricosus* (Winslow) Byvscheva, p. 136.

Remarks: This species accommodates forms which possess spinae and galeae, 3.0-12.0 μm in height.
Dimensions: 52-68 μm; 22 specimens.

Occurrence: Phyllite-Quartzite Group and Tercenas Formation (LN Miospore Biozone).

Suprasubturma PSEUDOSACCITRILETES Richardson, 1965

Infraturma MONOPSEUDOSACCITI Smith & Butterworth, 1967

Genus ANCYROSPORA Richardson emend. Richardson 1962

Type species: *Ancyrospora grandispinosa* (Richardson) Richardson, 1962; by original designation.

Ancyrospora? andevalensis González, Playford & Moreno, 2008

Plate 9, Figs. 5, 6

2005 *Ancyrospora? implicata* González, Moreno & Playford, p. 24, pl. 6, Figs. 1-6.

Diagnosis: Miospores radial, trilete. Amb convexly subtriangular to subcircular. Suturae distinct to obscure, simple with labra 2.0-4.0 μm in width, extending to intexine margin. Intexine distinct to indistinct, thin, laevigate, proximally attached to exoexine, outline conformable with amb. Exoexine two-layered. Inner layer 1.5-2.5 μm thick, laevigate to finely wrinkled, extending equatorially as a dark flange, 5.0-15.0 μm wide, equatorially sculptured with discrete, up to 25, conus and spina like projections, 3.0-15.0 μm in basal diameter, 5.0-22.5 μm in height, laevigate. Elements may be fused at bases forming a "pseudozona" of about 3.0-10.0 μm wide, termini truncate or multifurcate, with minute spinules up to 1.5 μm long. Non-flanged distal face unsculptured or bearing up to 7 discrete elements, mainly truncate or bifurcate coni and bacula, 5.0-22.5 μm long, 3.0-5.0 μm in basal diameter, and 7.0-15.0 μm apart. Outer exoexinal layer distinctly thinner, laevigate, distinct to indiscernible, sometimes degraded or absent, surrounding the ancyrate elements.

Dimensions: 55-85 μm; 37 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo and Phyllite-Quartzite Group (VH Miospore Biozone). Very frequently observed in the Cercal region.

Genus AURORASPORA Hoffmeister, Staplin & Malloy 1955

Type species: *Auroraspora solisortus* Hoffmeister, Staplin & Malloy, 1955; by original designation.

Auroraspora corporiga Higgs, Clayton & Keegan, 1988

Plate 9, Fig. 4

1988 *Auroraspora corporiga* Higgs Clayton & Keegan, p. 69; pl. 9, figs. 13-16, 20

Description: Miospores radial, camerate, trilete. Amb subcircular. Suturae distinct, straight, length of two-thirds of spore radius, accompanied by narrow labra of about 1 μm wide. Exine two-layered. Exoexine 1.0-1.2 μm thick, laevigate to scabrate. Intexine thin, laevigate, proximally attached to exoexine, excentrically disposed, circular to subcircular in polar view, peripherally folded, diameter about four-fifths that of exoexine.

Dimensions: 45-69 μm; 15 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt, Terenas Bordalete Formations of SWP Domain (LN to PC Miospore Biozones).

Previous records: From the Tournaisian of Ireland (HIGGS et al., 1988), Belgium (Higgs, 1996) and the uppermost Famennian of Portugal (PEREIRA, 1999) and Spain (GONZÁLEZ e tal., 2005).

Auroraspora macra Sullivan, 1968

Plate 9, Fig. 7, 8

1968 *Auroraspora macra* Sullivan, pp. 124- 125; pl. 27, figs. 6-10.

Description: Miospores radial, camerate, trilete. Amb subcircular or rarely rounded subtriangular. Laesurae distinct, simple, straight, extending to the margin of intexine. Exine two-layered, cavate. Intexine 1.0-2.0 μm thick, laevigate, outline conformable with amb. Exoexine laevigate or scabrate, sometimes folded equatorially, conferring a weakly undulate appearance to its margin.

Dimension: 35-62.5 μm; 47 specimens.

Occurrence: Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt, Terenas and Bordalete Formations of SWP Domain (VH to PC Miospore Biozones).

Previous records: From late Famennian through Viséan deposits worldwide distributed, but is markedly less frequent below the LN spore Biozone (BECKER et al., 1974; STREEL & TRAVERSE, 1978).

Genus DIDUCITES Van Veen 1981

Type species: *Diducites plicabilis* Van Veen, 1981; by original designation.

Remarks: The SPZ species described closely conform with those described and illustrated by VAN VEEN, for the Tournaisian of Ireland, in the so-called "Diducites mucronatus morphon" (1981).

Diducites mucronatus (Kedo) emend. Van Veen, 1981

Plate 9, Fig. 9

1953 *Hymenozonotriletes commutatus* Naumova non *H. commutatus* (Waltz) Ishchenko1952

1974 *Hymenozonotriletes mucronatus* Kedo in Golubtsov & Manjkin, p.40, pl. 10, fig11-13.

1977 *Auroraspora commutata* (Naumova) Keegan, p. 554.

1981 *Diducites mucronatus* (Kedo) Van Veen, p. 275, pl. 3, fig. 8; pl. 4, fig.5,7; pl. 5, fig.1-6.

Description: Miospores radial, trilete, cavate. Amb subcircular to convexly subtriangular. Suturae distinct to obscure, accompanied by narrow labra of about 1 μm wide, straight, reaching intexine margin. Intexine laevigate, 1.0-2.0 μm thick, covering two-thirds to three-quarters of total spore radius, outline conformable with amb. Exoexine two-layered. Inner layer thin, laevigate or scabrate, attached proximally to intexine. Outer layer, clearly thinner of about 0.5-1.5 μm, densely covered by narrow folds, just projecting beyond equator, resulting in a rugulate appearance to the exoexine.

Dimensions: 40-75 μm; 12 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (LN to VI Miospore Biozones, rare in the VI Biozone).

Previous records: From Famennian to lower Tournaisian of Europe (VAN VEEN, 1981, LOBOZIAK et al., 1994, LOBOZIAK & STREEL, 1988 HIGGS et al., 1988 HIGGS & STREEL, 1984 TURNER et al., 1989, PEREIRA, 1999, FILIPIAK, 2004, GONZÁLEZ et al., 2005, PEREIRA et al., 2007), Saudi Arabia (CLAYTON et al., 2000), upper Frasnian to lower Tournaisian of Russia (KEDO, 1957; KEDO et al., 1971) and upper Famennian of Brazil (LOBOZIAK et al., 1997).

Diducites poljessicus (Kedo) emend. Van Veen, 1981

Plate 9, Fig. 10

1957 *Hymenozonotriletes poljessicus* Kedo, p. 25, pl. 3, fig.6-8.

1974 *Auroraspora poljessica* (Kedo) Streel in Becker et al., p. 26, pl. 20, fig. 8-14.

1981 *Diducites poljessicus* (Kedo) emend. Van Veen, p. 271-273, pl. 4, fig. 1-4, 6.

Description: Miospores radial, trilete, cavate. Amb subcircular to convexly subtriangular. Suturae distinct, extending to intexine margin, accompanied by labra up to 2.0 μm in width. Intexine laevigate, 1.0-2.0 μm thick, clearly folded, excentrically disposed, attached proximally to exoexine and outline unconformable with amb. Exoexine two-layered. Inner layer laevigate or infragranulate, 1.0-1.5 μm thick. Outer layer thinner, distinct to perceptible, laevigate with fine, sinuous to straight folds, infrequently projecting beyond spore margin.

Dimensions: 58-72 μm; 10 specimens.

Occurrence: Phyllite-Quartzite Group and Tercenas and Bordalete Formations of SWP Domain (LN to PC Miospore Biozones).

Previous records: From the lower Famennian to upper Tournaisian of Western Europe, Poland,

and Russia (KEDO, 1957, KEDO et al., 1971, BECKER et al., 1974, HIGGS, 1975, LOBOZIAK & STREEL, 1981, 1988, VAN VEEN, 1981, HIGGS & STREEL, 1984, STREEL et al., 1987, HIGGS et al., 1988, TURNER et al., 1989, PEREIRA et al., 1994, PEREIRA, 1999, FILIPIAK, 2004, GONZÁLEZ et al., 2005, PEREIRA et al., 2008) and upper Famennian of U.S.A. (STREEL & TRAVERSE, 1978).

Diducites versabilis (Kedo) emend. Van Veen, 1981

Plate 9, Figs. 11, 16

1971 *Hymenozonotriletes versabilis* Kedo in Kedo et al., pl. III, fig. 4.

1974 *Rugospora versabilis* (Kedo) Streel in Becker, Bless, Streel & Thorez, pl. 21, figs. 3-5.

1975 *Auroraspora versabilis* (Kedo) Turnau, p. 561; pl. 5, fig. 7.

1981 *Diducites versabilis* (Kedo) emend. Van Veen, pp. 268-269; pl. 2, figs. 5, 6; pl. 3, figs. 1-6, 9.

Description: Miospores radial, trilete. Amb subcircular to convexly subtriangular with undulant margin. Suturae distinct to obscure, simple, straight, extending to margin of intexine. Intexine 1.5-2.5 μm thick, laevigate, occupying one-half to three-fifths of spore radius, with outline slightly more triangular than amb. Exoexine two-layered. Inner layer 1.0-1.5 μm thick, laevigate, attached proximally to intexine. Outer layer up to 1.0-1.5 μm thick, laevigate or infrapunctate, with regularly and often radially aligned distributed folds, 5-12 μm in length, up to 4 μm wide, projecting beyond equator.

Dimensions: 52-87.5 μm; 14 specimens.

Occurrence: Phyllite-Quartzite Group and Tercenas Formation (LN Miospore Biozone).

Previous records: From the upper Famennian to lower Tournaisian of Western Europe and Poland (BECKER et al., 1974; HIGGS, 1975; TURNAU, 1975; VAN VEEN, 1981; LOBOZIAK & STREEL, 1981, 1988; HIGGS & STREEL, 1984; STREEL et al., 1987; HIGGS et al., 1988; TURNER et al., 1989; LOBOZIAK et al., 1994; PEREIRA et al., 1994, 1996; FILIPIAK, 2004), and Spain (GONZÁLEZ et al., 2005), lower Famennian to lower Tournaisian of Russia (KEDO, 1957; KEDO et al., 1971); and upper Famennian of Canada (MCGREGOR & MCCUTCHEON, 1988).

Genus CRISTICAVATISPORA González, Moreno & Playford 2005

Type species: *Cristicavatispora dispersa* González, Moreno & Playford, 2005

Cristicavatispora dispersa González, Moreno & Playford, 2005

Plate 9, Fig. 12-14

1971 *Cristatisporites colliculus* Playford, p.40-41, pl. 14, fig. 1-2.

1973 *Dictyotriletes* cf. *submarginatus* Playford, Bertensel, pl. 13,figs. 5-9.

1981 *Asperispora perlota* (Naumova) Van der Zwan, Van der Zwan, pl. 3, figs. 4,5.

1988 *Bascaudaspora collicula* (Playford) Clayton, Higgs & Keegan, p.65, pl. 7, figs. 15-17.

2005 *Cristicavatispora dispersa* González, Moreno & Playford, p. 26, pl. 5, figs. 9-12.

Description: Miospores radial, trilete. Amb rounded subtriangular with serrate margin. Suturae distinct, straight to slightly curved, extending to spore equator, bordered by labra of about 1.5-2.5 μm in width. Exine two-layered. Intexine distinct to obscure, thin, laevigate, proximally attached to exoexine, occupying at least three-quarters of total equatorial diameter, outline conformable with amb. Exoexine 3.0-5.5 μm thick, distally and equatorially sculptured with sinuous or anastomosing cristae forming an irregular, highly imperfect reticulum.

Dimensions: 42-65 μm; 12 specimens.

Occurrence: Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt (VH and LN Miospore Biozones).

Genus ENDOCULEOSPORA Staplin emend Turnau 1975

Type species: *Endoculeospora rarigranulata* Staplin 1960

Remarks: Turnau (1975) emended the generic diagnosis in order to include miospores with an ornament of pila and bacula.

Endoculeospora gradzinskii Turnau, 1975

Plate 9, Fig. 15, 17

Description: Miospores radial, trilete. Amb subcircular. Suturae distinct, straight, simple or with thin labra, extending to margin of the intexine and terminating with curvaturae. Intexine distinct, laevigate, outline conformable with the amb. Exoexine thin, distally and equatorially sculptured with coni and small pila and bacula of about 0.5-1.5 μm in height. Ornament discrete. Ocasionally body folds are present.

Dimensions: 40-60 μm; 35 specimens.

Occurrence: Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt (VH and LN Miospore Biozones). Very frequently observed in samples of the Cercal region.

Genus ENDOSPORITES Wilson & Coe ex Schopf, Wilson & Bentall 1944

Type species: *Endosporites ornatus* Wilson & Coe, 1940; by subsequent designation of Schopf, Wilson & Bentall (1944, p. 45).

Endosporites globiformis (Ibrahim) Schopf, Wilson & Bentall, 1944

Plate 10, Fig. 1

1932 *Sporonites globiformis* Ibrahim in Potonié, Ibrahim & Loose, p. 447, pl. 14, fig.5.

1933 *Zonales-sporites globiformis* Ibrahim, p.28, pl. 1, fig.5.

1938 *Sporonites globiformis* (Ibrahim), Luber in Luber & Waltz, pl. 8, fig. 103.

1944 *Endosporites globiformis* (Ibrahim) Schopf, Wilson & Bentall, p. 45.

Description: Spores radial, trilete. Amb subcircular to rounded subtriangular. Suturae distinct, straight to sinuous, with labra up to 6 μm high and extending almost to equatorial margin. Exine two-layered, cavate. Intexine distinct, laevigate, 1.5 μm thick, conformable with amb reaching one-half of spore radius. Exoexine 0.5-1.0 μm thick, laevigate, granulate or microreticulate, with regular large compression folds.

Dimensions: 86-140 μm; 8 specimens.

Occurrence: Brejeira Formation of BAFG (SL Miospore Biozone of Moscovian age).

Endosporites tuberosus González, Moreno & Playford, 2005

Plate 10, Figs. 2, 3

1957 *Endosporites micromanifestus* Hacquebard, p.317, pl. 3, fig. 16.

1958 *Discernisporites concentricus* Neves, p. 5, pl. 3, fig.7.

1960 *Auroraspora micromanifestus* (Hacquebard) Richardson, p. 51.

1971 *Endosporites tuberosus* (Hacquebard) Sabry & Neves, p.56, pl. 3, fig. 11.

1975 *Endosporites tuberosus* (auct. non Hacquebard) Sabry & Neves; Higgs, pl. 5, fig. 13.

1988 *Endosporites tuberosus* (auct. non Hacquebard) Sabry & Neves; Higgs, Clayton & Keegan, p. 76; pl. 14, fig. 9.

2005 *Endosporites tuberosus* González, Moreno & Playford, p. 30, Pl. 6, Figs. 7-10

Diagnosis: Spores radial, trilete. Amb convexly subtriangular. Suturae distinct, straight to sinuous, with labra up to 6 μm high and extending to equatorial margin. Exine two-layered, cavate. Intexine distinct, laevigate, 0.5-1.5 μm thick, conformable with amb. Proximal intexine displaying 3 (rarely up to 5) rounded, interradial papillae, about 3.0-5.5 μm in diameter, in the polar region. Exoexine

1.0-1.5 μm thick, laevigate, with infrequent large compression folds.

Dimensions: 45-75 μm; 29 specimens.

Occurrence: Volcano Sedimentary Complex and Tercenas and Bordalete Formations (LN to PC Miospore Biozones)

Previous records: From the upper Famennian to lower Tournaisian of Ireland (HIGGS, 1975; HIGGS et al., 1988), Portugal (PEREIRA, 1999 as *D. micromanifestus* with papilla) and Spain (GONZÁLEZ et al., 2005)

Genus EPIGRUSPORA González, Moreno & Playford 2005

Type species: *Epigruspora regularis* González, Moreno & Playford 2005

Epigruspora regularis González, Moreno & Playford, 2005

Plate 10, Fig. 4-6

2005 *Epigruspora regularis* González, Moreno & Playford, p. 27, Pl. 5, fig. 3-8

Description: Miospores radial, trilete. Amb convexly subtriangular to subcircular. Suturae distinct, straight, extending the equator, bordered by labra of about 1-3 μm high. Exine two-layered, cavate. Intexine distinct, 0.5-1 μm thick, laevigate, attached proximally to exoexine, outline conformable with amb. Exoexine 1.5-2 μm thick, laevigate to infrapunctate, sculptured equatorially and distally with discrete (5.0 μm apart), bacula, spinae, moderately regularly disposed or fused. Sculptural elements subcircular to rounded polygonal in basal outline, about 1.5-2.5 μm in high, 1.0-3.0 μm in basal diameter, rare small bacula, verrucae and grana, may be distributed in the middle of the larger elements. Proximal surface laevigate.

Dimensions 35-55 μm; 17 specimens.

Occurrence: Neves Formation in Neves Corvo mine region of Iberian Pyrite Belt (LN Miospore Biozone).

Previous records: This species was only recorded from upper Devonian of the Iberian South Portuguese Zone, in Spain (GONZÁLEZ et al., 2005) and Portugal.

Genus GEMINOSPORA Balme 1962

Type species: *Geminospora lemurata* Balme emend Playford, 1983; by original designation.

Geminospora spongiata Higgs, Clayton & Keegan, 1988

Plate 10, Fig. 7

1975 *Geminospora* cf. *lemurata* Higgs, p. 400; pl. 6, fig. 17.

1988 *Geminospora spongiata* Higgs, Clayton & Keegan, p. 77; pl. 14, figs. 11- 15.

Description: Miospores radial, trilete. Amb convexly subtriangular to subcircular. Suturae distinct, straight, extending at least three-quarters of distance to equator, bordered by labra of about 2 μm wide. Exine two-layered, cavate. Intexine distinct to visible, up to 0.5 μm thick, laevigate, sometimes peripherally folded, attached proximally to exoexine, diameter about three-quarters to four-fifths of total diameter. Exoexine 1.5-2.0 μm thick, proximally laevigate, sculptured distally and equatorially with minute (0.3-1.0 μm wide basally and high) grana and coni. Sculptural elements regularly disposed, discrete about 1.5 μm apart, or rarely fused at bases. Equatorial exoexine marked by crassitude 3.5-5.5 μm wide.

Dimensions: 35-52.5 μm; 10 specimens.

Occurrence: Ribeira de Limas, Gafo Formations, Sta Iria, Horta da Torre and Represa Formations of Pulo do Lobo domain, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas and Bordalete Formations (VH to PC Miospores Biozones).

Previous records: From the uppermost Famennian to Tournaisian of Ireland (HIGGS et al., 1988), Portugal (PEREIRA et al., 1994), and Spain (GONZÁLEZ et al., 2002; 2005).

Geminospora lemurata Balme emend. Playford, 1983

Plate 10, Figs. 8, 9

1962 *Geminospora lemurata* Balme, p.5, pl. 1, fig.5-10.

1983 *Geminospora lemurata* Balme emend Playford, p.316, fig.1-9.

Description: Miospores radial, trilete. Amb convexly subtriangular to subcircular. Suturae distinct, straight, extending at least three-quarters of distance to equator, bordered by labra of about 1.0-3.5 μm wide. Curvaturae perfectae visible to invisible. Exine two-layered, cavate. Intexine distinct to visible, up to 0.5 μm thick, laevigate. Exoexine 2.0 μm thick, sculptured distally and equatorially with microconi and microspinae (0.5-1.0 μm wide basally and 0.5-1.5 μm high). Sculptural elements regularly disposed, discrete about 2.0 μm apart, or fused at bases. Equatorial exoexine laevigate, 0.5-1.0 μm thick with compression folds common.

Dimensions: Exoexine 39-60 μm; 36 specimens.

Occurrence:Ribeira de Limas, Gafo and Sta Iria, Horta da Torre and Represa Formations of Pulo do Lobo Domain, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (AD, BM, and VH to LN miospores Biozones).

Previous records: From the Givetian to upper Frasnian worldwide, specially abundant in the Givetian/Fransnian bondary (PLAYFORD, 1983; BALME, 1988; RICHADSON & MCGREGOR, 1986; MCGREGOR & PLAYFORD, 1993; BALME, 1995). Nevertheless, in the SPZ it occurs regularly in the upper Famennian age (VH to LN Miospore Biozones), this occurrence is interpreted as reworked miospores (PEREIRA, 1999, PEREIRA et al., 2006, 2007).

Genus GRANDISPORA Hoffmeister, Staplin & Malloy emend. McGregor 1973

Type species: *Grandispora spinosa* Hoffmeister, Staplin & Malloy, 1955; by original designation.

Grandispora acuta Higgs, Higgs, Avkhimovitch, Loboziak, Maziane-Serraj, Stempien-Salek & Streel 2000

Plate 11, Figs. 6, 7

1980 *Grandispora acuta* (Kedo) Byvscheva, p. 55.

1980 *Asperispora acutus* (Kedo) Van der Zwan, p. 226, pl. 13, figs. 1–5.

1985 *Cymbosporites acutus* (Kedo) Byvscheva, p. 127, pl. 24, fig. 13.

1988 *Spinozonotriletes saurotus* Clayton, Higgs & Keegan, p. 77, pl. 15, figs.1-3,5.

1993 *Grandispora saurota* (Higgs, Clayton & Keegan) Playford & McGregor, pp. 38–39, pl. 17, figs. 1–11.

2000 *Grandispora acuta* Higgs, Avkhimovitch, Loboziak, Maziane-Serraj, Stempien-Salek & Streel, p. 213, pl. 1, figs. 1-6.

Description: Miospores radial, trilete. Amb subcircular to rounded subtriangular. Suturae distinct, straight, bordered with narrow labra of about 2.0-3.0 μm high. Exine two layered. Intexine distinct, laevigate, conformable with the amb.

Exoexine sculptures with prominent spinae and galae, of basal diameter 4.0-8.0 μm and up to 10.0-12.0 μm high. Elements are subcircular in basal outline, discrete but commonly coalescent forming a sinouos cristae up to 23 μm in length.

Dimensions: 36-55 μm; 54 specimens.

Occurrence: Tercenas and Bordalete Formations (LN to PC Miospores Biozones).

Previous records: From the uppermost Devonian to Lower Carboniferous of Ireland (HIGGS et al., 1988) and Portugal (PEREIRA, 1997).

Grandispora cornuta Higgs, 1975

Plate 10, Figs. 10-14

1975 *Grandispora cornuta* Higgs, pp. 398- 399; pl. 4, figs. 4-6.

Description: Miospores radial, trilete. Amb convexly triangular to subcircular. Suturae distinct, straight, extending almost to equator, accompanied by narrow labra 2.5-5.0 μm high. Exine two-layered. Intexine distinct to weakly defined, laevigate, 0.5 to 1.0 μm thick, sometimes folded in the margin. Exoexine 1.5-2.5 μm thick, sculptured distally and equatorially with discrete (4.0-11.0 μm apart), evenly distributed spinae, 4.5-8.0 μm high, bases circular in outline, 2.0-3.5 μm in diameter, occasionally bulbous.

Dimension: 42-75 μm; 47 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt, Terenas Formation of SWP Domain (VH to LN Miospore Biozones).

Previous records: From the uppermost Devonian to Lower Carboniferous of Ireland (HIGGS, 1975; HIGGS et al., 1988) and Poland (FILIPIAK, 2004), upper Famennian of Germany (HIGGS & STREEL, 1984), and uppermost Famennian of Algeria (COQUEL & LATRECHE, 1989), Portugal (PEREIRA et al., 1994; PEREIRA, 1999; PEREIRA et al., 2006; 2007) and Spain (GONZÁLEZ et al., 2002).

Grandispora echinata Hacquebard emend Utting, 1987

Plate 11, Figs.1-5

1957 *Grandispora echinata* Hacquebard, p. 317; pl. 3, fig. 17.

1987 *Spelaeotriletes echinatus* (Hacquebard) emend. Utting, p. 33; pl. 4, figs. 9-12.

1993 *Grandispora echinata* Hacquebard emend. Utting 1987; Playford & Mc- Gregor, pp. 37-38; pl. 16, figs. 4-6, 7a,b.

Description: Miospores radial, trilete. Amb convexly subtriangular to subcircular. Suturae straight, bordered by narrow labra of 2.5-5.0 μm high, reaching almost to equator where curvature imperfectae are developed. Exine two-layered. Intexine laevigate, up to 0.5 μm thick, folded, occupying almost four-fifths of overall spore diameter, outline in polar view conformable with amb. Rarely featuring three small, rounded apical papillae. Exoexine thin (1.0-1.5 μm thick), sculptured proximally and equatorially with discrete spinae, coni and secondary galeae 1.0-3.0 μm high, 0.5-2.5 μm in basal diameter, 1.0-8.0 μm apart.

Dimensions: 40-76 μm; 37 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Terenas and Bordalete Formations of SWP Domain (VH to LN and VI to PC Miospore Biozones).

Previous records: Extensively described from upper Famennian to lower Tournaisian (less commonly upper Tournaisian) strata of the northern hemisphere (HIGGS et al., 1988; PLAYFORD & MCGREGOR, 1993).

Grandispora protea (Naumova) Moreau-Benoit, 1980

Plate 11, Fig. 14

1953 *Hymenozonotriletes proteus* Naumova, p. 40, Pl. 4, fig.5

1965 *Calyptosporites proteus* (Naumova) Allen, p. 735, Pl. 103, figs. 10, 11.

1967 (?) *Hymenozonotriletes proteus* Naumova; McGregor, 1967 p. 40, pl. 4, fig. 5.

1980 *Grandispora protea* (Naumova) Moreau-Benoit, p. 37, Pl. 11, fig. 6.

Description: Miospores radial, trilete. Amb rounded subtriangular. Suturae straight, hidden by elevated triradial exoexinal folds. Exine two-layered. Intexine distinct, laevigate, up to 1.5 μm thick. Exoexine thin (1.0-2.5 μm thick), commonly with minor folds, sculptured proximally and equatorially with discrete verrucae, rounded coni and rarely spinae and biform elements, 1.0-7.0 μm high, 1.5-5.5 μm in basal diameter, 2.0-8.0 μm apart.

Dimensions: 95-105 μm; 9 specimens.

Occurrence: Phyllite-Quartzite Group (AD Miospore Biozone, subzone lem).

Previous records: Extensively described from

Givetian worldwide (MCGREGOR & CAMFIELD, 1982; LOBOZIAK & STREEL, 1989; LOBOZIAK & STREEL, 1995; VILLE DE GOYET ET AL., 2007).

Grandispora variospinosa McGregor & Camfield, 1982

Plate 11, Figs. 13

1972 *Spinozonotriletes* sp. A, McGregor & Uyeno, Pl. 2, Fig.1.

1976 *Grandispora longus* Chi & Hills, p. 752, Pl. 14, figs 3-6.1982 *Grandispora variospinosa* McGregor & Camfield, p. 47, pl. 12, figs. 5,6.

Description: Miospores radial, trilete. Amb rounded subtriangular or circular. Suturae straight, hidden by prominent folds, like labra up to 10-15 μm high, often open, extending to beyond the spore margin, commonly to the equator. Exine two-layered. Intexine distinct, laevigate, up to 1.0-3.5 μm thick, with distinct to indistinct margin. Exoexine thin (1.0-2.5 μm thick), commonly with minor folds. Exine sculptured proximally and equatorially with discrete spinae and biform elements, some with an expanded bases, commonly tapering to a rounded point or surmounted by a small cone or spine. 5.0-12.0 μm high, 2.5-6.5 μm in basal diameter, 2.0-7.0 μm apart.

Dimensions: 75-118 μm; 7 specimens.

Occurrence: Phyllite-Quartzite Group (AD Miospore Biozone, subzone lem)

Genus RETISPORA Staplin 1960

Type species: *Retispora florida* Staplin, 1960; by original designation.

Retispora lepidophyta (Kedo) Playford, 1976

Plate 11, Figs. 8-10

1957 *Hymenozonotriletes lepidophytus* Kedo, p. 24; pl. II, figs. 19-21.

1976 *Retispora lepidophyta* (Kedo) Playford, pp. 45-46; pl. 10, figs. 1-15.

For further synonymy see Playford (1976, p. 45) and Byvsheva (1985, p.140).

Description: Miospores radial, trilete. Amb convexly subtriangular to subcircular. Suturae distinct, extending almost to equator, commonly bordered by labra 2.0-3.0 μm wide overall. Exine two-layered. Exoexine 1.5-2.0 μm thick, distally reticulate to foveolate with rounded to elongate lumina, 1.5-4.0 μm in maximum diameter and muri, 0.5-2.0 μm wide, sometimes accompanied by grana and minute coni (up to 0.5 μm high). Intexine 0.5-1.5 μm thick, laevigate, outline in polar view conformable with amb, occupying about two-thirds to three-quarters of exoexinal cavum. Frequently, 3 rounded apical papillae, about 3 μm in maximum diameter, developed interradially (see Plate 11, Fig. 10).

Dimensions 40-98 μm; 154 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Terenas Formation of SWP Domain.

Previous records: Reported worldwide from uppermost Devonian deposits, its stratigraphic extinction closely approximates the Devonian-Carboniferous boundary (OWENS & STREEL, 1967, RICHARDSON & MCGREGOR, 1986, STREEL et al., 1987, TURNER et al., 1989, CLAYTON et al., 1991, PLAYFORD, 1993, PLAYFORD & MCGREGOR, 1993, PEREIRA et al., 1994, PEREIRA 1999).

Retispora macroreticulata (Kedo) Byvsheva, 1985

Plate 11, Figs. 11, 12

Description: Miospores radial, trilete. Amb convexly subtriangular to subcircular. Suturae distinct, extending almost to equator. Exine two-layered. Exoexine 1.5-2.0 μm thick, distally reticulate to foveolate with rounded to elongate lumina, 5.5-15.0 μm in maximum diameter and muri, 2.0-4.5 μm wide, sometimes accompanied by grana and coni (up to 1.5 μm high). Intexine 1.0-1.5 μm thick, laevigate, outline in polar view conformable with amb, occupying about two-thirds to three-quarters of exoexinal cavum.

Dimensions: 65-135 μm; 12 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt (VH Miospore Biozone).

Genus RUGOSPORA Neves & Owens 1966

Type species: *Rugospora corporata* Neves & Owens, 1966; by original designation.

Rugospora explicata González, Moreno & Playford, 2005

Plate 11, Figs. 15-17

2005 *Rugospora explicata* González, Moreno & Playford, p.33, pl. 7, figs. 14-18, pl. 8, figs. 1-3.

Description: Miospores radial, trilete. Amb subtriangular to subcirclar. Suturae distinct, straight, extending almost to equatorial margin, simple or bordered by labra of about 1.5-3.5 μm in width. Intexine indistinct, laevigate, 1.0-1.5 μm thick, closely appressed to exoexine, occupying about 90-95% of overall spore diameter. Exoexine thin, 1.0-1.5 μm thick, proximally laevigate or scabrate, sculptured distally with relatively short, narrow, sinuous, rounded rugulae (up to 8.0-9.0 μm long and 0.5-2 μm broad) both branching and freely terminating. Rugulae 1.0-2.5 μm high, projecting equatorially and bearing low, broad-based coni, bacula, and minor pila, 0.5-1.5 μm broad basally and up to 2 μm high.

Dimensions: 40 - 55 μm; 35 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt (VH to LN Biozone).

Previous records: This species was only recorded from late Devonian of the Iberian South Portuguese Zone, in Spain (GONZÁLEZ et al., 2005) and Portugal (PEREIRA et al., 2006; 2007).

Rugospora flexuosa (Jushko) Streel, 1974

Plate 12, Figs. 1,2

1960 *Trachytriletes flexuosus* Jushko, Tab.1, fig.4.

1967 *Hymenozonotriletes famenensis* Kedo, Neves & Dolby, pl. 2.

1974 *Rugospora flexuosa* (Jushko) Streel em Becker et al., 1974, pl. 21, fig.8-11.

1976 *Trachytriletes radiatus* Byvscheva, pl. 14, fig.17-18.

1981 *Rugospora flexuosa* (Jushko) Streel, Van Veen, pl. 6, fig.5.

1984 *Rugospora flexuosa* (Jushko) Streel, Higgs & Streel, pl. 3, fig.14,15.

1985 *Rugospora radiata* (Jushko) Byvsheva, pp. 148-149, pl. 30, figs. 6-8.

1988 *Rugospora flexuosa* (Jushko) Streel, Higgs et al, p.72, pl. 12, fig.2,3,7.

1989 *Synosporites flexuosa (*Jushko) Streel, Richardson & Ahmed, p.551, pl. 2, fig1-3.

Description: Miospores radial, trilete. Amb convexly subtriangular. Suturae distinct or obscured by sculpture, straight to slightly sinuous, extending almost to equator, bordered with narrow labra of about 1.0-3.0 μm in overall width. Exoexine laevigate to scabrate, 2.0-3.0 μm thick, sculptured distally with rugulae 1.0-3.5 μm wide, 3.0-16 μm long, rugulae sinuous to furcate, irregularly or radially arranged reaching equator. Intexine often impossible to differentiate, laevigate. Intexinal body comprising 90-95% of total diameter, outline in polar orientation, conformable with amb.

Dimensions: 40-82 μm; 156 specimens.

Remarks: The SPZ specimens observed display a morphological evolution from forms with small, sinuous, irregularly disposed rugulae to forms with coarser, slightly curved, radially oriented folds. Miospores in the latter category have been characterized as *Rugospora flexuosa* (Jushko) Byvsheva, 1985. Following GONZALEZ et al., 2005, that mention that "no arbitrary distinction can be erected in terms of shape, size and arrangement of rugulae", the SPZ species studied are also considered as a junior synonym of *R. flexuosa* (Jushko) Streel, 1974.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VH to LN Biozone).

Previous records: Widely recorded from the upper Famennian of Euramerica. In Portugal was first recovered in SWP Domain (PEREIRA et al., 1994, 1996; PEREIRA, 1999).

Genus SPELAEOTRILETES Neves & Owens 1966

Type species: *Spelaeotriletes triangulus* Neves & Owens, 1966; by original designation.

Discussion and comparison: See PLAYFORD et al. (2001).

Spelaeotriletes arenaceus Neves and Owens, 1966

Plate 12, Figs. 3, 4

1966 *Spelaeotriletes arenaceus* Neves and Owens, pp. 345–346; pl. II, figs. 1–3.

1967 *Lophotriletes coniferus* auct. non Hughes and Playford 1961; Felix and Burbridge (pars), p. 365; pl. 55, fig. 1.

1976 *Imucogosporis dulcis* Bharadwaj, Kar, and Navale (pars), p. 68; pl. 1, figs. 11, 12 (non pl. 1, figs. 9, 10, ?13).

1979 *Spelaeotriletes dulcis* (Bharadwaj, Kar, and Navale) Playford and Powis (pars), p. 388.

Description: Spores radial, trilete. Amb convexly subtriangular with rounded apices and convex sides, less commonly subcircular. Suturae perceptible to distinct, straight reaching to margin of spore. Intexine, thin constituting slightly darker inner body with distinct or perceptible margin that, in polar orientation, is conformable with amb. Exoexine about 1.0-2.0 μm thick, laevigate proximally on the extensive contact faces, sculptured distally, equatorially, and on proximo-equatorial radii with composite, mostly discrete elements of small verrucae and coni, together with scattered bacula and pila. Elements of 1.0-2.5μm in basal width and 0.8-2.0 μm high, irregularly distributed (up to 4.5 μm apart) or basally fused.

Dimensions:52-95 μm; 14 specimens.

Occurrence: Volcano Sedimentary Complex of Iberian Pyrite Belt, Graça Formation of Lower Viséan age (TS Miospore Biozone).

Spelaeotriletes balteatus (Playford) Higgs, 2006

Plate 12, Fig.5

1963 *Spinozonotriletes balteatus* Playford, p.675, pl. 94, fig.4-6.

1964 *Crassispora balteata* (Playford) Sullivan, p.376.

1971 *Grandispora balteata* (Playford) Playford, p.46.

1975 *Spelaeotriletes balteatus* (Playford) Higgs, p.400, pl. 6, fig.10.

2006 *Spelaeotriletes balteatus* (Playford) Higgs, p. 291.

Description: Miospores radial, trilete. Amb rounded to convexly triangular. Suturae distinct or obscured by sculpture, straight to slightly sinuous, with narrow labra and extending to the equatorial margin and terminating in curvaturae. Proximal surface laevigate except at the radial extremities. Distal exoexine densely ornamented with small coni and subordinate grana up to 2.5-3.0 μm in height, very rare small mammillae and verrucae are present. Ornament discrete but bases may fuse to form low short rugulae and cristae. Intexine thin, laevigate, perceptible to obscure outline, conformable with amb.

Dimensions: Exoexine 45-95 μm; intexine 32-60 μm; 28 specimens.

Occurrence: Bordalete Formation of SWP Domain (PC Miospore Biozone).

Spelaeotriletes pretiosus (Playford) Neves & Belt, 1970

Plate 12, Figs. 6, 7

1964 *Pustulatisporites pretiosus* Playford, p.19, pl. 4, fig. 7-9.

1969 *Pustulatisporites* cf. *pretiosus* Playford in Lanzoni & Magloire, p.454, pl. 1, fig. 17-19.

1970 *Spelaeotriletes pretiosus* (Playford) Neves & Belt, p. 1241.

Description: Miospores radial, camerate, trilete. Amb rounded to convexly triangular with rounded to slightly pointed apices. Suturae distinct or obscured by sculpture, straight to slightly sinuous, extending to the equatorial margin and terminating in curvaturae imperfectae. Exine, infragranulate, 2.0-3.0 μm thick at the equator. Exoexine, 2 μm thick, densely ornamented wih low, simple verrucae, mammillate verrucae and spinae. Elements of verrucae subcircular in basal outline with rounded, flattened or more frequently mammillate tops, 1-4 μm height and 2.5-7.5 μm in width, with discrete or combined bases forming very large irregular verrucae. Spinae 1.0-4.0 μm in lenght and 1.0-3.5 μm in basal diameter. Intexine distinct 1.5-2.5 μm thick and laevigate.

Dimensions: Exoexine 65-104 μm; intexine 35-65 μm; 17 specimens.

Occurrence: Bordalete Formation of SWP Domain (PC Miospore Biozone) .

Remarks: The specimens of S. pretiosus recorded from SPZ are smaller than the original descriptions of PLAYFORD (1964) and UTTING (1987). The dimension are closer to the Irish specimens described by HIGGS et al, 1988 (exoexine 68-110 μm, intexine 35-70 μm).

Genus TEICHERTOSPORA Balme 1988

Type species: *Teichertospora torquata* (Higgs) McGregor & Playford, 1990; originally designated, as *T. cuvierica* Balme, 1988, by Balme (1988, p. 163).

Teichertospora iberica González, Moreno & Playford, 2005

Plate 12, Figs. 8, 9

2005 *Teichertospora iberica* González, Moreno & Playford, p.35, Pl. 8, Figs. 10-15, 18.

Description: Miospores radial, trilete. Amb rounded subtriangular. Suturae distinct, slightly sinuous, extending at least two-thirds of distance to intexine margin, bordered by labra 2.5-4.0 μm high, 2.0-3.5 μm wide overall, commonly extending beyond laesurae as exoexinal plications reaching equator. Exine two-layered. Intexine distinct, laevigate, unfolded, about 0.5-1.0 μm thick, circular to subcircular in outline (polar view), rounded to rouded triangular, attached proximally to exoexine and occupying two-thirds to four-fifths of total diameter. Exoexine 1.5- 2.5 μm thick, endoreticulate, with muri 0.2-1.0 μm wide and rounded to elongate lumina 0.1-4.0 μm, endoreticulum more clearly discernible in equatorial region of well-preserved specimens. Distal surface of exoexine commonly accompanied by few, irregular or sinuous, radially disposed folds, up to 16 μm long, rarely extending beyond intexine periphery.

Dimensions: 45-64 μm; 17 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt (VH to LN Biozone).

Previous records: This specie was only recorded from upper Devonian of the Iberian Soth Portuguese Zone, in Spain (GONZÁLEZ et al., 2005) and Portugal (PEREIRA et al., 2006; 2007).

Infraturma MEMBRANATI Neves 1961

Genus PROPISPORITES Neves 1958

Type species: *Propisporites rugosus* Neves 1958

Propisporites laevigatus Neves, 1961

Plate 12, Fig. 12

1961 *Propisporites laevigatus* Neves, p. 269, pl. 33, fig. 9-10.

Description: Trilete spore, equatorial outline of spore body rounded triangular. Suturae simple, straight occupying almost three-quarters of the radius of the spore body. Exine laevigate, strongly folded over the laevigate spore body. The folds, are sinuous and run over the surface of the spore, in places lie parallel to the compressed spore margin, where they appear as membranous projections.

Dimensions: 55-78 μm; 34 specimens.

Remarks: *P. rugosus* is distinguished by punctation of the spore body membrane.

Occurrence: Murração and Mértola Formations (NL Miospore Biozone).

Previous records: From Namurian of the Southern

Pennines, England (NEVES, 1961). From Viséan of Portugal (PEREIRA, 1997, 1999).

Turma MONOLETES Ibrahim 1933

Subturma AZONOMONOLETES Luber 1935

Infraturma PSILAMONOLETI van der Hammen

Genus LATOSPORITES Potonié & Kremp 1954

Type specimen *Latosporites latus* (Kosanke) Potonié & Kremp 1954

Latosporites sp. A sensu Owens, 1971

Plate 12, Fig. 11

1971 *Latosporites* sp. A sensu Owens, p. 135.

Description: Monolete, bilateral miospore. Amb subcircular to oval. Suturae simple, straight, extending almost to three-quarters of pore radius and terminating in curvaturae perfectae. Exine 3.0-5.5 μm thick and laevigate.

Dimensions: 65-102 μm; 27 specimens.

Occurrence: Tercenas and Bordalete Formations of SWP Domain (LN to PC Miospore Biozones).

Infraturma SCULPTATOMONOLETI Dybová & Jachowicz 1957

Genus ARATRISPORITES Leschik 1955 emend Playford & Dettman 1965

Type species: *Aratrisporites parvispinosus* Leschik 1955.

Aratrisporites saharaensis Loboziak, Clayton & Owens, 1986

Plate 12, Fig. 10

1986 *Aratrisporites saharaensis* Loboziak, Clayton & Owens, pl. 24, figs. 10, 13.

Description: Monolete, bilateral miospore. Amb subcircular. Suturae indistinct to distinct, simple, straight, extending almost to equator and terminating in curvaturae perfectae. Intexine laevigate, conformable with the amb, reaching one-half of spore radius. Exoexine sculptured with small isolated spinae, 2.5-3.0 μm high and occasionally some verrucae, grana and coni. A thickned band of about 2.0-5.0 μm caused by the curvaturae, occur approximately at the equator.

Dimensions: 58-80, 7 specimens.

Occurrence: Bordalete Formation of SWP Domain (PC Miospore Biozone).

Genus THYMOSPORA Wilson & Venkatachala 1963

Type specie *Thymospora thiessenii* (Kosanke) Wilson & Venkatachala 1963a

Thymospora obscura (Kosanke) Wilson & Venkatachala, 1963

Plate 12, Fig. 15

1950 *Laevigato-sporites obscurus* Kosanke, p.29, pl. 16, fig.6.

1954 *Verrucosisporites obscurus* (Kosanke) Potonié & Kremp, p.166.

1963 *Thymospora obscura* (Kosanke) Wilson & Venkatachala, p.76, pl. 1, fig.6.

Description: Monolete, miospore. Amb broadly oval, margin irregular due ornamentation. Suturae distinct, simple, obscure by ornamentation. Exine thick of about 2.0-2.5 μm, puctate, with rare folds. Sculpture comprises small verrucae with rounded apices and more or less confluent bases (2.5 μm diameter and 1.5-2.0 μm high).

Dimensions: 20-35 μm; 21 specimens.

Occurrence: Brejeira Formation (OT Miospore Biozone).

Thymospora psedothiessenii (Kosanke) Wilson & Venkatachala, 1963

Plate 12, Figs. 13, 14

1963 *Thymospora thiessenii* (Kosanke) Wilson &

Venkatachala, p.78, pl. 1, fig1-4.

Description: Monolete, miospore. Amb oval, margin irregular and broken due to ornamentation. Suturae distinct, and obscure by ornamentation. Exine thick of about 1.5-3.5 μm, with verrucate to reticulate ornament which is reduced on proximal surface. On distal profile verrucae of about 7.5 μm in breadth and 2.5 μm in height with coalescent bases.

Dimensions: 33-48 μm; 54 specimens.

Occurrence: Brejeira Formation (OT Miospore Biozone).

Genus TORISPORA (Balme) Doubinger & Horst 1961

Type specie *Torispora securis* Balme 1952

Torispora securis Balme, 1952

Plate 12, Figs. 17, 18

1952 *Torispora securis* Balme, p. 183.

1957 *Torispora recta* Dybová & Jachowicz, p.197, pl. 66, fig. 1-4.

1957 *Torispora speciosa* Dybová & Jachowicz, p. 198, pl. 68, fig. 1-4.

1957 *Torispora undulata* Dybová & Jachowicz, p. 197, pl. 67, fig. 1-4.

Description: Monolete, bilateral miospore. Amb oval, margin finelly irregular. Suturae distinct, simple, straight, suture line parallel to the major axis of the spore. Exine considerably thickned at one extremity of the spore and expanded into a crescentic or rectangular crassitude, which is darke in color than the remaining of the spore exine.

Dimensions: 26-44 μm; 47 specimens.

Occurrence: Brejeira Formation (SL to OT Miospores Biozones).

Anteturma POLLENITES Potonié 1931

Turma Saccites Erdtman 1947

Subturma MONOSACCITES Potonié & Kremp 1954

Infraturma ARADITES Schopf, Wilson & Bentall 1944

Genus FLORINITES Schopf, Wilson & Bentall 1944

Type specie *Florinites pellucidus* (Wilson & Coe) Wilson 1958

Florinites junior Potonié & Kremp, 1954

Plate 12, Fig. 19

1954 *Florinites junior* Potonié & Kremp, p. 118, pl. 21, fig. 466.

Description: Bilateral pollen. Amb oval, margin smooth, or minutely indented. Central body, visible, circular of small dimension. Trilete mark generally not apparent. Saccus laevigate and thin, but with reticulate infrasculpture. Lumina tend to be elongated radially, maximum dimension of lumina less than 1.0 μm, muri less than 2.5 μm.

Dimensions: Saccus: 65-95 μm; central body: 25-45 μm; 18 specimens.

Occurrence: Brejeira Formation (NJ to OT Miospores Biozones).

INSERTAE SEDIS

Genus COLATISPORITES Williams em Neves et al. 1973

Type specimen *Colatisporites decorus* (Bharadwaj & Venkatachala) Williams in Neves et al., 1973

Colatisporites decorus (Bharadwaj & Venkatachala) Williams *in* Neves et al., 1973

Plate 12, Fig. 16

1961 *Tholisporites decorus* Bharadwaj & Venkatachala, p.39, pl. 10, fig.142-146.

1973 *Colatisporites decorus* (Bharadwaj & Venkatachala) Williams in Neves et al., p.41, pl. 2, fig.1-13.

Description: Miospores radial, trilete. Amb rounded subcircular to convexo-triangular. Suturae distinct to indistinct, straight to slightly sinuous, simple or with labra, extending to spore margin and terminating in curvature perfectae. Intexine unornamented. Exoexine strongly infrapunctate and rarely folded.

Dimensions: 40-52 μm; 5 specimens.

Occurrence: Tercenas Formation (LN Miospore Biozone).

2. PRASINOPHYTES AND ACRITARCHS

Division CHLOROPHYTA Pascher, 1914

Class PRASINOPHYCEAE Christensen, 1962

Family LEIOSPHAERIDIACEAE Timofeev, 1956 nom. corr. Mädler, 1963

Genus LEIOSPHAERIDIA Eisenack, 1958

Type species: *Leiosphaeridia baltica* Eisenack, 1958; by original designation.

Leiosphaeridia spp.

Plate 13, Fig. 1

Remarks: Simple spherical vesicles (diameter 34-84 μm) with thin (up to 0.6 μm thick), psilate, clearly folded, unilayered eilyma. These forms provide minimal stratigraphic information, so no attempt is made here to segregate them at the specific level.

Occurrence: Devonian and Lower Carboniferous of the ZSP.

Family TASMANITACEAE Sommer, 1956 nom. corr. Tappan, 1980

Genus TASMANITES Newton, 1875

Type species: *Tasmanites punctatus* Newton, 1875; by original designation (monotypic).

Tasmanites spp.

Plate 13, Fig. 2

Remarks: Spherical or subspherical vesicles (diameter 35-67.5 μm) with thick (2.5-3.5 μm), psilate to finely punctate eilyma. These forms provide minimal stratigraphic information, so no attempt is made here to segregate them at the specific level.Occurrence: Devonian and Lower Carboniferous of the ZSP.

Family CYMATIOSPHAERACEAE Mädler, 1963

Genus CYMATIOSPHAERA O. Wetzel ex Deflandre, 1954

Type species: *Cymatiosphaera flexuosa* O. Wetzel, 1933; by subsequent designation of Deflandre (1954, p. 257).

Cymatiosphaera perimembrana Staplin, 1961

Plate 13, Fig. 3

1961 *Cymatiosphaera perimembrana* Staplin, p.417, pl. 49, fig.16,17.

1977 *Cymatiosphaera platoloma* Wicander & Loeblich, p.140, pl. 3, fig.3,4.

1990 *Cymatiosphaera perimembrana* Staplin 1961, Colbath, p.103, pl. 1, figs. 10, 11, 23, 24.

Description: Spherical vesicle, circular to subcircular in ouline. Vesicle surface regularly divided into numerous, small, polygonal (mainly pentagonal), lacunae (diameter 5-8μm) by thin, membranous, psilate, straight muri (3.5-4.5 μm high). No excystment structure observed.

Dimensions: Overall diameter 22-36 μm; 32 specimens.

Occurrence: Tercenas Formation; Phyllite-Quartzite Group and Volcano Sedimentary Complex (LN Miospore Biozone);

Previous records: Frasnian to Famennian of North America (STAPLIN, 1961; WICANDER, 1974; WICANDER & LOEBLICH, 1977; WICANDER & PLAYFORD, 1985) and China (LU & WICANDER, 1988); Frasnian of Western Australia (PLAYFORD & DRING, 1981; PLAYFORD, 1981; COLBATH, 1990) and Upper Devonian of Iran (COQUEL et al., 1977; HASHEMI & PLAYFORD, 1998).

Genus DICTYOTIDIUM Eisenack emend. Staplin, 1961

Type species: *Dictyotidium dictyotum* (Eisenack) Eisenack, 1955; by original designation.

Dictyotidium litum Colbath, 1990

Plate 13, Fig. 4

1985 *Dictyotidium* sp. of Wicander & Playford, p.105, pl. 2,figs.8,9.

1990 *Dictyotidium litum* Colbath, p.105, pl. 2, figs.2-7.

Description: Vesicle originally spherical, outline subcircular. Eilyma psilate. Low, thin, straight, psilate muri (0.5-0.8 μm high) regularly dividing vesicle surface into polygonal (mainly 5 or 6 sided) lacunae, each 3.5-6.5 μm in diameter. Excystment structure absent.

Dimensions: Overall diameter 19-39 μm; 6 specimens.

Occurrence: Represa Formation, Volcano Sedimentary Complex (VH and LN Miospore Biozone).

Previous records: From the Frasnian of Iowa, USA (WICANDER & PLAYFORD, 1985), Western Australia (COLBATH,1990) and Frasnian of Iran (HASHEMI & PLAYFORD, 1998).

Genus DUVERNAYSPHAERA (Staplin) Deunff 1964

Type species: *Duvernaysphaera tenuicingulata* Staplin 1961

Duvernaysphaera radiata Brito, 1967

Plate 15, Figs. 1-2

1967 *Duvernaysphaera radiata* Brito, p.477, pl. 1, fig.1-3.

Description: Vesicle star-shaped, circular to subcircular in outline. Eilyma, 1-1.5 μm thick, psilate. Vesicle encompassed by a very thin, diaphanous, psilate membrane that imparts a circular outline. Membrane strengthened by 12-15 narrow, small, processes, which constitute elongated radial extensions of vesicle wall. No excystment structure observed.

Dimensions: Overall diameter 35-42.5 μm; 5 specimens.

Occurrence: Tercenas Formation of SWP Domain (LN Miospore Biozone).

Previous records: Middle Devonian of Maranhão Basin, Brasil (BRITO, 1967).

Duvernaysphaera stellata Deunff, 1964

Plate 15, Fig. 3

1964 *Duvernaysphaera stellata* Deunff, p.212, fig.4.

Description: Vesicle 7-8 sided in outline, sides straight to gently concave. Eilyma, 1.0-1.3 μm thick, scabrate to psilate. Vesicle encompassed by a very thin, diaphanous, psilate membrane that imparts a near-circular outline. This membrane is absent in most of the specimens documented. Membrane strengthened by narrow, small, rod–like projections, which constitute elongated radial extensions of vesicle wall. No excystment structure observed. Dimensions: Overall diameter 25-31 μm; 5 specimens.

Occurrence: Tercenas Formation of SWP Domain (LN Miospore Biozone).

Previous records: Upper Devonian sediments of Tunisia (DEUNFF, 1964, 1966).

Duvernaysphaera tessella Deunff, 1964

Plate 15, Fig. 4

1964 *Duvernaysphaera tessella* Deunff, p.212, fig.5.

1966 *Veliferites tenuimarginatus* Brito, p.79.

1967 *Veliferites tenuimarginatus* Brito, p. 477, pl. 1, fig. 4-8.

Description: Vesicle quadrangular in outline, with slightly concave, straight, or slightly convex sides. Eylima, 0.7-1.2 μm thick, scabrate to psilate. Very thin, diaphanous, psilate membrane, equatorial flange, stiffened by one or sometimes two, small rod-like, coplanar extensions emanating radially from the vesicle wall at or near the each vesicle corner. Flange is not preserved in the specimens recognized. Excystment consisting of simple split, in vesicle wall.

Dimensions: Overall diameter 34-50 μm; 5 specimens.

Occurrence: Tercenas Formation of SWP Domain (LN Miospore Biozone).

Previous records: From Upper Devonian of Tunisia (DEUNFF, 1964, 1966), Lower to Middle Devonian of Brasil (BRITO, 1967) and Givetian to Frasnian of Tenesse (REAUGH, 1978).

Family PTEROSPERMELLACEAE Eisenack, 1972

Genus MARANHITES Brito, 1965

Type species: *Maranhites brasiliensis* Brito, 1965; by original designation.

Maranhites brasiliensis Brito, 1965

Plate 13, Figs. 5,6

1965 *Maranhites brasiliensis* Brito, p. 2; pl. 1, fig. 1.

Description: Vesicle originally discoidal, outline circular. Eilyma two layered; endeilyma psilate, 1-2 μm thick; equatorial periphery consisting of a series of dark-coloured thickenings, with circular or subcircular outlines and up to 4-5 μm in maximum dimension, commonly connected by smaller circular, subcircular, or arcuate lateral thickenings. Perieilyma fine, diaphanous, displaying a fine rugulate/reticulate pattern, darker color that the vesicle. No excystment structure observed.

Dimensions: Overall diameter 80-120 μm; 19 specimens.

Occurrence: Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas and Bordalete Formations of SWP Domain (VCo, VH and LN Miospore Biozones).

Previous records: (BRITO, 1965a,b, 1967a,b, 1976, 1978; BURJACK & OLIVEIRA, 1989); Emsian to lower Frasnian of France (MOREAU-BENOIT, 1974; TAUGOURDEAU-LANTZ 1968), Portugal (CUNHA & OLIVEIRA, 1989; PEREIRA, 1997, 1999), Upper Devonian of Spain (MORENO et al., 2003; GONZÁLEZ et al., 2005), Emsian to Frasnian of Ghana (ANAN-YORKE, 1974), Givetian to Frasnian of Western Australia (COLBATH, 1990) and Famennian of North America (WOOD, 1984; PLAYFORD & MCGREGOR, 1993).

Maranhites britoii Stockmans & Williere, 1969

Plate 13, Figs. 7, 10

1969 *Maranhites britoii* Stockmans & Williere, p.44, pl. 2, fig.4,7.

1980 *Maranhites* sp. Attar, Candilier, Fournier & R. Coquel, p.594, pl. 5, fig 6.

1981 *Maranhites britoii* Stockmans & Williere, p.24, pl 4, fig.6, 12.

For additional synonymy see Martin (1985, p. 24) and Le Hérissé & Deunff (1988, p. 126).

Description: Vesicle originally discoidal, circular to subcircular in outline, originally probably discoidal. Eilyma two-layered; endeilyma psilate, 1 μm thick. Marginal zone consisting of series of a chain of elongated, light-coloured cells (each 4-15 μm) separated by isolated or proximally connected columnar thickenings (2-6 μm wide, up to 7-10 μm high). Perieilyma much thinner, psilate orfinely regulate to reticulate. No excystment structure observed.

Dimensions: Overall diameter 50-78μm; 10 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas and Bordalete Formations of SWP Domain (VH and LN Miospore Biozones).

Previous records: From the Frasnian of France (LE HÉRISSÉ & DEUNFF, 1988), upper Frasnian and lower Famennian of Belgium (STOCKMANS & WILLIÈRE, 1969; MARTIN, 1981, 1985), Upper Devonian to Lower Carboniferous of Algeria (MOREAU-BENOIT et al., 1993; LATRECHE & COQUEL, 1996), Famennian to Strunian of Portugal (PEREIRA, 1997), Frasnian of Iran (HASHEMI & PLAYFORD, 1998) and Upper Devonian of Spain (GONZÁLEZ et al., 2005).

Maranhites gallicus Taugourdeau-Lantz, 1968

Plate 13, Figs. 8, 9

1968 *Maranhites gallicus* Taugourdeau-Lantz, p. 162; pl. 13, fig. 9; pl. 14, figs. 1-3.

Description: Vesicle originally discoidal, outline circular to subcircular. Eilyma two-layered. Endeilyma relatively thick, psilate possessing a thickening, circular to elliptical in outline; 2-5 μm in maximum diameter, on each concavity, projecting beyond margin of endeilyma. Perieilyma thinner, psilate or finely regulate to reticulate especially in "polar" areas. No excystment structure observed.

Dimensions: Overall diameter 70-120 μm; 8 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas and Bordalete Formation in SWP Domain of SPZ (LN Miospore Biozone).

Previous records: From the lower Frasnian of France (TAUGOURDEAU-LANTZ, 1968; HERISSÉ & DEUNFF (1988), Famennian to Strunian of Algeria (JARDINÉ et al., 1974), in the Frasnian to Famennian of the the Pulo do Lobo and Iberian Pyrite Belt (LAKE, 1991) and in the Volcano Sedimentary Complex of Iberian Pyrite Belt in Spain (GONZÁLEZ et al., 2005) and in Portugal in the Bordalete Formation (PEREIRA, 1997).

Maranhites mosesii (Sommer) Brito, 1967

Plate 13, Figs. 11-13

1956 *Tasmanites mosesii* Sommer, p 458; pl. 1, figs. 6-8; pl. 2, fig. 5.

1967 *Maranhites mosesii* (Sommer) Brito, pp. 164-165; pl. 2, figs. 3-6.

1989 *Maranhites insulatus* Burjack & Oliveira, pp. 52-54; pl. 1, figs. 7, 10, 12.

1989 *Maranhites mosesii* (Sommer) Brito emend. Burjack & Oliveira, pp. 51-52; pl. 2, figs. 7-10.

Description: Vesicle originally discoidal, outline circular to subcircular. Eilyma two-layered. Endeilyma psilate, 1-1.5 μm thick; marginal development of 3-15 pads, subcircular to elliptical in outline. Pads commonly reaching peripheral margin, where they may be discrete or joined by a narrow arched to scalloped equatorial thickening. Pads tending to be more circular in outline if they where not attaining equatorial margin. Perieilyma much thinner than endeilyma, psilate to finely regulate to reticulate, closely appressed to endeilyma. No excystment structure observed.

Dimensions: Overall diameter 65-125 μm (87 specimens).

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas and Bordalete Formations of SWP Domain (VCo, VH, LE and LN Miospore Biozones).

Previous records: From the Devonian of France (MOREAU-BENOIT, 1966); Middle and Upper Devonian of Brazil (SOMMER, 1956; SOMMER & VAN BOEKEL, 1963, 1966; BRITO, 1965b, 1967a,b, 1976; BRITO & QUADROS, 1984; LUDWIG & MÜLLER, 1968; BURJACK & OLIVEIRA, 1989); Famennian of Portugal (CUNHA & OLIVEIRA, 1989; OLIVEIRA et al., 2007; PEREIRA et al., 1994, 2004; PEREIRA, 1997, 1999); Upper Devonian of Spain (RODRIGUES, 2002; MORENO et al., 2003; GONZÁLEZ et al., 2005); Upper Devonian of North America (MOLYNEUX et al., 1984; PLAYFORD & MCGREGOR, 1993); and Upper Devonian to lowermost Carboniferous of Algeria (ATTAR et al., 1980; COQUEL & LATRECHE, 1989).

Maranhites multioculus González, Moreno & Playford, 2005

Plate 14, Figs. 1-3

2005 *Maranhites multioculus* González, Moreno & Playford, p.61, pl. 3, figs.7-13.

Description: Vesicle originally discoidal, outline circular to subcircular. Eilyma two-layered. Endeilyma1-1.5 μm thick, psilate, with scalloped (3-5 μm in wave-length) and up to 2.5 μm thickened margin; each concavity possessing a hollow, light-coloured cell with circular to elliptical outline, discrete from adjacent cells. Cells 1.5-5 μm and 2.5-6 μm in radial and tangential dimensions respectively; extending slightly beyond equatorial margin to be closely covered by the thinner, psilate, diaphanous perieilyma. Perieilyma finely reticulate to scabrate and darker at the polar areas. No excystment structure observed.

Dimension: Overall diameter 55-92 μm; 32 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt.

Previous records: Upper Devonian of Iberian Pyrite Belt in Spain (GONZÁLEZ et al., 2005).

Maranhites perplexus Wicander & Playford, 1985

Plate 14, Figs. 4-7

1985 *Maranhites perplexus* Wicander & Playford, p. 110; pl. 3, figs. 11a-b, 12.

Description: Vesicle originally discoidal, circular to subcircular in outline with scalloped margin. Eilyma two-layered. Endeilyma psilate, relatively thick; equatorial margin consisting of 10-16, hollow, blunted projections (4-8 μm in basal diameter, 5-11 μm long), radially arranged, with concave margin of endeilyma between them. Perieilyma finer, diapahanous, reaching equatorial margin, commonly dissociated from embayments between peripheral projections and extending somewhat beyond latter. Perieilyma finely reticulate to scabrate radially distributed and darker at the polar areas. No excystment structure observed.

Dimension: Overall diameter 40-60 μm; 23 specimens.

Occurrence: Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VH and LN Miospore Biozones).

Previous records: From the Upper Devonian (Frasnian) of Iowa, U.S.A. (WICANDER & PLAYFORD, 1985), Iran (GHAVIDEL-SYOOKI, 2001), Famennian to Strunnian of Portugal (PEREIRA, 1999) and Spain (LAKE, 1991, MORENO et al., 2003 e GONZÁLEZ et al., 2005).

Maranhites sp. A

Plate 14, Fig. 8

Description: Vesicle originally discoidal, circular to subcircular in outline with scalloped margin. Eilyma two-layered. Endeilyma psilate, relatively thick; equatorial margin consisting of 15-18, rounded and short projections (2-5 μm in basal diameter, 3-5 μm long). Perieilyma finer, diapahanous, reticulate to scabrate, darker at the polar areas, radially distributed to a thicker concentrically arranged ring. No excystment structure observed.

Dimension: Overall diameter 45-70 μm; 5 specimens.

Occurrence: Phyllite-Quartzite Group of the Neves Corvo mine region (LN miopore Biozone).

Maranhites sp. B

Plate 14, Fig. 9

Description: Vesicle originally discoidal, circular to subcircular in outline with scalloped margin. Eilyma two-layered. Endeilyma psilate, relatively thick; equatorial margin consisting of 35-37, rounded alternated thinner and thicker projections (0.5-1 μm the thinner and 3-4 μm the thicker, in basal diameter, 4-5 μm long), radially arranged, with concave margin of finer endeilyma between them. Perieilyma much finer, reaching equatorial margin, finely reticulate concentrically distributed, forming a ring and darker at the polar areas. No excystment structure observed.

Dimension: Overall diameter 45-70 μm; 2 specimens.

Occurrence: Phyllite-Quartzite Group of the Neves Corvo mine region (LN miopore Biozone).

Genus PTEROSPERMELLA Eisenack 1972

Espécie tipo *Pterospermella aureolata* (Cookson & Eisenack) Eisenack 1972

Pterospermella euriptio Martin, 1984

Plate 14, Figs. 10-11

1969 *Pterospermosis heol* (Deunff) Stockmans & Wilière, p.42, pl. 2, fig.5.

1981 *Pterospermella* cf. *P. heol* (Deunff) Martin, p.27, pl. 4

1984 *Pterospermella euriptio* Martin, p.29, pl. 9, fig.5,7,11,12.

Description: Vesicle originally spherical, outline circular to subcircular, surrounded equatorially by thin, diaphanous flange, reticultate with delicate radial folds (40-50) extending from vesicle/flange boundary to or almost to, outer margin of flange. Vesicle wall psilate to microgranulate (1-15 μm thickness) and with periferical folds.

Dimension: Overall diameter 25-35 μm; membrane diameter 17-25 μm; 9 specimens.

Occurrence: Represa Formation in Mina de S. Domingos mine region, Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VH and LN Miospore Biozones).

Previous records: From lower Famennian of Belgium (MARTIN, 1984) and Portugal (PEREIRA, 1997).

Group ACRITARCHA Evitt, 1963

Genus CHOMOTRILETES Naumova ex Naumova, 1953

Type species: *Chomotriletes vedugensis* Naumova, 1953; by subsequent (monotypic) designation of Naumova (1953, p. 58).

Chomotriletes vedugensis Naumova, 1953

Plate 15, Fig. 5

1953 *Chomotriletes vedugensis* Naumova, p. 58; pl. 7, figs. 21,22.

Description: Vesicle circular to subcircular in "polar" view, biconvex to flattened in lateral aspect; isopolar.Eilyma psilate, 0.5-0.8 μm thick, with low, psilate, concentrically arranged ridges on both faces of vesicle; ridges normally continuous to form discrete or rarely conjoined rings, individually 0.5-2 μm wide, up to 4 μm apart, commonly developing 10-25 μm beyond "polar area". No excystment structure observed.

Dimensions: Overall diameter 35-44 μm; 8 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VH and LN Miospore Biozones).

Previous records: From the Givetian of Poland (TURNAU & RACKI, 1999), Frasnian of Russia (NAUMOVA, 1953), Western Australia (BALME, 1962; PLAYFORD, 1981; PLAYFORD & DRING, 1981), Tornaisian of Ireland (HIGGS et al., 1988), Iran (GHAVIDEL-SYOOKI, 2001, 2003), Famennian of Canada (PLAYFORD & MCGREGOR, 1993), and Portugal (PEREIRA et al., 1994, 1996).

Genus CRASSIANGULINA Jardiné, Combaz, Magloire, Peninguel & Vachey, 1972

Type species: *Crassiangulina tesselita* Jardiné, Combaz, Magloire, Peninguel & Vachey, 1972; by original designation.

Crassiangulina tesselita Jardiné, Combaz, Magloire, Peninguel & Vachey, 1972

Plate 15, Figs. 6-9

Description: Vesicle triangular to quadrangular in outline, sides straight to deeply concave, corners rounded. Eilyma scabrate less than 1 μm thick, reinforced by continuous marginal thicknening (4.0-5.0 μm wide at corners, 0.5-1.5 μm at interangular positions).

Dimensions: Overall diameter 20-25 μm; 17 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VH and LN Miospore Biozones).

Previous records: Famennian/Strunian Sahara Algeria (JARDINÉ et al., 1972).

Genus CRATERISPHAERIDIUM Deunff, 1981

Type species: *Craterisphaeridium sprucegrovense* (Staplin) Turner, 1986; originally designated as *C. inuncans* Deunff, 1981, junior synonym of *C. sprucegrovense* (Staplin) Turner, 1986 according to Turner (1986, p. 602).

Craterisphaeridium sprucegrovense (Staplin) Turner, 1986

Plate 15, Figs. 10-12

1961 *Multiplicisphaeridium*? *sprucegrovensis* Staplin, p. 411; pl. 48, fig. 22; pl. 49, fig. 6; text-fig. 9j.

1970 *Ammonidium sprucegrovensis* (Staplin) Lister, p. 49.

1978 *Hercyniana sprucegrovensis* (Staplin) Vanguestaine in Kimpe et al., p. 96; pl. 13, figs. 5, 6.

1986 *Craterisphaeridium sprucegrovense* (Staplin) Turner, pp. 602-606; pl. 1, figs. 1-6; pl. 2, figs. 1-4. For further synonymy see Martin (1981, p. 12).

Description: Vesicle originally spheroidal to polyhedral, outline circular to rounded polygonal. Eilyma 0.6-1 μm thick, sculptured with subcircular to rounded polygonal foveolae up to 1 μm in diameter. Processes discrete, homomorphic, rigid, evenly distributed (6-10 per vesicle), psilate, hollow, interiors freely communicating with vesicle cavity. Proximal process contacts angular to slightly curved; distal termini palmate, composed of 4.0-6.0, homomorphic, solid, psilate, straight to sinuous, distally acuminate pinnae, 2.0-6.0 μm long. Processes 10-20 μm long, diameter 2.0-3.5 μm at base, decreasing gradually to ca. 1 μm near point of branching. No excystment structure observed.

Dimensions: Overall diameter 32-35 μm; 11 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group of Iberian Pyrite Belt (VH and LN Miospore Biozones).

Previous records: From the Frasnian of western Canada (STAPLIN, 1961; TURNER, 1986); middle Frasnian to lower Famennian of Belgium (MARTIN, 1981, 1982; KIMPE et al., 1978; STOCKMANS & WILLIÈRE, 1962a,b, 1969, 1974), upper Famennian of Portugal (CUNHA & OLIVEIRA, 1989) and Upper Devonian of Spain (GONZÁLEZ et al., 2005).

Genus DAILLYDIUM Stockmans & Willière, 1969

Type species: *Daillydium pentaster* (Staplin) emend. Playford in Playford & Dring, 1981; originally designated as *D. quadridactylites* (Stockmans & Willière) Stockmans & Willière, 1969 (junior synonym of *D. pentaster*).

Daillydium pentaster (Staplin) emend. Playford in Playford & Dring, 1981

Plate 15, Figs. 14-15

1961 *Cymatiosphaera pentaster* Staplin, p. 416; pl. 49, fig. 18.

1962 *Hystrichosphaeridium quadridactylites* Stockmans & Williére, p.67-68, pl. 1, fig.1-14.

1966 *Cymatiosphaera tetraster* Staplin, Deunff, p.140-144, pl. 4, fig.165-167.

1969 *Daillydium quadridactylites* (Stockmans & Williére) Stockmans & Williére, p.33-35, pl. 1, fig.1-14.

1981 *Daillydium pentaster* (Staplin) emend. Playford in Playford & Dring, p. 17, 18; pl. 3, figs. 1-14; text-fig. 4.

For further synonymy see Hashemi & Playford (1998, pp. 143-144).

Description: Vesicle originally spherical, outline circular to subcircular. Eilyma 0.8-1.0 μm thick. Vesicle surface divided into triangular lacunae by thin, membranous, psilate muri 1.5-2.5 μm high, up to 0.3 μm wide. Each lacunae is 5.0-9.0 μm in diameter and with floors finely scabrate. There are 3 to 8 vase shaped, hollow, membranous processes (4.0-6.0 μm broad basally, 7.0-12.0 μm long) each developed at a lacunae corner and non communicative with vesicle interior. A spine-like projection, slender, flexible, distally tapering, arising from centre of eilyma are enclosed by each process. Projections are 0.8-1.0 μm in basal diameter, 8.0-12.0

μm long. No excystment structure observed.

Dimensions: Vesicle diameter 15-22 μm; overall diameter 25-52.5 μm; 13 specimens.

Occurrence: Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VCo, VH, LE and LN Miospore Biozone).

Previous records: *D. pentaster* is widely distributed in Upper Devonian (upper Givetian to upper Famennian) strata, as documented by PLAYFORD & DRING (1981); LU LI-CHANG & WICANDER (1988), and HASHEMI & PLAYFORD (1998). In Portugal, it was documented in the Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group of PB (CUNHA & OLIVEIRA, 1989) and in the SWS (PEREIRA, 1997).

Genus DELTOTOSOMA Playford, 1981

Type species: *Deltotosoma intonsum* Playford in Playford & Dring, 1981.

Deltotosoma sp.

Plate 15, Fig. 13

Description: Vesicle triangulat to subtriangular in outline, apices rounded, sides straight to concave or occasionally slightly convex. Eilyma 0.5-0.8 μm of thickness, psilate. Vesicle surface covered with numerous, discrete, homomorphic, solid processes, 0.5 μm broad at base, 1-1.5μm long, 1-1.5 μm apart and with evexate to slightly rounded distal extremities.

Dimensions: Overall diameter 20-32μm; 6 specimens.

Occurrence: Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group of Iberian Pyrite Belt.

Previous records: From the Frasnian of Western Australia (PLAYFORD & DRING, 1981) and Iran (GHAVIDEL-SYOOKI, 1988, 1995).

Genus DUPLICIRADIATUM González, Moreno & Playford, 2005

Type species: *Dupliciradiatum crassum* González, Moreno & Playford, 2005

Dupliciradiatum crassum González, Moreno & Playford, 2005

Plate 15, Figs. 16-17

2005 *Dupliciradiatum crassum* González, Moreno & Playford, p.64, pl. 4, fig.16, pl. 5,figs 1-4.

Description: Vesicle originally discoidal, with circular/subcircular to stellate outline. Eilyma two-layered. Endeilyma psilate, 1.5 μm thick, having in each face 7-11 discrete, coplanar, elongate, thickened, spoke-like ridges in radial disposition. Ridges straight to somewhat sinuous, 10-2 μm long, 1-2.5 μm wide, tapering slightly from an equatorially projecting rounded or capitate end. External margin of endeilyma, occupying the concavity between radial projections consists of a continuous 2-8 μm wide thickening. Perieilyma very thin (less than 0.5 μm), extending equatorially as a thin membranous flange, 5-10 μm wide, reinforced by radial projections of endeilyma, but not extending equatorially beyond projections. Non-equatorial perieilyma, psilate to finely rugulate/reticulate. Excystment by simple splitting of eilyma.

Dimensions: Overall diameter 45-75 μm; 38 specimens.

Occurrence: Represa Formation of Pulo of Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt.

Previous records: Upper Devonian in Spain (GONZÁLEZ et al., 2005).

Dupliciradiatum tenue González, Moreno & Playford, 2005

Plate 15, Figs.18-19

2005 *Dupliciradiatum tenue* González, Moreno & Playford, p. 61, pl. 5, figs. 5-8.

Description: Vesicle originally discoidal, outline circular/subcircular. Eilyma two-layered. Endeilyma psilate, 1 μm thickness; each vesicle face modified by a variable number (12-20) of narrow, straight to slightly curved, ridges (0.5-1.5 μm wide, 4.0-9.0 μm long) that are radially arranged and project equatorially. Ridges, pointed from rounded equatorial end to acuminate inner (near-polar) limit. Between ridge projections, peripheral margin of endeilyma has thickness 1.0-2.5 μm large. Perieilyma very thin, extending equatorially to form a thin flange (2.0-3.0 μm wide), absent in most of the specimens documented. Excystment by simple splitting.

Dimensions: Overall diameter 35-65 μm; 23 specimens.

Occurrence: Represa Formation of Pulo of Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt (VH Miospore Biozone).

Previous records: Upper Devonian in Spain (GONZÁLEZ et al., 2005).

Genus GORGONISPHAERIDIUM Staplin, Jansonius & Pocock 1965

Type species: *Gorgonisphaeridium winslowiae* Staplin, Jansonius & Pocock, 1965; by original designation.

Gorgonisphaeridium ohioense (Winslow) Wicander, 1974

Plate 16, Figs. 1-2

1962 *Hystrichosphaeridium ohioensis* Winslow, p.77; pl. 19, fig. 1; pl. 22, fig. 9.

1974 *Gorgonisphaeridium ohioense* (Winslow) Wicander, p. 26; pl. 12, figs. 7-9.

For further synonymy see Playford & McGregor (1993, p. 14).

Description: Vesicle originally spherical with circular/subcircular outline, well-demarcated from processes. Eilyma, 1-1.5 μm thick, psilate to scabrate, with numerous, discrete, solid, psilate, straight, homomorphic, spine-like processes. Processes in number 20 to 34 are acuminate distally, 1.5-2.5 μm broad at base, 10-19 μm long, 3-8 μm apart. Excystment by simple splitting of vesicle wall.

Dimension: Overall diameter 48-62 μm; 57 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas and Bordalete Formations of SWP Domain (VH, LE, LN and VI Miospore Biozones).

Previous records: Widely recorded in Upper Devonian, cosmopolitan from upper Frasnian to uppermost Strunian (PLAYFORD & MCGREGOR, 1993). In Portugal, *G. ohioense* was recorded in the upper Strunian (PEREIRA, 1997; PEREIRA et al., 2006) and upper Famennian from the PB in Spain (GONZÁLEZ et al., 2005).

Gorgonisphaeridium plerispinosum Wicander, 1974

Plate 16, Figs. 3-4

1974 *Gorgonisphaeridium plerispinosum* Wicander, p. 26; pl. 12, figs. 10-12.

Description: Vesicle originally spherical, outline circular/subcircular, distinct from processes. Eilyma 1-1.1 μm thick, psilate or scabrate. Numerous (100-200) close-spaced but discrete processes evenly distributed over vesicle surface. Processes homomorphic, solid, spine-like, straight to slightly curved, 2.2-3.3 μm long, with angular proximal contacts and circular bases 1-1.5 μm in diameter; processes tapering distally to simple acuminate or evexate tips. Excystment by simple eilyma split.

Dimensions: Vesicle diameter 33-47 μm; 51 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas and Bordalete Formations of SWP Domain (VH, LE, LN and VI Miospore Biozones).

Previous records: From the Upper Devonian (upper Frasnian to upper Famennian) of North America (WICANDER, 1974; WICANDER & LOEBLICH, 1977; PLAYFORD & MCGREGOR, 1993); upper Famennian of Belgium (VANGUESTAINE, 1978); upper Frasnian-Famennian of China (LU LI-CHANG & WICANDER, 1988) and Upper Devonian of Morocco (RAHMANI- ANTARI, 1990), upper Strunian of Portugal (PEREIRA, 1997; PEREIRA et al., 2006) and Spain (GONZÁLEZ et al., 2005).

Genus HOROLOGINELLA Coockson & Eisenack 1962

Type species: *Hologinella lineata* Coockson & Eisenack 1962

Horologinella horologia (Staplin) Jardiné, Combaz, Magloire, Peninguel & Vachey, 1972

Plate 16, Figs. 5-6

1960 *Azonotetraporina horologia* Staplin, p.6, pl. 5, fig.3.

1963 *Tetraporina horologia* (Staplin) Playford, p.659.

1964 *Tetraporina horologia* (Staplin) Cramer, p.335.

1972 *Horologinella horologia* (Staplin) Jardiné, Combaz, Magloire, Peninguel & Vachey, pp. 1, figs, 3, 4.

Description: Vesicle quadrangular in ouline, apices rounded, sides straight to concave. Eilyma psilate, 0.5-0.8 μm thick. No excystment structure observed.

Dimensions: Overall diameter 45-55 μm; 17 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Tercenas Formation of SWP Domain (VH, LE and LN Miospore Biozones).

Previous records: From Famennian to Lower Carboniferous of Sahara (JARDINÉ et al., 1972).

Genus MICRHYSTRIDIUM Deflandre, 1937

Type species: *Micrhystridium inconspicuum* Deflandre 1937; by original designation.

Micrhystridium stellatum Deflandre, 1945

Plate 16, Figs.7-8

1942 *Micrhystridium stellatum* Deflandre, p.476, fig.7,8.

1945 *Micrhystridium stellatum* Deflandre, p. 65; pl. 3, figs. 16-19.

For additional synonymy see Playford & Dring (1981, p. 46).

Description: Vesicle originally spheroidal, outline circular, clearly demarcated from processes (14 to 21). Eilyma psilate, 0.6-0.8 μm thick. Processes 5.5-10 μm in length, basal diameter 1-2.5 μm, psilate, rigid, homomorphic, spine-like, hollow, freely communicating with vesicle interior, tapering gradually to simple, acuminate distal terminus of processes. No excystment structure observed.

Dimensions: Vesicle diameter 15-20 μm; overall diameter 25-30 μm; 31 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas and Bordalete Formations of SWP Domain (VH, LE, LN and VI Miospore Biozones).

Previous records: *M. stellatum* is a cosmopolitam species, widely distributed, with a geologic age from the Palaeozoic and Mesozoic (Ordovician to Jurassic, LISTER, 1970; EISENACK et al., 1979).

Genus NAVIFUSA Combaz, Lange & Pansart 1967

Type species: *Navifusa navis* (Eisenack) Combaz, Lange & Pansart 1967

Navifusa bacilla (Deunff) Playford, 1977

Plate 16, Fig. 13

1955 *Leiofusa bacillum* Deunff, p.148, pl. 4, fig.2.

1965 *Leiofusa brasiliensis* Brito & Santos, p.8, pl. 1,2, fig.2,3.

1965 *Leiofusa brasiliensis* lingula Brito & Santos, p.8, pl. 1, fig.1.

1965 *Leiofusa cylindricum* Brito & Santos, p.16, pl. 1, fig.4.

1965 *Leiofusa eisenacki* Brito & Santos, p.17,18, pl. 11, fig.3.

1973 *Quisquilites widderensis* Legault, p.60, 61, pl. 11, fig. 17-21.

1974 *Navifusa drosera* Wicander, p.30, pl. 15, fig. 7-9.

1977 *Navifusa bacilla* (Deunff) Playford, p. 34, pl. 14, fig.5,6.

Description: Vesicle cylindrical or rodlike in form, with rounded edges. Eilyma single layered 1-2 μm thick, surface granulate, scabrate to psilate. Excystment opening consisting of a simple eilyma split.

Dimensions: Length 65-150 μm; 17 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VCo, VH, LE and LN Miospore Biozones).

Previous records: From Frasnian of southern Ontario (DEUNFF, 1967; LEGAULT, 1973), Devonian of Brasil (BRITO, 1967); Emsian to Upper Devonian of North Africa (JARDINÉ, 1972; JARDINÉ et al., 1974) and Upper Devonian of Ohio (WICANDER, 1974).

Genus PALACANTHUS Wicander emend. Sarjeant & Stancliffe, 1994

Type species: *Palacanthus lacutus* Wicander, 1974, by original designation

Palacanthus ledanoisii (Deunff) Playford, 1977

Plate 16, Figs.9-10

1957 *Veryhachium le danoisi* Deunff, p.9, fig.6.

1962 *Veryhachium stelligerum* auct. non Deunff; Stockmans & Willière, p. 85, pl1, fig. 8-10.

1966 *Veryhachium le danoisi* Deunff; Deunff, p. 54-55, Pl. 10, fig. 111.

1966 *Veryhachium cf. stelligerum* Deunff p. 78, Pl. 3, fig. 32, 35, 38, 39.

1974 *Estriastra pentagonalis* Pothe de Baldis, p. 371, Pl. 2, fig.5.

1977 *Palacanthus ledanoisii* (Deunff) Playford, pl. 14, figs. 1-10.

Description: Vesicle "star-shaped" in form, with 3-4 processes (commonly 3), disposed in the same plane. Eilyma single layered 0.5-1 μm thick, surface scabrate to psilate. Processes have broad, contiguous bases 5.0-10.0 μm diameter, interiors hollow and opening freely into central cavity. Processes attain lengths of 20.0-40.0 μm and taper to sharp or blunted, closed distal tips. Excystment opening consisting of a simple linear eilyma split.

Dimensions: Overall size 36-45 μm; 25 specimens.

Occurrence: Represa Formations of Pulo do Lobo and Phyllite-Quartzite Group Iberian Pyrite Belt.

Previous records: From Middle to Upper Devonian of Ontario (DEUNFF, 1957; PLAYFORD, 1977), Devonian of Tunisia (DEUNFF, 1966a), Brittany (Deunff, 1966b), Frasnian of Belgium (STOCKMANS & WILLIÈRE, 1962) and Middle Devonian of Paraguai (POTHE DE BALDIS, 1974), Upper Devonian of Australia (PLAYFORD & DRING, 1981) and Ohio, USA (WICANDER & WOOD, 1981). In Portugal, *P. ledanoisii* was recorded for the first time in the Represa Formation (CUNHA & OLIVEIRA, 1989)

Palacanthus tripus Martin, 1984

Plate 16, Figs.11-12

Description: Vesicle "star-shaped" in form, with 3 processes. Eilyma single layered 0.5-1 μm thick, surface scabrate to psilate. Processes have broad, contiguous bases and opening freely into central cavity. Processes of 48-50 μm in length and taper to sharp or blunted, closed distal tips. Excystment opening consisting of a simple linear eilyma split.

Dimensions: Overall size 65-150 μm; 7 specimens.

Occurrence: Represa Formations of Pulo do Lobo and Phyllite-Quartzite Group Iberian Pyrite Belt.

Previous records: From the Frasnian to Famennian of Belgium (MARTIN, 1984)and from the Upper Devonian of Represa Formation in São Domingos mine in Iberian Pyrite Belt, Portugal (CUNHA & OLIVEIRA, 1989).

Genus STELLINIUM Jardiné, Combaz, Magloire, Peniguel & Vachey, 1972

Type species: *Stellinium micropolygonale* (Stockmans & Willière) PLAYFORD, 1977; originally designated as *S. octoaster* (Staplin) JARDINÉ, COMBAZ, MAGLOIRE, PENIGUEL & VACHEY, 1972, by JARDINÉ et al. (1972, p. 298).

Stellinium comptum Wicander & Loeblich, 1977

Plate 16, Figs.14-15

1977 *Stellinium comptum* Wicander & Loeblich, p.151-152, pl. 9, fig.1-6.

Description: Vesicle quadrate in outline, with sraigth to moderate concave sides, 22.0-24.0 μm long. Eilyma psilate to slightly granulate, 0.5-0.8 μm thick. Vesicle interior prolonged outwards to form, at each of the vesicle corners, an elongate, hollow, 12.0-16.0 μm long processes, tapering from 4.0-5.0 μm wide base to simple closed distal tip. Two extra similar processes developed, arising from the vesicle surface. All processes with narrow, longitudinal ridge, converging with ridges of adjacent processes on the vesicle center. No excystment structure observed.

Dimensions: Overall diameter 22-32 μm; 34 specimens

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VH, LE and LN Miospore Biozones).

Previous records: From Givetian of North America (WICANDER & WOOD, 1981), from Frasnian-Famennian of USA (WICANDER & LOEBLICH, 1977) lower Famennian of Belgium (MARTIN, 1981), Upper Famennian to Strunian of Portugal (CUNHA & OLIVEIRA, 1989; PEREIRA, 1997).

Stellinium micropolygonale (Stockmans & Willière) Playford, 1977

Plate 16, Figs. 16-17

1960 *Micrhystridium micropolygonale* Stockmans & Willière, p. 4; pl. 1, fig. 12.

1977 *Stellinium micropolygonale* (Stockmans & Willière) Playford, p. 36; pl. 18, figs. 7-9.

For further synonymy see Playford (1977, p. 36).

Description: Vesicle originally polyhedral, outline stellate. Eilyma 0.5-0.8 μm thick, scabrate to slightly granulate, bearing 8-12 evenly distributed, hollow, conical processes, freely communicating with vesicle cavity; processes broadly based, 8-14 μm long, sharp to bluntly pointed distally. Each process possessing a narrow, 0.5 μm wide, medial-longitudinal ridge, converging with ridges of adjacent processes at the central point on the cyst surface. No excystment structure observed.

Dimensions: 30 - 55 μm; 82 specimens.

Occurrence: Horta da Torre, Sta Iria and Represa Formations of Pulo do Lobo, Phyllite-Quartzite Group and Volcano Sedimentary Complex of Iberian Pyrite Belt and Tercenas and Bordalete Formations of SWP Domain (VH, LE, LN and VI Miospore Biozones).

Previous records: Widely distributed in both northern and southern hemispheres, ranging through much of the Devonian (e.g., PLAYFORD, 1976; WICANDER & WOOD, 1981; CUNHA & OLIVEIRA, 1989; GONZÁLEZ et al., 2005) to Lower Carboniferous (MCNESTRY, 1988; PEREIRA, 1997).

Genus UMBELLASPHAERIDIUM Jardiné, Combaz, Magloire, Peniguel & Vachey, 1972

Type species: *Umbellasphaeridium saharicum* Jardiné, Combaz, Magloire, Peniguel & Vachey, 1972; by original designation.

Umbellasphaeridium deflandrei (Moreau-Benoit) Jardiné, Combaz, Magloire, Peniguel & Vachey, 1972

Plate 16, Fig. 19

1964 *Hystricosphaeridium* sp. in Regali, p.176, fig.8.

1967 *Archaeohystrichosphaeridium deflandrei* Moreau-Benoit, p. 203; pl. 1, figs. 22, 23.

1972 *Umbellasphaeridium deflandrei* (Moreau-Benoit) Jardiné, Combaz, Magloire, Peniguel & Vachey, p. 303; pl. 3, figs. 2, 3.

1976 *Archaeohystrichosphaeridium deflandrei* Moreau-Benoit in Moreau-Benoit, p.203, pl. 1, fig.22,23.

Description: Vesicle originally spherical, outline circular to subcircular. Eilyma 2.0 μm thick, psilate. More than 20 processes, discrete, hollow, freely communicating with vesicle interior, bases rounded (2.0-3.0 μm in diameter), overall length 4-8 μm; form of small processes umbrellate, with trunk tapering slightly to terminate distally as a shallow, distally expanded, small colar structure. No excystment structure observed.

Dimensions: Vesicle diameter 28-50 μm; 12 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain.

Previous records: From Emsian to Strunian (WOOD, 1984). In Portugal, *U. deflandrei* was firstly reported in PEREIRA (1999) and PEREIRA et al. (2007).

Umbellasphaeridium saharicum Jardiné, Combaz, Magloire, Peninguel & Vachey, 1972

Plate 16, Fig.18

1964 *Hystricosphaeridium* sp. in Regali, p. 176, fig.8.

1964 *Hystricosphere* in Wray, pl. 1, fig. 3.

1965 *Hystricosphaeridium* sp. in Brito, p. 2, pl. 1, fig. 5-8.

1972 *Umbellasphaeridium saharicum* Jardiné, Combaz, Magloire, Peninguel & Vachey, pl. 22, fig. 11, 12; pl. 3, fig. 1.

Description: Vesicle originally spherical, outline circular to subcircular. Eilyma 0.5-0.8 μm thick psilate. Processes 4-10 in number, discrete, psilate, hollow, evenly distributed, freely communicating with vesicle interior, bases rounded (2-3 μm in diameter), overall length 7-15 μm; form of processes umbrellate, with trunk tapering slightly to terminate distally as a shallow, distally expanded, funnel-like structure, up to 5 μm in maximum diameter and showing some variation on given specimen. No excystment structure observed.

Dimensions: Vesicle diameter 28-50 μm; 12 specimens.

Occurrence: Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain.

Previous records: This distinctive species has been widely reported, with a range of Emsian through Famennian (WOOD, 1984), and in the Famennian to Strunian of Portugal (CUNHA & OLIVEIRA, 1989; PEREIRA, 1995, 1997).

Genus UNELLIUM Rauscher, 1969

Type species: *Unellium piriforme* Rauscher, 1969; by original designation.

Unellium piriforme Rauscher, 1969

Plate 17, Fig. 1

1969 *Unellium piriforme* Rauscher, p. 35-36, figs. 1-6.

1974 *Unellium ampulium* Wicander, p. 34; pl. 18, figs. 7-9.

Description: Vesicle originally spheroidal, piriform to oval in outline. Eilyma thin, 0.2-0.5 μm, laevigate to faintly scabrate. Two distinct types of processes; a single, relatively large major process (9-15 μmlong and 3-6 μm in basal diameter) and a variable number (13-22) of less substantial minor proceses (6-12 μm long and basal diameter 2-3 μm). All processes spine like, discrete, hollow, freely communicating with vesicle interior, tapering from near circular bases to distally simple acuminate. No excystment structure observed.

Dimensions: Overall diameter 29-47 μm; 16 specimens.

Occurrence: Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VH and LN Miospore Biozone).

Previous records: As summarized by PLAYFORD & MCGREGOR (1993), this species has been widely reported from Middle Devonian to (probably) Lower Carboniferous rocks. In Portugal, this specie is reported from the Strunian (CUNHA & OLIVEIRA, 1989).

Genus VERYHACHIUM Deunff ex Downie 1959 emend. Sarjeant & Stancliffe, 1994

Type species: *Veryhachium trisulcum* (Deunff) Deunff, 1959; by subsequent designation of Downie (1959, p. 62).

Veryhachium downiei Stockmans & Willière, 1962

Plate 17, Figs.2-4

1962 *Veryhachium downiei* Stockmans & Willière, p.47-48, pl. 2, fig.20-22.

Description: Vesicle triangular in outline, with straight to slightly concave sides. Eilyma 0.4-0.5 μm thick, laevigate. Three simple, tapering, spine-like processes, 5-28 μm in length, drawn out from each vesicle corner. Excystment by formation of an epityche.

Dimensions: Overall size 15-32 μm; 62 specimens.

Occurrence: Horta da Torre, Sta Iria, Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group and Volcano-sedimentary Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VH and LN Miospore Biozone).

Previous records: This species has been widely reported from Middle Devonian to Lower Carboniferous rocks (PLAYFORD, 1977, WICANDER & LOEBLICH, 1977 and PLAYFORD & MCGREGOR, 1993). In Portugal, this specie is reported from the Famennian to Strunian (CUNHA & OLIVEIRA, 1989; OLIVEIRA et al., 2006; PEREIRA, 1997; PEREIRA et al., 2006).

Veryhachium pannuceum Wicander & Loeblich, 1977

Plate 17, Figs.5-7

1977 *Veryhachium pannuceum* Wicander & Loeblich, p. 156; pl. 10, fig. 4.

Description: Vesicle triangular in outline, with straight to concave or slightly convex sides. Eilyma, psilate or scabrate, 0.4-0.6 μm thick. Three simple, coplanar, tapering, spine-like processes (length 7-10 μm, basal diameter 1.5-2.5 μm) drawn out from each vesicle corner, psilate to scabrate, hollow, opening into vesicle cavity. Eilyma surface modified by low, narrow folds (up to 1.5 μm wide), paralleling vesicle margin and extending to vesicle corners, locally onto proximal process contacts. No excystment structure observed.

Dimensions: Overall size 25 - 38 μm; 17 specimens.

Occurrence: Horta da Torre, Sta Iria, Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group and Volcano-sedimentary Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VCo, VH and LN Miospore Biozone).

Previous records: From the Frasnian-Famennian of Indiana, U.S.A. (WICANDER & LOEBLICH, 1977) and Famennian of Portugal, North Africa and Spain (CLAYTON et al., 2002; GONZÁLEZ et al., 2005).

Veryhachium polyaster Staplin, 1961

Plate 17, Fig.8

1961 *Veryhachium polyaster* Staplin, p. 413; pl. 49, fig. 20.

1961 *Veryhachium polyaster* var. *hexaster* Staplin, p. 413; pl. 49, fig. 19.

Description: Vesicle quadrate in outline, with slightly concave sides. Eilyma, 0.5-0.8 μm thick, psilate to minutely granulate, with 5-7 spine-like, straight to slightly curved processes, 4 of which are drawn out from each vesicle corner in the same plane, with the other or others arising perpendicularly to that plane. Processes 21.0-28.0 μm in length, psilate, hollow, communicating with vesicle cavity, with broad bases 4.0-9.0 μm in diameter, and tapering to simple acuminate distal ends. No excystment structure observed.

Dimensions: 60-75 μm; 11 specimens

Occurrence: Horta da Torre, Sta Iria, Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group and Volcano-sedimentary Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VCo, VH and LN Miospore Biozone).

Previous records: From the Frasnian to Famennian of Canada (STAPLIN, 1961; PLAYFORD& MCGREGOR, 1993); Givetian to Famennian of North America (PLAYFORD, 1977; WICANDER & LOEBLICH, 1977; WICANDER & WOOD, 1981; WICANDER & PLAYFORD, 1985), Frasnian of Western Australia (PLAYFORD, 1981), Famennian to Strunian of Portugal and Spain (CLAYTON et al., 2002; GONZÁLEZ et al., 2005).

Veryhachium trispinosum (Eisenack) Stockmans & Willière, 1962 "complex"

Plate 17, Figs.9-11

1938 *Hystrichosphaeridium trispinosum* Eisenack, pp. 14, 16; text-figs. 2, 3.

1954 *Veryhachium trispinosum* (Eisenack) Deunff, p. 306. [combination invalid: I.C.B.N., Article 33.2]

1962 *Veryhachium trispinosum* (Eisenack) Stockmans & Willière, pp. 46-47; pl. II, figs. 25, 26; text-fig. 1. [1962a]

1981 *Veryhachium trispinosum* (Eisenack) auct. non Deunff, 1954 "complex"; Wicander & Wood, pp. 67-71; pl. 17, fig. 8.

For complete synonymy see Wicander & Wood (1981, pp. 67-70).

Description: Vesicle triangular in outline, with slightly concave to slightly convex sides of equal or near-equal length. Eilyma 0.5-0.7 μm thick, psilate. Vesicle cavity extending laterally at each vesicle corner to form a psilate, straight to somewhat curved, spine-like, tapering, hollow process freely communicating with vesicle interior. Processes 1.5-2.5 μm basal diameter, 7-35 μm long. Excystment by epityche.

Dimensions: Vesicle diameter 13 (21) 33 μm; 48 specimens.

Remarks: Specimens recovered in the SPZ appear to intergrade between *Veryhachium trispinosum* (Eisenack) Stockmans & Willière, 1962 and *V. downiei* Stockmans & Willière, 1962.

Occurrence: Horta da Torre, Sta Iria, Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group and Volcano-sedimentary Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VCo, VH and LN Miospore Biozone).

Previous records: Numerous reports from Silurian, Devonian, and Carboniferous strata, connote a cosmopolitan stratigraphic distribution.

Veryhachium sp. A

Plate 17, Figs.12-13

Description: Vesicle triangular in outline, with straight to concave or slightly convex sides. Eilyma, psilate or scabrate, 0.4-0.6 μm thick. Three simple, coplanar, tapering, spine-like processes (length 7-10 μm, basal diameter 1.5-2.5 μm) drawn out from each vesicle corner, psilate to scabrate, hollow, opening into vesicle cavity. Eilyma surface marked by low, narrow folds (up to 1.0-1.5 μm wide), extending from centre vesicle to vesicle corners, close by onto proximal process contacts. No excystment structure observed.

Dimensions: 22 - 35 μm; 16 specimens.

Occurrence: Horta da Torre, Sta Iria, Represa Formation of Pulo do Lobo (VH Miospore Biozone).

Genus WINWALOEUSIA Deunff, 1977

Type species: *Winwaloeusia distracta* (Deunff) Deunff, 1977; by original designation.

Winwaloeusia repagulata González, Moreno & Playford, 2005

Plate 17, Figs.14-15

Description: Vesicle rectangular in outline with concave sides. Eilyma thin (up to 0.5 μm thick), psilate to scabrate. Four processes, 10-15 μm in length and 2.5-3.5 μm basal diameter, homomorphic, spine-like, hollow, psilate, radiate from each vesicle corner in same plane and freely communicating with vesicle interior. Each vesicle face bearing 3 narrow ridges (2-2.5 μm high), 2 ridges disposed symmetrically in relation to the longitudinal vesicle axis, the third ridge extending from the junction of the other 2 ridges along the longitudinal axis to the closest transverse side of the vesicle. Excystment structure consisting of a simple split developed at opposite transverse side.

Dimensions: 21- 41 μm; 34 specimens.

Occurrence: Represa Formation of Pulo do Lobo, Phyllite-Quartzite Group of Iberian Pyrite Belt and Tercenas Formation of SWP Domain (VH and LN Miospore Biozone).

Previous records: From the Upper Devonian of Iberian Pyrite Belt in Spain (GONZÁLEZ et al., 2005) and Portugal (PEREIRA, 1997, classified as *W. ranulaeforma*).

REFERENCES

Note: In accordance with conventional practice, the listing below excludes "taxa-only references", the references that appear in addition to the taxonomic names (e.g., CALAMOSPORA Schopf, Wilson & Bentall, 1944).

ABDESSELAM-ROUIGHI, F. (1996). Biostratigraphie des spores du Dévonien de la synéclise Illizi-Ghadamès, Algérie, Bulletin du Service Géologique de l'Algérie, 7, pp. 171–209.

ABDESSELAM-ROUIGHI, F.F., COQUEL, R. (1997). Palynologie du Devonien terminal. Carbonifère inférieur dans le sud-est du bassin d'Illizi (Sahara algérien): position des premières lycospores dans la série stratigraphique. Annales de la Société Géologique du Nord 5, 2, pp. 47–57.

AL-GHAZI (2007). New evidence for the Early Devonian age of the Jauf Formation in northern Saudi Arabia. Revue de Micropaléontologie, 50, 1, pp. 59-72.

ALLEN, K.C. (1965). Lower and Middle Devonian spores of north and central Vestspitsbergen. Palaeontology, 8, pp. 687-748.

ALLEN, K.C. (1967). Spore assemblages and their stratigraphical application in the Lower and Middle Devonian of north and central Vestspitsbergen. Palaeontology, 10, pp. 280-297.

ALLEN, K.C. (1973). Further information on the Lower and Middle Devonian spores from Dickson Land, Spitsbergen. Norsk Polarinstitut Arbok, 1971, pp. 43-54.

ALLEN, K.C. (1982). Samarisporites triangulatus Allen, 1965, an important Devonian miospore, and its synonymous species. Pollen et Spores, 24, pp. 157-166.

ALPERN, B., DOUBINGER, J., LIABEUF, J.J. (1970). Bases logiques et données objectives de la classification des monolètes. C.R. VI Int. Cong. Carb. Strat. Geol., Sheffield, 1967, I, pp. 377-387.

ALVES, P., JOUBERT, M., LECA, X. (1985). Notice explicative du levé géologique au 1/25000. Rel. Técnico Consórcio Grândola (SPE/SEREM/EDMA), Arq. INETI, 29 pp.

AMENABAR, C. (2006). Significado estratigráfico de palinomorfos retrabajados en la Formación Malimán (Viseano) en la Sierra del Volcán, Provincia de San Juan, Argentina: resultados preliminares. Revista Brasileira de Paleontologia 9, 1, pp. 21-32.

ANDRADE R., SCHERMERHORN, L. (1971). Aljustrel and Gavião. In: Carvalho, D., Goinhas, J., Schermerhorn, L.J.S., (Eds.,). Livro guia da excursão 4. I Congresso Hipano-Luso-Americano de Geologia Económica, 32-59.

ATTA-PETERS, D., ANAN-YORKE, R. (2003). Latest Devonian and Early Carboniferous pteridophytic spores from the Sekondi Group of Ghana. Revista Española de Micropaleontología, 35, pp. 9-27.

ATTAR, A., FOURNIER, J., CANDILIER, A.M., COQUEL, R. (1980). Étude palynologique du Dévonien terminal et du Carbonifère Inférieur du Bassin d'Illizi (Fort-Polignac) Algérie. Revue de l'Institut Français du Pétrole, 23, pp. 585-619.

AVCHIMOVITCH, V.I. (1986). Zonal differentiation and correlation of the Devonian/Carbonife-rous boundary deposits in Byelorussia (Pripyat Depression) with the standard sections in the Franco-Belgian Basin by spores. In: Palaeontology and its role in the knowledge of the geological structure of Byelorussia. Nauka i Teknika, pp. 145-165 (in Russian).

AVCHIMOVITCH, V.I. (1993). Zonation and spore complexes of the Devonian and Carboniferous boundary deposits of the Pripyat Depression (Byelorussia). Annales de la Société Géologique de Belgique, 115, pp. 425- 451. (imprinted 1992)

AVCHIMOVITCH, V.I., BYVSHEVA, T.V., HIGGS, K., STREEL, M., UMNOVA, V.T. (1988). Miospore systematics and stratigraphic correlation of Devonian-Carboniferous boundary deposits in the European part of the USSR and western Europe. Courier Forschungs Institut Senckenberg, 100, pp. 169-191.

AVCHIMOVITCH, V.I., TCHIBRIKOVA, E.V., OBUKHOVSKAYA, T.G., NAZARENKO, A.M., UMNOVA, V.T., RASKATOVA, L.G., MANTSUROVA, V. N., LOBOZIAK, S., STREEL, M. (1993). Middle and Upper Devonian miospore zonation of eastern Europe. Bulletin des Centres de Recherches Exploration-Production Elf Aquitaine, 17, pp. 79- 147.

AZCUY, C.L. , OTTONE, E.G. (1987). Datos palinológicos de la Formación Retama en la Encañada de Beu, Rio Alto Beni (Bolivia). IV Congreso Latinoamericano de Paleontología, Santa Cruz de la Sierra, 1, pp. 235-249.

BAIN, A., DOUBINGER, J. (1965). Étude d'un microplancton (acritarches) du Dévonien Supérieur des Ardennes. Bulletin du Service de la Carte Géologique d'Alsace Lorraine, 18, pp. 15-30.

BALME, B.E. (1962). Upper Devonian (Frasnian) spores from the Carnarvon Basin, Western Australia. The Palaeobotanist, 9, pp. 1-10.

BALME, B.E. (1988). Teichertospora n. gen., an endoreticulate miospore from the Late Devonian of Western Australia. Senckenbergiana Lethaea., 69, pp. 159-169.

BALME, B.E., HASSELL, C.W. (1962). Upper Devonian spores from the Canning Basin, Western Australia. Micropaleontology, 8, pp. 1-28.

BARRIE, C., AMELIN, Y., PASCUAL, E. (2002). U-Pb geochronology of VMS mineralization in the Iberian Pyrite Belt. Mineralium Deposita 37/8, 684-703. Barriga, F., 1983. Hydrotermal metamorphism and ore génesis at Aljustrel, Portugal. PhD Thesis, University Western Ontario, London, 368 pp.

BARRIGA, F. (1983). Hydrotermal metamorphism and ore génesis at Aljustrel, Portugal. PhD Thesis, University Western Ontario, London, 368 pp.

BARRIGA, F., CARVALHO, D., RIBEIRO, A. (1997). Introdution to the Iberian Pyrite Belt. SEG Neves Field Conference. Guidebook Series, 27, pp. 1-20.

BERTELSEN, F. (1972). A Lower Carboniferous microflora from the Ørslev No. 1 borehole, Island of Falster, Denmark. Danmark Geologiske Undersogelse 2 rk, 99, pp. 1-78.

BOOGAARD, M. (1967). Geology of Pomarão region (Southern Portugal). Thesis. Graffisch Centrum Deltro. Rotterdam.

BOOGARD, M., SCHERMERHORN, L.J.G. (1981). Conodont faunas from Portugal and Southwestern Spain. Part 6. A Lower Famennian conodont faunas at Monte Forno da Cal (South Portugal). Scripta Geol. 63, pp. 1-16.

BOUCKAERT, J., STREEL, M., THOREZ, J. (1969). Biostratigraphic chart of the Famennian stage (Upper Devonian) in the type localities of Belgium; a preliminary report. Journal of Paleontology, 43, pp. 727-734.

BREUER P., DISLAIRE G., FILATOFF J., PIRARD E., STEEMANS P. (2007). A classification of spores by support vectors based on an analysis of their ornament spatial distribution. An application to Emsian miospores from Saudi Arabia. In: STEEMANS, P., JAVAUX, E. (Eds.), Recent Advances in Palynology. Carnets de Géologie / Notebooks on Geology, Brest, Memoir 2007/01, Abstract 02, pp. 11-17 (CG2007_M01/01).

BRITO, I.M. (1965a). Novos microfósseis Devonianos do Maranhão. Escola de Geologia, Universidade da Bahia, Publicação Avulsa, 2, pp. 1-4.

BRITO, I.M. (1965b). Nota prévia sôbre os microfósseis Devonianos de Pernambuco. Escola de Geologia, Universidade da Bahia, Publicação Avulsa, 3, pp. 1-8.

BRITO, I.M. (1967a). Silurian and Devonian Acritarcha from Maranhão, Brazil. Micropaleontology, 13, pp. 473-482.

BRITO, I.M. (1967b). Nôvo subgrupo de Acritarcha do Devoniano do Maranhão Escola de Geologia, Universidade da Bahia, Publicação Avulsa, 39, pp. 163-166.

BRITO, I.M. (1976). Contribuição ao conhecimento dos microfósseis Devonianos de Pernambuco. III Alguns Acritarcha comuns aos do Devoniano do Saara. Anais da Academia Brasileira de Ciências, 48, pp. 747-756.

BRITO, I.M. (1978). Maranhites, um importante fóssil índice do Devoniano Superior (Acritarcha Scutellomorphitae). In: Advances in palaeobotany and allied sciences in Brazil (O. Rösler, Ed.). Instituto de Geociências, Universidade de São Paulo, 9, pp. 80-85.

BRITO, I.M., QUADROS, L.P. (1984). Novas ocorrências de acritarchae no Devoniano da Bacia do Parnaíba. Boletim, Instituto de Geociencias. Universidade de São Paulo, Paleobotânica e Palinologia na América do Sul (1983), pp. 15-19.

BRITO, I.M., SANTOS, A.S. (1965). Contribuiçao ao conhecimento dos microfósseis Silurianos e Devonianos da Bacia do Maranhão. I. Os Netromorphitae (Leiofusidae). Departamento Nacional de Produçao Mineral, Dovisão de Geologia e Mineralogia, Notas Preliminares e Estudios, 129, pp. 1-29.

BURJACK, M.I.A., OLIVEIRA, S.F. (1989). Contribuição ao conhecimento morfológico e sistemático do género Maranhites Brito. Boletim, Instituto de Geociencias. Universidade de São Paulo. Publicação Especial, 7, pp. 45-67.

BUTERWORTH M.A., WILLIAMS R.W. (1958). The small spore floras of coals in the Limestone Coal Group and Upper Limestone Group of the Lower Carboniferous of Scotland. Trans. Royal Soc. Edinb., 63, pp. 353-392.

BYVSHEVA, T.V. (1976). Zonal complexes of spores in the Devonian-Carboniferous boundary deposits in the eastern region of the Russian Plate. Trudy Vsesoiuznogo. Nauchno-Issledovatel'skogo Geologaraz-vedochnogo Neftianogo Institut, 192, pp. 67-93. (in Russian)

BYVSHEVA, T.V. (1985). Spores in deposits of the Tournaisian and Viséan stages, Russian Platform. In: Atlas of spores and pollen in oil- and gas-bearing Phanerozoic rocks of the Russian and Turanian Plates (V.V. Menner, T.V. Byvsheva, Eds.). Trudy Vsesoiuznogo. Nauchno-Issledovatel'skogo Geologaraz-vedochnogo Neftianogo Institut, 253, pp. 80-158 (in Russian).

BYVSHEVA, T.V., HIGGS, K., STREEL, M. (1984). Spore correlations between the Rhenish Slate Mountains and the Russian Platform near the Devonian-Carboniferous boundary. Courier Forschungs Institut Senckenberg, 67, pp. 37-45.

CARVALHO, D. (1976). Considerações sobre o vulcanismo de Cercal - Odemira: Suas relações com a Faixa Piritosa, Comunicações dos Serviços Geológicos de Portugal, pp. 215-238.

CARVALHO, D., CORREIA, M., INVERNO, C. (1976). Contribuição para o conhecimento geológico do Grupo Ferreira-Ficalho. Suas relações com a Faixa Piritosa e o Grupo do Pulo do Lobo. Mem. Not. Mus. Lab. Min. Fac. Cienc. Coimbra, 82, pp. 145-169.

CARVALHO, D., BARRIGA, F.J.A., MUNHÁ, J. (1999). Bimodal-siliciclastic systems. The case of the Iberian Pyite Belt. In: BARRIE, T. & HANNINGTON, M. (eds). Volcanic - Associated Massive Sulfide Deposits: Processes and Examples in Modern and Ancient Settings. Reviews in Economic Geology, 8, 16, pp. 375-408.

CHATEAUNEUF, J., REYRE, Y. (1974). Éléments de Palynology. Applications géologiques. 1ere Ed. Laboratoire de Paléontologie de L'Université de Genéve. Genéve. 345 pp.

CLAYTON, G. (1971). A Lower Carboniferous miospore assemblage from the Calciferous Sandstone Measures of the Cockburnspath region of Eastern Scotland. Pollen et Spores, 12, 4, pp. 578-600.

CLAYTON, G. (1985). Dinantian Miospores and intercontinental correlation. C.R. 10e, International Congress Stratigraphy Geology Carboniferous, Madrid 1983, 1, pp. 9-23.

CLAYTON, G. (1986). Late Tournaisian miospores from the Ballycultra Formation at Cultra, County Down, Northern Ireland. Irish Journal of Earth Sciences, 8, pp. 73-79.

CLAYTON, G. (1995). Carboniferous miospore and pollen assemblages from the Kingdom of Saudi Arabia. Review of Palaeobotany and Palyno-logy, 89, pp. 115-123.

CLAYTON, G. (1996). Mississippian Miospores. In: Palynology: Principles and applications. JANSONIUS J., MCGREGOR D.C, (eds.), American Association of Stratigraphic Palynologist, Found, Vol. 2, pp. 589-596.

CLAYTON, G., HIGGS, K. (1979). The Tournaisaian marine transgression in Ireland. Irish J. Earth Sci., 2, pp. 1-10.

CLAYTON, G., HIGGS, K., KEEGAN, J.B. (1977). Late Devonian and Early Carboniferous occurrences of the miospore genus *Emphanisporites* McGregor in southern Ireland. Pollen et Spores, 19, pp. 415-425.

CLAYTON, G., COQUEL, R., DOUBINGER, J., GUEINN K.J., LOBOZIAK, S., OWENS B, STREEL M. (1977). Carboniferous Miospores of Western Europe: illustration and zonation. Meded. Rijks Geol. Dienst 29, pp. 1-71.

CLAYTON, G., HIGGS, K., KEEGAN, J.B., SEVASTOPULO, G.D. 1978. Correlation of the palynological zonation of the Dinantian of the British Iles. Palinología, Número extraord. 1, pp. 137-147. (Coloq. Internacional de Palinologia, I°, Léon, 1977).

CLAYTON, G., JOHNSTON, I.S., SEVASTOPULO, G.D., SMITH, D.G. (1980). Micropalaeontology of a Courceyan (Carboniferous) borehole section from Ballyvergin, County Clare, Ireland. Journal of Earth Sciences (Royal Dublin Society), 3, pp. 81-100.

CLAYTON, G., KEEGAN, J.B., SEVASTOPOULO, G.D. (1982). Palynology and stratigraphy of Late Devonian and Early Carboniferous rocks, Ardmore, County Waterford, Ireland. Pollen et Spores, 24, pp. 511-521.

CLAYTON, G., LOBOZIAK, S. (1985). Early Carboniferous (early Viséan-Serpukhovian) palynomorphs. In: Palynostratigraphy of north-east Libya. B. Thusu, B. Owens. (eds.). Journal of Micropalaeontology, 4, pp. 83- 101.

CLAYTON, G., LOBOZIAK, S., STREEL, M., TURNAU, E., UTTING, J. (1991). Palynological events in the Mississippian (Lower Carboniferous) of Europe, North Africa and North America. Courier Forschungs Institut Senckenberg, 130, pp. 79-84.

CLAYTON, G., MANGER, W.L., OWENS, B. (1998). Mississippian (Lower Carboniferous) miospores from the Cuyahoga and Logan Formations of northeastern Ohio, U.S.A. Journal of Micropalaeontology, 17, pp. 183-191.

CLAYTON, G., MCCLEAN, D., OWENS, B. (2003). Carboniferous palinostratigraphy: recent developments in Europe (Abstract 103). International Congress on Carboniferous and Permian Stratigraphy, Utrecht, August 2003.

CLAYTON, G., OWENS, B., AL-HAJRI, S., FILATOFF, J. (2000). Latest Devonian and Lower Carboniferous miospore assemblages from Saudi Arabia. In: Stratigraphic palynology of the Palaeozoic of Saudi Arabia. S. Al-Hajri, B. Owens (eds.). Special GeoArabia Publications, 1, pp. 146-153.

CLAYTON, G., WICANDER, R., PEREIRA, Z. (2002). Palynological evidence concerning the relative positions of northern Gondwana and southern Laurussia in latest Devonian and Mississippian times. Special Papers in Palaeontology, 67, pp. 45-56.

CLENDENING, J.A., EAMES, L.E., WOOD, G.D. (1980). Retusotriletes phillipsii n. sp., a potential Upper Devonian guide palynomorph. Palynology, 4, pp. 15-22.

COLBATH, G.K. (1990). Devonian (Givetian-Frasnian) organic-walled phytoplankton from the Limestone Billy Hills reef complex, Canning Basin, Western Australia. Palaeontographica, Abt. B, 217, pp. 87-145.

COLBATH, G.K. (1996). Green and blue-green algae, introduction. In: Palynology: principles and applications (J. Jansonius, D.C. McGregor. (eds.). American Association of Stratigraphic Palynologist Foundation, 1, pp. 171-172.

COLEMAN, U., CLAYTON, G. (1987). Palynostratigraphy and palynofacies of the uppermost Devonian and lower Mississippian of Kentucky (U.S.A.) and correlation with western Europe. Courier Forschungs Institut Senckenberg , 98, pp. 75-93.

COMBAZ, A., STREEL, M. (1970). Microfossiles végétaux du Tournaisien inférieur dans le 'core drill' de Brévillers (Pas-de-Calais, France). Congrès et Colloques Universite de Liège, 55, pp. 227-240.

COQUEL, R., ABDESSELAM-ROUIGHI, F. (2000). Révision palynostratigraphique du Dévonien terminal-Carbonifère Inférieur dans le Grand Erg occidental (Bassin de Béchar), Sahara algérien. Revue de Micropaléontologie, 43, pp. 353-364.

COQUEL, R., LATRECHE, S. (1989). Etude palynologique de la Formation d'Illerène (Dévono-Carbonifère) du Bassin d'Illizi (Sahara algérien oriental). Palaeontographica Abt. B, 212, pp. 47-70.

COQUEL, R., LOBOZIAK, S., STAMPFLI, G., STAMPFLI-VUILLE, B. (1977). Palynologie du Dévonien Supérieur et du Carbonifère Inférieur dans l'Elburz oriental (Iran Nord-est). Revue de Micropaléontologie, 20, pp. 59-71.

COQUEL, R., MOREAU-BENOIT, A. (1986). Les spores dês séries struniennes et tournaisiennes de Libye occidentale. Revue de Micropaléontologie, 29, pp. 17-43.

CRAMER, F.H. (1964). Microplankton from three Palaeozoic formations in the Province of León, NW-Spain. Leidse Geologische Mededelingen, 30, pp. 253-361.

CRAMER, F.H. (1970). Distribution of selected Silurian acritarchs. An account of the palynostratigraphy and paleogeography of selected Silurian acritarch taxa. Revista Española de Micropaleontología, número extraordinario, 1, pp. 1-203.

CUNHA T., OLIVEIRA J. T. (1989). Upper Devonian Palynomorphs from the Represa and Phyllite-Quartzite Formation, Mina de São Domingos region, Southwest Portugal. Tectonostratigraphic implications. Bull. Société Belge Géol., 98, 3/4, pp. 295-309.

DAEMON, R.F. (1974). Palinomorfos-guias do Devoniano Superior e Carbonifero Inferior das bacias do Amazonas e Parnaíba. Anais da Academia Brasileira de Ciências, 46, pp. 549-587.

DAWSON, G., CAESSA, P., ALVERCA R., SOUSA, J. (2001). Geology of the Aljustrel Mine area, southern Portugal. Geode workshop "Massive sulphide deposits in the Iberian Pyrite Belt: New advances and comparisons with equivalent Systems". Aracena, Spain.

DEFLANDRE, G. (1945). Microfossiles des calcaires siluriens de la Montagne Noire. Annales de Paléontologie, 31, pp. 38-75.

DEFLANDRE, G. (1954). Systématique des hystrichosphaeridés: sur l'acception du genre Cymatiosphaera O. Wetzel. Compte Rendu Sommaire des Séances de la Sócieté Geologique de France, 4, pp. 257-258.

DETTMANN, M.E. (1963). Upper Mesozoic microfloras from south-eastern Australia. Proceeding of the Royal Society of Victoria, 77, pp. 1-148.

DEUNFF, J. (1954). Veryhachium, genre nouveau d'hystrichosphères du Primaire. Compte Rendu Sommaire des Séances de la Sócieté Geologique de France, 13, pp. 305-307.

DEUNFF, J. (1955). Un microplancton fossile Dévonien à hystrichosphères du continent Nord-Américain.

Bulletin de Microscopie apliquée, sér. 2, 5, pp. 138-149.

DEUNFF, J. (1964). Le genre Duvernaysphaera Staplin. Grana Palynologica, 5, pp. 210-215.

DEUNFF, J. (1966)a. Acritarches du Dévonien de Tunisie. Compte Rendu Sommaire des Séances de la Sóciété Geologique de France, 1, pp. 22-24.

DEUNFF, J. (1966)b. Un microplancton à hystrichosphères dans le Trémadoc du Sahara. Revue de Micropaléontologie, 4,1, pp. 37–52.

DEUNFF, J. (1977). Winwaloeusia, genre nouveau d'Acritarche du Dévonien. Géobios, 10, pp. 465-469.

DOLBY, G. (1970). Spore assemblages from the Devonian-Carboniferous transition measures in southwest Britain and southern Eire. Congrès et Colloques Universite de Liège, 55, pp. 267-274.

DUEÑAS, H., CÉSARI, S.N. (2006). Palynological evidence of Early Carboniferous sedimentation in the Llanos Orientales Basin, Colombia, Review of Palaeobotany and Palynology, 138, pp. 31–42.

EDEN, C. P. (1991). Tectonostratigraphic analysis of the Northern Extent of the Oceanic Exotic Terrane, Northwestern Huelva Province, Spain. PhD thesis. Univ. Southampton, 281 pp.

EISENACK, A., CRAMER, F.H., DIEZ, M. DEL C.R. (1979). Katalog der fossilen Dinoflagellaten, Hystrichosphäeren und verwandten Mikrofossilien. Band V, Acritarcha, 3. Teil. E. Schweizerbart'sche Verlagsbuchhandlung, 529 pp.

FANTINET, D. (1971). Mise en evidence d'un chevauchement d'age varisque et étude de ses déformations ultérieures (région de Mértola, Baixo Alentejo, Portugal). C.R. Heebr. Scéanc. Academ. Sci. Paris. Ser. D.- Sciences Naturelles, 272, pp. 3122-3125.

FANTINET, D., DRESSEN, R., DUSAR, M., TERMIER, G. (1976). Faunes famenniennes de certains horizons calcaires dans la formation quatzitophylladique aux environs de Mértola (Portugal méridional). Comunicações Serviços Geológicos de Portugal, 60, pp. 121-138.

FELIX, C.J., BURBRIDGE, P.P. (1967). Palynology of the Springer Formation of southern Oklahoma, U.S.A. Palaeontology, 10, pp. 349-425.

FENSOME, R.A., WILLIAMS, G.L., BARSS, M.S., FREEMAN, J.M., HILL, J.M. (1990). Acritarchs and fossil prasinophytes: an index to genera, species and intraspecific taxa. American Association of Stratigraphic Palynologist, Contribution Series, 25, 771 pp.

FILIPIAK, P. (2004). Miospore stratigraphy of upper Famennian and Lower Carboniferous deposits of the Holy Cross Mountains (central Poland). Review of Palaeobotany and Palynology, 128, pp. 291-322.

FILIPIAK, P. (2005). Late Devonian and Early Carboniferous acritarchs and prasinophytes from the Holy Cross Mountains (central Poland), Review of Palaeobotany and Palynology 134 (1–2), pp. 1–26.

FONSECA, P., RIBEIRO, A. (1993). Tectonics of the Beja-Acebuches Ophiolite: a major suture in the Iberian Variscan Foldbelt. Geol. Rundsch, 82, pp. 440-447.

FOSTER, C.B., BALME, B.E. (1994). Ultrastructure of Teichertospora torquata (Higgs) from the Late Devonian: oldest saccate palynomorph. In: Ultrastructure of fossil spores and pollen. M.H. Kurmann, J.A. Doyle. (eds.). Royal Botanical Gardens, London, 87-97.

GHAVIDEL-SYOOKI, M. (1995). Palynostratigraphy and palaeogeography of a Palaeozoic sequence in the Hassanakdar area, Central Alborz Range, northern Iran. Review of Palaeobotany and Palynology, 86, 1-2, pp. 91-109

GHAVIDEL-SYOOKI, M. (2001). Palynostratigraphy and paleogeography of the Late Devonian in northeastern Esfahan City, central Iran. In: Proceedings of the IX International Palynological Congress, Houston, Texas, U.S.A., 1996. D.K. Goodman, R.T. Clarke. (eds.). American Association of Stratigraphic Palynologist Foundation, pp. 37-51.

GHAVIDEL-SYOOKI, M. (2003). Palynostratigraphy of Devonian sediments in the Zagros Basin, southern Iran. Review of Palaeobotany and Palynology, 127, pp. 241-268.

GIESE, V., REITZ, E., WALTER, R. (1988). Contributions to the stratigraphy of the Pulo do Lobo succession in Southwest Spain. Comunicações Serviços Geológicos de Portugal, 74, pp. 79-84.

GONZALEZ, F., MORENO, C., SAEZ, R., CLAYTON, G. (2002). Ore genesis age of the Tharsis mining district (Iberian Pyrite Belt) - a palynological approach. Journal of the Geological Society, Special Paper, 159, pp. 229-232.

GONZÁLEZ, F., MORENO, C., LÓPEZ, M.J., DINO, R., ANTONIOLI, L. (2004). Palinoestratigrafia del Grupo PQ del Sector más oriental de la Faja

Pirítica Ibérica, SO de España. Revista Española de Micropaleontologia, 36, 2, pp. 279-304.

GONZALEZ, F. (2005). Las pizarras negras del límite Devónico/Carbonífero de la Faja Pirítica Ibérica (S.O. de España). Estúdio bioestratigráfico e implicaciones sobre la paleogeografía de la cuenca y el origen de las mineralizaciones de sulfuros. Tesis Doctoral. Facultad de Ciencias Experimentales, Departamento de Geologia, Área de Estratigrafia, Universidad de Huelva, 200 pp.

GONZÁLEZ, F., PLAYFORD, G., MORENO, C. (2005) a - Upper Devonian biostratigraphy of the Iberian Pyrite Belt, southwest Spain. Part One: Miospores. Palaeontographica, Abt. B., 273, pp. 1-51.

GONZÁLEZ, F., PLAYFORD, G., MORENO, C. (2008) - New epithet for an Upper Devonian miospore species from the Iberian Pyrite Belt, southwest Spain. Micropaleontology, 53, 5, p. 431.

GONZÁLEZ, F., MORENO, C., PLAYFORD, G. (2005)b. Upper Devonian biostratigraphy of the Iberian Pyrite Belt, southwest Spain. Part Two: Organic-walled microphytoplankton. Palaeontographica, Abt. B., 273, pp. 53-86.

GRAHAM, J.R., CLAYTON, G. (1994). Late Tournaisian conglomerates from County Donegal, northwest Ireland; ault-controlled sedimentation and overstep during basing extension. Irish Journal of Earth Sciences, 13, pp. 95-105.

GREBE, H.,1972. A recommended terminology and descritive method for spores. In: Microfossiles Organiques du Paleozoique, 4, Les Spores, pp. 7-34.

GREUTER, W., MCNEILL, J., BARRIE, F.R., BURDET, H.M., DEMOULIN, V., FILGUEIRAS, T.S., NICOLSON, D.H., SILVA, P.C., SKOG, J.E., TREHANE, P., TURLAND, N.J., HAWKSWORTH, D.L. (2000) - International code of botanical nomenclature (St. Louis Code). Regnum Vegetabile, 138, 18, 474 pp. (Koeltz ScientificBooks) Königstein.

GREY, K. (1992). Miospore assemblages from the Devonian reef complexes, Canning Basin, Western Australia. Bulletin of Geological Survey of Western Australia, 140, 139 pp.

HACQUEBARD, P.A. (1957). Plant spores in coal from the Horton Group (Mississippian) of Nova Scotia. Micropaleontology, 3, pp. 301-324.

HASHEMI, H., PLAYFORD, G. (1998). Upper Devonian palynomorphs of the Shishtu Formation, Central Iran Basin, east-central Iran. Palaeontographica, Abt. B, 246, pp. 115-212.

HENNESSY, D., HIGGS, K. (1999). Palynological zonation of the Late Devonian and Early Carboniferous of the Avon Gorge, southwest England. Bolletino della Societa Paleontologica Italiana, 38, pp. 177-186.

HÉRISSÉ, A., DEUNFF, J. (1988). Acritarches et prasinophycees (Givetien supérieur-Frasnien moyen) de Ferques (Boulonnais-France). In: Le Dévonien de Ferques, Bas-Boulonnais (N. France) (D. Brice, Ed.). Biostratigraphie du Paléozoïque, 7, pp. 103-152.

HIGGS, K. (1975). Upper Devonian and Lower Carboniferous miospore assemblages from Hook Head, County Wexford, Ireland. Micropaleontology, 21, pp. 393-419.

HIGGS, K. (1996). Taxonomy and systematic study of some Tournaisian (Hastarian) spores from Belgium. Review of Palaeobotany and Palynology, 93, pp. 269-297.

HIGGS, K. (1984). Stratigraphic palynology of the Carboniferous rocks in Northwest Ireland. Geological Survey Ireland, Bull., 3: 171-201.

HIGGS, K.T., AVCHIMOVITCH, S.I., LOBOZIAK, S., MAZIANE, N., STAMPIEN-SALEK, M., STREEL, M. (2000). Systematic study and stratigraphic correlation of the Grandispora complex in the Famennian of northwest and eastern Europe. Review of Palaeobotany and Palynology, 112, pp. 207-228.

HIGGS, K., CLAYTON, G. (1984). Tournaisian miospore assemblages from Maesbury in the eastern Mendips, England. Journal of Micropalaeontology, 3, pp. 17-28.

HIGGS, K., CLAYTON, G., KEEGAN, B.J. (1988). Stratigraphic and systematic palynology of the Tournaisian rocks of Ireland. Geological Survey Ireland, Spec. Pap. 7, pp. 1-93.

HIGGS, K., RUSSELL, K.J. (1981). Upper Devonian microfloras from southeast Iveragh, County Kerry, Ireland. Bulletin of the Geological Survey of Ireland, 3: pp. 17-50.

HIGGS, K., STREEL, M. (1984). Spore stratigraphy at the Devonian-Carboniferous boundary in the Northern "Rheinisches Schieferebirge" Germany. Cour.Forsch.-Inst. Senckenberg, 67: pp. 157-180.

HIGGS, K., STREEL, M. (1994). Palynological age for the lower part of the Hangenberg Shales in Sauerland, Germany. In: M. Streel, E. Paproth. (eds), Carboniferous Biostratigraphy. Ann.Soc. géol. Belgique, 116, 1993, 2: 243-248.

ISHCHENKO, A.M. (1952). Atlas of microspores and pollen of the Middle Carboniferous of the western part of the Donetz Basin. Izd. Akademia Nauk Ukrainian S.S.R., Inst. Geologicheskikh Nauk, 83 pp. (in Russian)

ISHCHENKO, A.M. (1956). Spores and pollen from the Lower Carboniferous sediments of the western extension of the Donetz Basin and their stratigraphic importance. Trudy Instituta Geologicheskikh Nauk, Kiev, Seriia Stratigrafii i Palaeontologii., 11, 185 pp. (in Russian)

JARDINÉ, S., COMBAZ, A., MAGLOIRE, L., PENIGUEL, L., VACHEY, G. (1972). Acritarches du Silurien terminal et du Dévonien du Sahara algérien. Compte Rendu Septième Congrés International de Stratigraphie et de Géologie du Carbonifère, Krefeld (August 1971), 1, pp. 295-311.

JARDINÉ, S., COMBAZ, A., MAGLOIRE, L., PENIGUEL, L., VACHEY, G. (1974). Distribution stratigraphique des acritarches dans le Paléozoïque du Sahara algérien. Review of Paleobotany and Palynology 89, pp. 19-25.

JULIVERT, M., FONTBONÉ, J., RIBEIRO, A., CONDE, L., 1972. Memória Explicativa del Mapa Tectónico de la Península Ibérica y Baleares. Inst. Geol. Min. España. Madrid.

JUSHKO, L.A. (1960). New species of microspores from Cherepetsk deposits of the Tournaisian stage of the Moscow Basin. In: Data on geology and useful minerals of central regions of the European part of U.S.S.R., 3, pp. 121-137. (in Russian)

KAISER, H. (1970). Die Oberdevon-Flora der Bäreninsel. 3. Mikroflora des höheren Oberdevons und des Unterkarbons. Palaeontographica, Abt. B, 129, pp. 71-124.

KEDO, G.I. (1957). Spores from the supra-salt Devonian deposits of the Pripyat Basin and their stratigraphic significance. Academiia Nauk Belorusskoi S.S.R, Minsk, 2, pp. 3-43. (in Russian)

KEDO, G.I. (1963). Spores of the Tournaisian stage of the Pripyat Depression and their stratigraphic significance. Academiia Nauk Belorusskoi S.S.R, Minsk, 4, pp. 3-121. (in Russian)

KEDO, G.I. (1974). New spore forms from the Upper Devonian Pripyat Depression. In: Spores of the Palaeozoic of Byelorussian Pripyat Depression. W.K. Golubkov, S.S. Manjkin (eds.). Belorusskii Nauchno-Issledovatel'skii Geologorazvedochnii Institut (BelNIGRI), Minsk, pp. 3-72. (in Russian)

KEDO, G.I., GOLUBTSOV, V.K. (1971). Palynological criteria for determination of boundaries between Devonian and Carboniferous in Pripyat Basin. In: Palynology research in Byelorussia and other regions of U.S.S.R. Nauka i Texnika, pp. 5-34. (in Russian)

KEDO, G.I., NAZARENKO, A.M., NEKRYATA, N.S., RASKATOVA, L.G., SENNOVA, V.F., CHIBRIKOVA, E.V. (1971). New spore species from Famennian deposits of the Pripyat Basin, central district of Russia Platform, Volga-Ural oil and gas province, and Timan. In: Palynology research in Byelorussia and other regions of the U.S.S.R. Nauka i Texnika, pp. 172 205. (in Russian)

KEEGAN, B. (1977). Late Devonian and Early Carboni ferous miospores from the Galley Head-Leap Harbour region of southwest Ireland. Pollen et Spores, 19, pp. 545-573.

KEEGAN, J.B. (1981). Palynological correlation of the Upper Devonian and Lower Carboniferous in Central Ireland. Review of Palaeobotany and Palynology, 34, 1, pp. 99-106.

KIMPE, W.F.M., BLESS, M.J.M., BOUCKAERT, J., CONIL, R., GROESSENS, E., MEESSEN, J.P.M.T., POTY, E., STREEL, M., THOREZ, J., VANGUESTAINE, M. (1978). Paleozoic deposits east of the Brabant Massif in Belgium and the Netherlands. Mededelingen Rijks Geologische Dienst, 30, pp. 37-103.

KNOX, E. M. (1948). The microspores in coals f the Limestone Coal Group in Scotland. Instn. Min. Rngrs. London, 107, pp. 155-163.

KREMP, G.O.W. (1965). Morphologic encyclopedia of palynology. Program in Geochronology, University of Arizona, Contribution 100, 186 pp.

KORN, D. (1997). The Paleozoic ammoids of the South Portuguese Zone. Mem Inst Geol Min Portugal, 33, pp. 1-131.

LAKE, P. A. (1991). The Biostratigraphy and Structure of the Pulo do Lobo Domain within Huelva Province, Southwest Spain. PhD Thesis, Univ. of Southampton, pp. 1-324.

LANZONI, E., MAGLOIRE, L. (1969). Associations palynologiques et leurs applications stratigraphiques dans le Dévonien Supérieur et Carbonifère Inférieur du Grand Erg occidental (Sahara algérien). Revue de l'Institut Français du Pétrole, 24, pp. 441-469.

LATRECHE, S., COQUEL, R. (1996). Stratigraphie, sédimentologie et palynologie de la Formation d'Illerène (Dévonien-Carbonifère) du Bassin d'Illizi (Sahara algérien). Bulletin du Service Géologique de l'Algérie, 7, pp. 87-107.

LEITÃO, J. (1998). Geologia dos depósitos de sulfuretos maciços de Aljustrel. In: Oliveira, J.T., Dias R.P. (eds.,), Livro Guia da Excursões. V Congresso Nacional de Geologia, Instituto Geológico e Mineiro, pp. 101-110.

LELE, K.M., STREEL, M. (1969). Middle Devonian (Givetian) plant microfossils from Goé (Belgium). Annales de la Société géologique de Belgique, 92, pp. 89- 121.

LISTER, T.R. (1970). A monograph of the acritarchs and Chitinozoa from the Wenlock and Ludlow series of the Ludlow and Millichope areas, Shropshire, part 1. Paleontographical Society Monographs, 124 (publ. 528/1), 100 pp.

LOBOZIAK, S. (1974). Considerations palynologiques sur le Westphalien d'Europe occidentale. Review of Palaeobotany and Palynology, 18, pp. 271-289.

LOBOZIAK, S., CLAYTON, G. (1988). The Carboniferous palynostratigraphy of northeast Libya. In: Subsurface palynostratigraphy of northeast Libya. A. El arnauti, B. Owens, B. Thusu (eds.). Garyounis University Publications, pp. 129-149.

LOBOZIAK, S., STREEL, M. (1989). Middle-Upper Devonian Miospores from the Ghadamis Basin (Tunisia–Libya): systematics and stratigraphy. Rev. Palaeobot. Palynol. 58, pp. 173-196.

LOBOZIAK, S., MELO, J.H.G. (2002). Devonian miospore successions of Western Gondwana: update and correlation with Southern Euramerican miospore zones Review of Palaeobotany and Palynology, 121, pp. 133-148.

LOBOZIAK, S., STREEL, M. (1980). Miospores in Givetian to lower Frasnian sediments dated by conodonts from the Boulonnais, France. Review of Palaeobotany and Palynology, 29, pp. 285-299.

LOBOZIAK, S., STREEL, M. (1981). Miospores in middle-upper Frasnian to Famennian sediments partly dated by conodonts (Boulonnais, France). Review of Palaeobotany and Palynology, 34, pp. 49-66.

LOBOZIAK, S., STREEL, M. (1988). Synthèse palynostratigraphique de l'intervalle Givétien-Famennien du Boulonnais (France). In: Le Dévonien de Ferques. Bas-Boulonnais (N. France). Biostratigraphie du Paléozoïque (D.Brice, Ed.). Université de Bretagne occidentale, 7, pp. 71-77.

LOBOZIAK, S., CAPUTO, M.V., MELO, J.H.G. (2000). Middle Devonian-Tournaisian miospore biostratigraphy in the southwestern outcrop belt of the Parnaíba Basin, north-central Brazil. Revue de Micropaléontologie, 43, pp. 301-318.

LOBOZIAK, S., MELO, J.H.G., QUADROS, L.P., STREEL, M. (1997) - Palynological evaluation of the Famennian Protosalvinia (Foerstia) Zone in the Amazon Basin, northern Brazil: a preliminary study. Review of Palaeobotany and Palynology, 96, pp. 31-45.

LOBOZIAK, S., STREEL, M., CAPUTO, M.V., MELO, J.H.G. (1991). Evidence of west European-defined miospore zones in the uppermost Devonian and Lower Carboniferous of the Amazonas Basin (Brazil). Géobios, 24, pp. 5-11.

LOBOZIAK, S., STREEL, M., DUSAR, M., BOULVAIN, F., DE GEYTER, G. (1994). Late Devonian-Early Carboniferous miospores from Menen borehole, Namur synclinorium, Belgium. Review of Palaeobotany and Palynology, 80, pp. 55-63.

LOBOZIAK, S. VACHARD, D., FADLI, D., STREEL, M. (1991). Datation par miospores et foraminifers du Tournaisien et du Viséen de l'Oued Zemrine (Massif des Mdakra, Maroc). Journal of African Earth Sciences, 11, pp. 113-118. (imprinted 1990)

LOEBLICH, A.R., Jr. (1970). Morphology, ultrastructure and distribution of Paleozoic acritarchs. Proceeding of the North American Paleontological Convention, Chicago (1969), part G, 2, pp. 705-788.

LOTZE, F. (1945). Zur Gliederung der Varisziden der Iberischen Meseta. Geotekt. Forsch., 6, pp. 78-92.

LUBER, A.A., WALTZ, I.E. (1938). Classification and stratigraphic value of spores of some Carboniferous coal deposits in U.S.S.R. Trudy Tsentral`ngo Nauchno- Issledovatel'skogo Geologo-Razvedochnogo Instituta, 105, pp. 45 (in Russian)

LUBER, A.A., WALTZ, I.E. (1941). Atlas of microspores and pollen grains of the Palaeozoic of U.S.S.R. Trudy Tsentral` ngo Nauchno-Issledovatel'skogo Geologo-Razvedochnogo Instituta, 139, 107 pp. (in Russian)

LUDWIG, G., MÜLLER, H. (1968). Zur frage der prakarbonischen Diskordanz in Maranhão, Tucano und Jatoba-Becken (Brasilien). Beihefte zum Geologischen Jahrbuch, 85, pp. 197-517.

LU LI-CHANG, WICANDER, R. (1988). Upper Devonian acritarchs and spores from the Hongguleleng Formation, Hefeng district in Xinjiang, China. Revista Española de Micropaleontología, 20, pp. 109-148.

MARSHALL, J.E.A., ALLEN, K.C. (1982). Devonian miospore assemblages from Fair Isle, Shetland. Palaeontology, 25, pp. 277-312.

MARTIN, F. (1981). Acritarches du Famennien inférieur à Villers-sur-Lesse (Belgique). Bulletin d'Institut Royal des Sciences Naturales de Belgique, Sciences de la Terre, 52, pp. 1-49.

MARTIN, F. (1982). Acritarches et chitinozoaires de la partie supérieur du Frasnien dans un affleurement au nord immediat de Frasnes (Belgique). Bulletin d'Institut Royal des Sciences Naturales de Belgique, Sciences de la Terre, 54, pp. 1-17.

MARTIN, F. (1985). Acritarches du Frasnien supérieur et du Famennien inférieur du bord méridional du Bassin de Dinant (Ardenne belge). Bulletin d'Institut Royal des Sciences Naturales de Belgique, Sciences de la Terre, 55, pp. 1-57.

MASSA, D., COQUEL, R., LOBOZIAK, S., TAUGOURDEAU-LANTZ, J. (1980). Essai de synthèse stratigraphique et palynologique du Carbonifère en Libye occidentale. Annales de la Société Géologique du Nord, 9, pp. 429- 442.

MASSA, D., MOREAU-BENOIT, A. (1976). Essai de synthèse stratigraphique et palynologique du système Dévonien en Libye occidentale. Revue de l'Institut Français du Pétrole, 31, pp. 287-333.

MATOS, J.X. (2005). Carta geológica e mineira da Mina de Aljustrel, esc. 1/5000, INETI.

MATOS, J.X. (2006). Carta geológica e mineira da Mina de Caveira, esc. 1/5000, INETI.

MATOS, J., OLIVEIRA, V., BARRIGA, F. (1998). Contribuição para o conhecimento geológico e metalogenético da Jazida de Lagoa Salgada, Faixa Piritosa Ibérica – Bacia Terciária do Sado. Actas V Cong. Nacional de Geologia, Comunicações IGM, 84, 2, pp. 11-14, Lisboa.

MATOS, J., BARRIGA, F., OLIVEIRA, V., RELVAS, J., CONCEIÇÃO, P. (2000). The structure and hydrothermal alteration of the Lagoa Salgada orebody (Iberian Pyrite Belt – Sado Tertiary Basin). Volcanic Environments and Massive Sulfide Deposits. SEG/CODES Int. Conf. Abstract, Tasmania, pp. 119-121.

MATOS, J., BARRIGA, F., OLIVEIRA, V. (2003). Alunite veins versus supergene kaolinite/halloysite alteration in the Lagoa Salgada, Algares and S. João (Aljustrel) and S. Domingos massive sulphide deposits, Iberian Pyrite Belt, Portugal. Ciências da Terra (UNL) 5, pp. B56-B59.

MATOS, J.X., PEREIRA, Z., OLIVEIRA, V., OLIVEIRA, J.T. (2006). The geological setting of the S. Domingos pyrite orebody, Iberian Pyrite Belt. In: VII Congresso Nacional de Geologia, Mirão, J., Balbino, A. (eds.), Vol 1, pp. 283-286.

MAZIANE, N., HIGGS, K.T., STREEL, M. (1999). Revision of late famennian miospore zonation scheme in eastern Belgium. Journal of Micropalaeontology, 18, pp. 17-25.

MCGREGOR, D.C. (1961). Spores with proximal radial pattern from the Devonian of Canada. Bulletin of the Geological Survey of Canada, 76, 11 pp.

MCGREGOR, D.C. (1964). Devonian miospores from the Ghost River Formation, Alberta. Bulletin of the Geological Survey of Canada, 109, 31 pp.

MCGREGOR, D.C. (1970). *Hymenozonotriletes lepidophytus* Kedo and associated spores from the Devonian of Canada. Congrès et Colloques Universite de Liège, 55, pp. 315-326.

MCGREGOR, D.C. (1973). Lower and Middle Devonian spores of eastern Gaspé, Canada. I. Systematics. Palaeontographica, Abt. B, 142, pp. 1-77.

MCGREGOR, D.C. (1979). Devonian miospores of North America. Palynology, 3, pp. 31-52.

MCGREGOR, D.C. (1982). Middle Devonian miospores from the Cape de Bray, Weatherall, and Hecla Bay Formations of northeastern Melville Island, Canadian Arctic. Bulletin of the Geological Survey of Canada, 348, 105 pp.

MCGREGOR, D.C. (1984). Late Silurian and Devonian spores from Bolivia. Academia Nacional de Ciencias, Miscelánea 69, pp. 3-43.

MCGREGOR, D.C., CAMFIELD, M. (1976). Upper Silurian? to Middle Devonian spores of the Moose River Basin, Ontario. Bulletin of the Geological Survey of Canada, 263, 63 pp.

MCGREGOR, D.C., CAMFIELD, M., (1982). Middle Devonian Miospores from the Cape de Bray, Weatherall, and Hecla Bay Formations of Northeastern Melville Island, Canadian Artic. Geol. Surv. Canada Bull., 348, pp. 1-105.

MCGREGOR, D.C., MCCUTCHEON, S.R. (1988). Implications of spore evidence for Late Devonian age of the Piskahegan Group, southwestern New Brunswick. Canadian Journal of Earth Sciences, 25, pp. 1349-1364.

MCGREGOR, D.C., PLAYFORD, G. (1990). Morphology and distribution of the miospore Teichertospora torquata comb. nov. in the Upper Devonian of Euramerica and Australia. Palynology, 14, pp. 7-18.

MCGREGOR, D.C., PLAYFORD, G. (1992). Canadian and Australian Devonian spores: zonation and correlation. Geol. Surv. Can. Bull., 438, pp. 1-125.

MCNESTRY, A. (1988). The palynostratigraphy of two uppermost Devonian-Lower Carboniferous borehole sections in South Wales. Review of Palaeobotany and Palynology, 56, pp. 69-87.

MELO, J. H. G., LOBOZIAK, S. (2000). Viséan miospore biostratigraphy and correlation of the Poti Formation (Parnaíba Basin, northern Brazil). Review of Palaeobotany and Palynology, 112, pp. 147-165.

MOLYNEUX, S.G., MANGER, W.L., OWENS, B. (1984). Preliminary account of Late Devonian palynomorph assemblages from the Bedford Shale and Berea Sandstone Formations of central Ohio, U.S.A. Journal of Micropalaeontology, 3, pp. 41-51; London.

MOLYNEUX, S. G., LE HÉRISSÉ, A., WICANDER, R. (1996). Paleozoic phytoplankton. In: Palynology: principles and applications. J. Jansonius, D.C. McGregor (eds.). American Association of Stratigraphic Palynologist Foundation, 2, pp. 493-529.

MOREAU-BENOIT, A. (1966). Étude des spores du Dévonien inférieur d'Avrillé (Le Fléchay), Anjou. Revue de Micropaléontologie., 8, pp. 215-232.

MOREAU-BENOIT, A. (1967). Quelques microplanctontes du Dévonien inférieur de l'Anjou. Revue de Micropaléontologie, 10, pp. 200-208.

MOREAU-BENOIT, A. (1974). Recherches de palynologie et de planctonologie. Sur le Dévonien et quelques formations siluriennes dans le sud-est du Massif Armoricain. Mémoires de la Société Géologique et Minéralogique de Bretagne, 18, 248 pp.

MOREAU-BENOIT, A. (1979). Les spores du Dévonien de Libye (première partie). Cahiers de Micropaléontologie, C.N.R.S., 4, pp. 1-58.

MOREAU-BENOIT, A., COQUEL, R., LATRECHE, S. (1993). Étude palynologique du Dévonien du Bassin d'Illizi (Sahara oriental algérien). Approche biostratigraphique. Géobios, 26, pp. 3-31.

MUNHÁ, J.M. (1983). Low grade metamorphism in the Iberian Pyrite Belt Pyrite: Comunicações Serviços Geológicos de Portugal, 69, 1, pp. 3-35.

MUNHÁ, J., OLIVEIRA, J., RIBEIRO, A., OLIVEIRA, V., QUESADA, C., KERRICH, R., 1986. Beja-Acebuches Ophiolite: Characterization and geodynamic significance. Maleo 2, pp. 13-31.

NAUMOVA, S.N. (1953). Upper Devonian spore-pollen assemblages of the Russian Platform and their stratigraphic significance. Trudy Instituta Geologicheskikh Nauk, Akademiia Nauk SSSR, 143, pp. 1-204. (in Russian)

NEKRYATA, N.S. (1974). Spore complexes in lower Famennian deposits of the Pripyat Depression and their stratigraphic importance. In: Spores of the Palaeozoic of Byelorussian Pripyat Depression. W.K. Golubkov, S.S. Manjkin. (eds.). Beloruskii Nauchno-Issedovatel'skogo Geologoraz-vedochnogo Neftianogo Institut (BelNIGRI), pp. 73-94. (in Russian)

NEVES, R. (1972a). Recent developments in Carboniferous Palynology C.R. Cong. Internat. Strat. Géol. Carbonif., 7e, Krefeld, 1971, Vol.1, pp. 69-90. Geologisches Landesamt Northrein-Westfalen. Krefeld.

NEVES, R. (1972b). A scheme of miospore zone for the British Dinantian C.R. Cong. Internat. Strat. Géol. Carbonif., 7e, Krefeld, 1971, Vol.1, pp. 347-353. Geologisches Landesamt Northrein-Westfalen. Krefeld.

NEVES, R., DOLBY, G. (1967). An assemblage of miospores from the Portishead Beds (Upper Old Red Sandstone) of Mendip Hills, England. Pollen et Spores, 9, pp. 607-614.

NEVES, R., IOANNIDES, N. (1974). Palynology of the Lower Carboniferous (Dinantian) of the Spilmersford borehole, east Lothian, Scotland. Bulletin of the Geological Survey of Great Britain, 45, pp. 73-97.

NEVES, R., OWENS, B. (1966). Some Namurian camerate miospores from the English Pennines. Pollen et Spores, 8, pp. 337-360.

NEVES, R., GUEINN, K.J., CLAYTON, G., IOANNIDES, N.S., NEVILLE, R.S.W., KRUSZEWSKA, K. (1973). Palynological correlations within the Lower Carboniferous of Scotland and northern England. Transactions of the Royal Society of Edinburgh, 69, pp. 23-70.

NORRIS, R.E. (1980). Prasinophytes. In: Phytoflagellates (E.R. Cox, ed.). Elsevier North Holland, pp. 85-145.

OBUKHOVSKAYA, T.G., AVCHIMOVITCH, V.I., STREEL, M., LOBOZIAK, S. (2000). Miospores from the Frasnian-Famennian boundary deposits in eastern Europe (the Pripyat Depression, Belarus and the Timan-Pechora Province, Russia) and comparison with western Europe (northern

France). Review of Palaeobotany and Palynology, 112, pp. 229-246.

OLIVEIRA, J. (1983). The marine carboniferous of South Portugal: a stratigraphic and sedimentological approach. In: The Carboniferous of Portugal. LEMOS DE SOUSA, M.J., OLIVEIRA, J.T. (eds.). Memórias Serviços Geológicos de Portugal 29, pp. 3-38.

OLIVEIRA, J.T. (1990). Stratigraphy and syn-sedimentary tectonism in the South Portuguese Zone. In: Pre-Mesozoic Geology of Iberia. DALLMEYER, R. D., MARTINEZ GARCIA, E. (eds.). Springer Verlag. pp. 334-347.

OLIVEIRA, J., QUESADA, C. (1998). A comparison of stratigraphy, structure and paleogeography of the South Portuguese Zone and Southwest England, European Variscides. Annual Conference of the Ussher Society, Geoscience in south-west England 9, 141-150.

OLIVEIRA, J., SILVA, J., 1990. Carta Geológica de Portugal à escala 1:50000, Folha 46-D, Mértola. Serviços Geológicos de Portugal.

OLIVEIRA, J., SILVA, J., 2007. Noticia Explicativa da Folha 46-D, Mértola. Dep. Geologia. INETI, 1-46.

OLIVEIRA, J., WAGNER GENTHIS, C. (1983). The Mértola and Mira formations boundary between Doguedo and Almada do Ouro, marine Carboniferous of South Portugal. In: Contributions to the Carboniferous Geology and Palaeontology of the Iberian Peninsula. LEMOS DE SOUSA, M.J. (ed.,), pp. 1-39.

OLIVEIRA J.T., CARVALHO P., PEREIRA Z., PACHECO N., FERNANDES J.P., KORN D. (1997). The stratigraphy of the Neves Corvo Mine Region. SEG Guide Book Series 27, pp. 86-87.

OLIVEIRA, J.T., CUNHA, T.A., STREEL, M., VANGUESTAINE, M. (1986). Dating the Horta da Torre Formation, a new lithostratigraphic unit of the Ferreira-Ficalho Group, South Portuguese Zone: Geological consequences. Comunicações Serviços Geológicos de Portugal, 72, 1/2, pp. 129-135 363-368.

OLIVEIRA, J., HORN, M., PAPROTH, E. (1979). Preliminary note on the stratigraphy of the Baixo-Alentejo Flysch Group, Carboniferous of Portugal, and on the palaeogeographic development compared to corresponding units in NorthWest Germany. Comunicações dos Serviços Geológicos de Portugal 65, pp. 151-168.

OLIVEIRA, J., HORN, M., KULLMANN, J., PAPROTH, E. (1985). The stratigraphy of the Upper devonian and Carboniferous sediments of Southwest Portugal. C.R. 10e, International Congress Stratigraphy Geology Carboniferous, Madrid 1983, 1, pp. 1-17.

OLIVEIRA, J.T., PEREIRA Z., CARVALHO P., PACHECO N., KORN D. (2004). Stratigraphy of the tectonically imbricated lithological succession of the Neves-Corvo Mine region, Iberian Pyrite Belt. Implications for the regional basin dynamics. Mineralium Deposita 34, pp. 422-436.

OLIVEIRA, J.T., PEREIRA, Z., ROSA, C., ROSA, D., MATOS, J. (2005). Recent advances in the study of the stratigraphy and the magmatism of the Iberian Pyrite Belt, Portugal. In: The southern Variscan belt. Carosi, R., Dias, R., Iacopini, D., Rosenbaum, G., (eds.). Journal of the Virtual Explorer, Electronic Edition, 19, 9, pp. 1441-8142.

OLIVEIRA, J.T., PEREIRA, Z., FERNANDES, P., MATOS, J. (2007). Palynostratigraphic contributions to the understanding Ossa Morena and South Portuguese Zone geology, Portugal. CIMPLISBON'07, Field trip Book, pp. 1-46.

OLIVEIRA, J.T., RELVAS, J., PEREIRA, Z., MATOS, J., ROSA, C., ROSA; D., MUNHÁ, J.M, JORGE, R., PINTO, A. (2006). O Complexo Vulcano-Sedimentar da Faixa Piritosa: estratigrafia, vulcanismo, mineralizações associadas e evolução tectono-estratigráfica no contexto da Zona Sul Portuguesa. In: Geologia de Portugal no contexto da Ibéria. DIAS, R., ARAÚJO, A., TERRINHA, P., KULLBERG, J.C. (eds.). Univ. Évora, Évora, pp. 207-243.

OLIVEIRA, J.T., RELVAS, J., PEREIRA, Z., MATOS, J., ROSA, C., ROSA; D., MUNHÁ, J.M, FERNANDES, P., JORGE, R., PINTO, A., (2008 Em prep). Geologia da Zona Sul Portuguesa, com ênfase na estratigrafia e na vulcanologia física, geoquímica e mineralizações da Faixa Piritosa. In: Geologia de Portugal no contexto da Ibéria 2ª Edição. DIAS, R., ARAÚJO, A., TERRINHA, P., KULLBERG, J.C., (eds).

OLIVEIRA, V., MATOS, J., BENGALA, M., SILVA, N., SOUSA, P., TORRES, L.(1998a). Geology and geophysics as successful tools in the discovery of the Lagoa Salgada Orebody (Sado Tertiary Basin-Iberian Pyrite Belt), Grândola, Portugal, Mineralium Deposita 33, pp. 170-187.

OLIVEIRA, V., MATOS, J., BENGALA, M., SOUSA, P. (1998b). Principais alinhamentos vulcânicos a norte da Falha de Grândola, sob formações da Bacia Terciária do Sado e sua potencialidade mineira no contexto da Faixa Piritosa Ibérica.

Actas V Cong. Nacional de Geologia, Comunicações do IGM , T. 84 F. 2, pp. 15-18.

OWENS, B. (1996). Upper Carboniferous Spores and Pollen. In: Palynology: Principles and applications. Jansonius J., Mcgregor D.C, (eds.), American Association of Stratigraphic Palynologist, Found, Vol. 2, pp. 597-606.

OWENS, B. (1971). Miospores from the Middle and early Upper Devonian rocks of the western Queen Elizabeth Islands, Arctic Archipelago. Paper of the Geological Survey of Canada, 70, pp. 38-157.

OWENS, B., MCLEAN. D., BODMAN, D. (2004). A revised palynozonation of British Namurian deposits and comparisons with eastern Europe. Micropalaeontology, vol 50, 1, pp. 89-103.

OWENS, B., STREEL, M. (1967). Hymenozonotriletes lepidophytus Kedo, its distribution and significance in relation to the Devonian-Carboniferous boundary. Review of Palaeobotany and Palynology, 1: 141-150.

OWENS, B., NEVES, R., GUEINN, K.J., MITSHELL, D.R.F., SABRY, H.S.M.Z., WILLIAMS, J.E. (1977). Palynological division of the Namurian of northern England and Scotland. Proc. Yorkshire geol. Soc., 41, 3: 381-398.

PAPROTH, E., STREEL, M. (1972) – Corrélations biostratigraphiques prés de la limite Devonien/Carbonifère entre les facies littoraux ardennais et les facies bathyaux rhenans. Colloque sur la Stratigraphie du Carbonifère. Congress et Colloques Univ. Liège, 55: pp. 365-398.

PAPROTH, E., CONIL, R., BLESS, M.J.M., BOONEN, P., CARPENTIER, N., COEN, M., DELCAMBRE, B., DEPRIJCK, C.H., DEUZON, S., DREESEN, R., GROESSENS, E., HANCE, L., HENNEBERT, M., HIBO, D., HAHN, G., HAHN, R., HISLAIRE, O., KASIG, W., LALOUX, M., LAUWERS, A., LEES, A., LYS, M., OP DE BEEK, K., OVERLAU, P., PIRLET, H., POTY, E., RAMSBOTTOM, W., STREEL, M., SWENNEN, R., THOREZ, J., VANGUESTAINE, M., VAN STEENWINKEL, M., VIESLET, J.L. (1983). Bio-and lithostratigraphical subdivisions of the Dinantian in Belgium, a review. Annales de la Société géologique de Belgique, 106, pp. 185-239.

PARIS, F., RICHARDSON, J.B., RIEGEL, W., STREEL, M., VANGUESTAINE, M. (1985). Devonian (Emsian-Famennian) palynomorphs. In: Palynostratigraphy of north-east Libya. B. Thusu,, B. Owens. (eds.). Journal of Micropalaeontology, 4, pp. 49-82.

PEREIRA, Z. (1997). Palinologia e petrologia orgânica do Sector SW da Zona Sul Portuguesa. PhD Thesis. Fac. Ciências da Universidade do Porto, 268 p.

PEREIRA, Z. (1999). Palinoestratigrafia do Sector Sudoeste da Zona Sul Portuguesa. Comunicações IGM, Portugal 86, pp. 25-57.

PEREIRA, Z., OLIVEIRA, J.T. (1995). Estudo palinológico da Formação da Brejeira, sector Sudoeste da Zona Sul Portuguesa. In: IV Congresso Nacional de Geologia, Porto, 1995. Sodré Borges F., Marques, M.M., (eds.). Resumos Alargados, Memórias do Museu Laboratório Mineralógico Geológico da Faculdade de Ciências, Porto, 4, pp. 111-115.

PEREIRA, Z., OLIVEIRA, J.T. (2006). Recent advances on the Upper Devonian palynostratigraphy of the Pulo do Lobo Domain, South Portuguese Zone, Portugal. In: Paleozoic Palynology in Space and Time. Bek, J., Brocke, R. Daskova J.,Fatka, O. (eds). Inst. Geology, Academy of Sciences, Prague. Czech Republique, pp. 42-43.

PEREIRA, Z., GONZÁLEZ-CLAVIJO, E. (2007). New palynological ages improving the geological background of the Rio Tinto Mine Area (spanish part of the iberian Pyrite Belt). In: Abstracts CIMPLISBON'07. PEREIRA, Z., OLIVEIRA, J.T., WICANDER, R. (eds)., pp. 105-109.

PEREIRA, Z., CLAYTON, G., OLIVEIRA, J.T. (1994) Palynostratigraphy of the Devonian-Carboniferous Boundary in Southwest Portugal. Annales de la Société Géologique de Belgique, 117, 1, pp. 189-199.

PEREIRA, Z., SAEZ, R., PONS, J., OLIVEIRA, J., MORENO, C. (1996). Edad devónica (Struniense) de las mineralizaciones de Aznalcóllar, Fajã Pirítica Ibérica, en base a palinología. Geogaceta 20, 7, pp. 1609-1612.

PEREIRA, Z., FERNANDES, P., OLIVEIRA , J.T. (2006a) -Palinoestratigrafia do Domínio Pulo do Lobo, Zona Sul Portuguesa. VII Congresso Nacional de Geologia, Estremoz, Universidade de Évora, Portugal, pp. 649-652.

PEREIRA, Z., FERNANDES, P., OLIVEIRA , J.T. (2006b). Palinoestratigrafia do Domínio Pulo do Lobo, Zona Sul Portuguesa. Comunicações Geológicas, 93, 23-38.

PEREIRA, Z., PACHECO, N., OLIVEIRA, J.T. (2004). A case of applied palynology: dating the lithological succession of the Neves-Corvo mine, Iberian Pyrite Belt, Portugal. In: Proceedings of the XVth ICCP Stratigraphy. WONG, TH.E (ed.). R. D. Academy Arts and Sciences, pp. 345-354.

PEREIRA, Z., MATOS, J., FERNANDES, P., OLIVEIRA, J.T. (2007). Devonian and Carboniferous palynostratigraphy of the South Portuguese Zone, Portugal. An overview. In: Abstracts CIMPLISBON'07. PEREIRA, Z., OLIVEIRA, J.T., WICANDER, R. (eds)., pp. 111-114.

PEREIRA, Z., MATOS, J., FERNANDES, P., OLIVEIRA, J.T. (2007). Devonian and Carboniferous palynostratigraphy of the South Portuguese Zone, Portugal. Comunicações Geológicas, 94, pp. 53-79.

PEREIRA, Z., MATOS, J., FERNANDES, P., OLIVEIRA, J.T. (2008). New data on the late Famennian miospore assemblage of the Cercal Anticline (westernmost Iberian Pyrite Belt area), Portugal. Abstract Volume, 12th International Palynological Congress (IPC-XII 2008), 8th International Organisation of Palaeobotany Conference (IOPC-VIII 2008). Joint Congress in Bonn, 2008, pp. 219-220.

PEREZ-LEYTON, M. (1991). Miospores du Dévonien moyen et supérieur de la coupe de Bermejo-La Angostura (sud-est de la Bolivie). Annales de la Société géologique de Belgique, 113, pp. 373-389.

PFEFFERKORN, H. W. (1968). Geologie des Gebietes zwischen Serpa und Mértola (Baixo Alentejo), Portugal. PhD Thesis. Munster. Forsch.Geol. Palaont., 9, pp. 2-143

PHILLIPS, W.E.A., CLAYTON, G. (1980). The Dinantian clastic succession of Clare Island, Country Mayo. Journal of Earth Sciences (Royal Dublin Society), 2, pp. 115-135.

PLAYFORD, G. (1962). Lower Carboniferous microfloras of Spitsbergen. Part one. Palaeontology, 5, pp. 550-618.

PLAYFORD, G. (1963). Lower Carboniferous microfloras of Spitsbergen. Part two. Palaeontology, 5, pp. 619-678.

PLAYFORD, G. (1964). Miospores from the Mississippian Horton Group, eastern Canada. Bulletin of the Geological Survey of Canada, 107, 47 pp.

PLAYFORD, G. (1971). Lower Carboniferous spores from the Bonaparte Gulf Basin, Western Australia and Northern Territory. Bulletin of the Bureau of Mineral Resources, Geology and Geophysics, Australia, 115, 105 pp.

PLAYFORD, G. (1976). Plant microfossils from the Upper Devonian and Lower Carboniferous of the Canning Basin, Western Australia. Palaeontographica, Abt. B, 158, pp. 1-71.

PLAYFORD, G. (1977). Lower to Middle Devonian acritarchs of the Moose River Basin, Ontario. Bulletin of the Geological Survey of Canada, 279, 87 pp.

PLAYFORD, G. (1978). Lower Carboniferous spores from the Ducabrook Formation, Drummond Basin, Queensland. Palaeontographica, Abt. B, 167, pp. 105-160.

PLAYFORD, G. (1981). Late Devonian acritarchs from the Gneudna Formation in the western Carnarvon Basin, Western Australia. Géobios, 14, pp. 145-171.

PLAYFORD, G. (1982). A latest Devonian palynoflora from the Buttons Beds, Bonaparte Gulf Basin, Western Australia. BMR Journal of Australian Geology and Geophysics, 7, pp. 149-157.

PLAYFORD, G. (1983). The Devonian miospore genus Geminospora Balme, 1962: a reappraisal based upon topotypic G. lemurata (type species). Memoir of the Association of Australasian Palaeontologists, 1, pp. 311-325.

PLAYFORD, G. (1991). Australian Lower Carboniferous miospores relevant to extra-Gondwanic correlations: an evaluation. In: International division and correlation of the Carboniferous system. P.L. Brenckle, W.L. Manger. (eds.). Courier Forschungs Institut Senckenberg, 130, pp. 85-125. (Imprinted 1990)

PLAYFORD, G. (1993). Miospores and organic-walled microphytoplankton characteristic of strata contiguous with the Devonian-Carboniferous boundary. Comptes Rendus Douzième Congres International de la Stratigraphie et Geologie du Carbonifere et Permien, Buenos Aires (Sept. 1991), 1, pp. 127-160.

PLAYFORD, G. (2003). Acritarchs and prasinophyte phycomata: a short course. American Association of Stratigraphic Palynologist, Contribution Series, 41, 39 pp.

PLAYFORD, G., DETTMANN, M.E. (1996). Spores. In: Palynology: principles and applications. J. Jansonius, D.C. McGregor. (eds.). American Association of StratigraphicPalynologists Foundation, Dallas, 1, pp. 227-260.

PLAYFORD, G., DINO, R., MARQUES-TOIGO, M. (2001). The Upper Palaeozoic miospore genus Spelaeotriletes Neves and Owens, 1966, and constituent Gondwanan species. Journal of South American Earth Sciences, 14, pp. 593-608.

PLAYFORD, G., DRING, R.S. (1981). Late Devonian acritarchs from the Carnarvon Basin, Western Australia. Special Papers in Palaeontology, 27, 78 pp.

PLAYFORD, G., MCGREGOR, D.C. (1993). Miospores and organic-walled microphytoplankton of Devonian-Carboniferous boundary beds (Bakken Formation), southern Saskatchewan: a systematic and stratigraphic appraisal. Bulletin of the Geological Survey of Canada, 445, pp. 1-107.

PLAYFORD, G., SATTERTHWAIT, D.F. (1985). Lower Carboniferous (Viséan) spores of the Bonaparte Gulf Basin, northwestern Australia: Part one. Palaeontographica, Abt. B, 195, pp. 129-152.

PLAYFORD, G., SATTERTHWAIT, D.F. (1986). Lower Carboniferous (Viséan) spores of the Bonaparte Gulf Basin, northwestern Australia: Part two. Palaeontographica, Abt. B, 200, pp. 1-32.

POTONIÉ, R. (1958). Synopsis der Gattungen der Sporae dispersae. II. Teil: Sporites (Nachträge), Saccites, Aletes, Praecolpates, Polyplicates, Monocolpates. Beihefte zum Geologischen Jahrbuch, 31, 114 pp.

POTONIÉ, R. (1966). Synopsis der Gattungen der Sporae dispersae. IV. Teil: Nachträge zu allen Gruppen (Turmae). Beiheftem zum Geologischen Jahrbuch, 72, 244 pp.

POTONIÉ, R. (1970). Synopsis der Gattungen der Sporae dispersae. V. Teil: Nachträge zu allen Gruppen (Turmae). Beiheftem zum Geologischen Jahrbuch, 87, 222 pp.

POTONIÉ, R. (1975). Beiträge zur Sporologie. Fortschritte in der Geologie von Rheinland und Westfalen, 25, 281 pp.

POTONIÉ, R., KREMP, G. (1954). Die Gattungen der paläozoischen Sporae dispersae und ihre Stratigraphie. Beiheftem zum Geologischen Jahrbuch, 69, pp. 111-194.

POTONIÉ, R. (1955). Die Sporae dispersae des Ruhrkarbons, ihre Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte, Teil I. Palaeontographica, Abt. B, 98, pp. 1-136.

PRUVOST, P. (1914). Observations sur les terraines Dévoniens et Carboniféres du Portugal et sur leur faune. Comunicações Serviços Geológicos de Portugal, 10, pp. 1-21.

QUESADA, C., FONSECA, P., MUNHÁ, J., OLIVEIRA, J.T., RIBEIRO, A. (1994). The Beja - Acebuches Ophiolite: Geological caracterization and geodynamic significance. Boletim Geológico Mineiro, 105, pp. 3-49.

QUIRING. R. (1936). Die Jungtertiaren Eisenmanganerzvorkommen in Devon, Karbon und Pliocan vom Sudportugal. Preussichen GeologischenLandsanstalt. Berlin (Arch. Fur Lagerstattenforschung H.63).

RAHMANI-ANTARI, K. (1990). Étude palynologique et evaluation de l'indice d'altération thermique du Páleozoique du forage DOT 1 (bassin des Doukkala centreouest Marocain). Review of Palaeobotany and Palynology, 66, pp. 211-227.

RAUSCHER, R. (1969). Présence d'une forme nouvelle d'acritarches dans le Dévonien de Normandie. Comptes Rendus des Séances de l'Academie des Sciences, Serie D, Sciences Naturalles, 268, pp. 34-36.

RAVN, R.L., BENSON, D.G. (1988). Devonian miospores and reworked acritarchs from southeastern Georgia, U.S.A. Palynology, 12. 179-200.

RIBEIRO, A. (1983). Structure of the Carrapateira Nappe in the Bordeira Area, SW Portugal In: The Carboniferous of Portugal. Lemos de Sousa, M.J., Oliveira, J.T. (eds.). Serviços Geológicos de Portugal, 29, pp. 91-97.

RIBEIRO, A. (2006). A evolução Geodinâmica de Portugal. In: Geologia de Portugal no contexto da Ibéria. DIAS, R., ARAÚJO, A., TERRINHA, P., KULLBERG, J.C. (eds.). Univ. Évora, Évora, pp. 1-27.

RIBEIRO, A., OLIVEIRA, J.T., RAMALHO, M., RIBEIRO, M.L., SILVA, J.B. (1987). Carta Geológica de Portugal na escala de 1/50 000. Notícia Explicativa da Folha 48-D, Bordeira. 79 pp. Serviços Geológicos de Portugal. Lisboa.

RIBEIRO, A., QUESADA, C., DALLMAYER, R. D. (1990). Geodynamic evolution of the Iberian Massif. In: Pre-Mesozoic Geology of Iberia. DALLMEYER, R. D., MARTINEZ GARCIA, E. (eds.). Springer Verlag. pp. 399-409

RICHARDSON, J.B. (1960). Spores from the Middle Old Red Sandstone of Cromarty, Scotland. Palaeontology, 3, pp. 45- 63.

RICHARDSON, J.B. (1965). Middle Old Red Sandstone spore assemblages from the Orcadian Basin, northeast Scotland. Palaeontology, 7, pp. 559-605.

RICHARDSON, J.B., AHMED, S. (1989). Miospores, zonation and correlation of Upper Devonian sequences from western New York State and Pennsylvania. In: Devonian of the World, volume III: Paleontology, paleoecology and biostratigraphy. N.J. MCMILLAN,, D.J. GLASS (eds.). Canadian Society of Petroleum Geologists, 541-558.

RICHARDSON, J.B., LISTER, T. R. (1969). Upper Silurian and Lower Devonian spore assemblages from the Welsh Borderland and South Wales. Palaeontology, 12, 2, pp. 201-252.

RICHARDSON, J., RASUL, S.M. (1979a). Palynological evidence for the age and provenance of the Lower OLd Red Sandstone from the Apley Barn Borehole, Witney, Oxforshire. Proc. geolog. Assoc., 90, 1:27-42.

RICHARDSON, J., RASUL, S.M. (1979b). Palynomorphs in Lower Devonian sediments from the Apley Barn Borehole, Southern England. Pollen et Spores, 20, 3, 423-462.

RICHARDSON, J., RASUL, S.M. (1990). Palynofacies in a Late Silurian regressive sequence in the Welsh Borderland and Wales. J. Geol. Society of London, 147, 675-686.

RICHARDSON, J., STREEL, M., HASSAN, A., STEEMANS, PH.(1982). A new spore assemblage to correlate between the Breconian (British Isles) and the Gedinnian (Belgium). Ann. Soc. géol. Belgique, 102: 135-143.

RICHARDSON, J.B., MCGREGOR, D.C. (1986). Silurian and Devonian spore zones of the Old Red Sandstone continent and adjacent regions. Bulletin of the Geological Survey of Canada, 364, 79 pp.

RIEGEL, W. (1973). Sporenformen aus den Heisdorf-, Lauch- und Nohn-Schichten (Emsium und Eifelium) der Eifel, Rheinland. Palaeontographica, Abt. B, 142, pp. 78-104.

RODRIGUEZ, R.M. (1983). Palinología de las Formaciones del Silurico Superior-Devónico Inferior de la Cordillera Cantábrica. Universidad de Léon. (Tesis Doutoral), pp. 1-231.

RODRIGUEZ, R., DIEZ, A., LEYVA, F., MATAS, J., ALMARZA, J., DONAIRE, M. (2002). Datación palinoestratigráfica del volcanismo en la sección de la Ribera del Jarama, Faja Pirítica Ibérica, Zona Surportuguesa). Geogaceta 32, pp. 247-250.

RODRIGUEZ, R.M., MEDINA VAREA, P., GONZÁLEZ LODEIRO, F., MARTÍN PARRA, L.M., MARTÍNEZ POYATOS, D., MATAS, J. (2007). Microflora y conodontos del Mississippiense en la FM Gévora (núcleo del sinforme la Codosera-puebla de Obando, SO de la Zona Centroibérica). Revista de la Sociedad Geológica de España, 20, 1-2, pp. 71-88.

ROSA, C. (2006). Facies architecture of the Volcanic Sedimentary Complex of the Iberian Pyrite Belt, Portugal and Spain. Unpub. PhD Thesis, University of Tasmania, Hobart, Australia, 357 p.

ROSA, C., MCPHIE, J., RELVAS, J. (2004). Architecture of the felsic volcanic succession hosting massive sulfide deposits in the Iberian Pyrite Belt, Portugal. In: McPhie, J., McGoldrick, P., (Eds.,), Dynamic earth: Past, present and future. 17th Australian Geological Convention, Hobart, Tasmania, Australia, abstracts 73, 1-288.

ROSA, C., MCPHIE, J., RELVAS, J., PEREIRA, Z., PACHECO, N. (2005). Felsic pyroclastic and effusive volcanic facies hosting the Neves Corvo massive sulfide deposit, Iberian Pyrite Belt, Portugal. In: Mao, J., Bierlein, F.P., (Eds.,), Mineral Deposit Research: Meeting the Global Challenge 1, 691-694.

ROSA, C., MCPHIE, J., RELVAS, J., PEREIRA, Z., OLIVEIRA, J.T., PACHECO N. (2008) - Facies analyses and volcanic setting of the giant Neves Corvo massive sulphide deposit, Iberian Pyrite Belt, Portugal. Mineralium Deposita, 43, pp. 449-466.

ROSA, D., INVERNO, C., OLIVEIRA, V., ROSA C. (2004). Geochemistry of volcanic rocks, Albernoa area, Iberian Pyrite Belt, Portugal. Int Geol Ver, 46, pp. 366-383

ROSA, D., INVERNO, C., OLIVEIRA, V., ROSA, C. (2006). Geochemistry and geothermometry of volcanic rocks from Serra Branca, Iberian Pyrite Belt, Portugal. Gondwana Res, 10, pp. 328-339.

ROSA, D., FINCH, A., ANDERSEN, T., INVERNO, C. (2009). U–Pb geochronology and Hf isotope ratios of magmatic zircons from the Iberian Pyrite Belt. Miner Petrol., 95, pp. 47-69.

RUBINSTEIN, C. (1999). Primer registro palinológico de la Formación Punta Negra (Devónico medio-superior), de la Precordillera de San Juan, Argentina. 10° Simposio Argentino de Paleobotánica y Palinología. Asociación Paleontológica Argentina Publicación Especial 6, pp. 13-18.

RUBINSTEIN, C.V., MELO, J.H.G., STEEMANS, P. (2005). Lochkovian (earliest Devonian) miospores from the Solimões Basin, northwestern Brazil. Review of Palaeobotany and Palynology 133, pp. 91- 113.

SABRY, H., NEVES, R. (1971). Palynological evidence concerning the unconformable Carboniferous basal measures in the Sanquhar Coalfield, Dumfrieshire, Scotland. Comptes Rendus Sixième Congrés International de Stratigraphie et de Géologie du Carbonifère, Sheffield (1967), 4, pp. 1441-1458.

SCHERMERHORN, L.G. (1971). An outline stratigraphy of the Iberian Pyrite Belt. Boletim Geológico Mineiro, España, 82, 3-4, pp. 239-268.

SCHERMERHORN, L., STATON, W. (1969). Folded overthrusts at Aljustrel (South Portugal). Geological Magazine 106, 130-141.

SCHOPF, J.M., WILSON, L.R., BENTALL, R. (1944). An annotated synopsis of Paleozoic fossil spores and the definition of generic groups. Illinois State Geological Survey, Report of Investigations, 91, 73 pp.

SILVA, J.B. (1989). Estrutura de uma geotransversal da Faixa Piritosa: Vale do Guadiana. Tese de Doutoramento. Fac. Ciências Lisboa. 201 pp.

SILVA J.B. (1998). Enquadramento geodinâmico da Faixa Piritosa na Zona Sul Portuguesa. In: Livro Guia, V Congresso Nacional de Geologia. Oliveira, J.T., Dias, R.P., (eds.). Excursão 2, pp. 79-89.

SILVA J.B., OLIVEIRA J.T., RIBEIRO A. (1990). South Portuguese Zone. Structural outline. In: Pre-Mesozoic Geology of Iberia. DALLMEYER, R. D., MARTINEZ GARCIA, E. (eds.). Springer Verlag., pp. 348-362.

SMITH, A.H.V., BUTTERWORTH, M.A. (1967). Miospores in the coal seams of the Carboniferous of Great Britain. Special Paper in Palaeontology, 1, 324 pp.

SOMMER, F.W. (1956). South American Paleozoic sporomorphae without haptotypic structures. Micropaleontology, 2, pp. 175-181.

SOMMER, F.W., VAN BOEKEL, N.M. (1963). Some new Tasmanaceae from the Devonian of Pará. Anais da Academia Brasileira de Ciências, 35, pp. 61-65.

SOMMER, F.W., VAN BOEKEL, N.M. (1966). Revisão das Tasmanáceas Paleozóicas Brasileiras. Anais da Academia Brasileira de Ciências, 38, pp. 53-65.

STAPLIN, F.L. (1961). Reef-controlled distribution of Devonian microplankton in Alberta. Palaeontology, 4, pp. 392-424.

STEEMANS, P. (1989). Etude palynostratigraphique du Devonien Infèrior dans l'ouest de l'Europe. Mémoires pour servir à l'Explication des Cartes Géologiques et Minières de la Belgique, 27, 453 pp.

STEMPIEN-SALEK, M. (2002). Miospore taxonomy and stratigraphy of Upper Devonian and lowermost Carboniferous in western Pomerania (NW Poland). Annales Societatis Geologorum Poloniae, 72, pp.163-190.

STOCKMANS, F., WILLIÈRE, Y. (1960). Hystrichosphères du Dévonien belge (sondage de l'Asile d'aliénés à Tournai). Senckenbergiana Lethaea, 41, pp. 1-11.

STOCKMANS, F., WILLIÈRE, Y. (1962a). Hystrichosphères du Dévonien belge (sondage de l'Asile d'aliénés à Tournai). Bulletin de la Société Belge de Géologie, de Paléontologie et de Hydrologie, 71, pp. 41-77.

STOCKMANS, F., WILLIÈRE, Y. (1962b). Hystrichosphères du Dévonien belge (sondage de Wépion). Bulletin de la Société Belge de Géologie, de Paléontologie et de Hydrologie, 71, pp. 83-99.

STOCKMANS, F., WILLIÈRE, Y. (1967). Les acritarches du Dinantien du sondage de Vieux Leuze à Leuze (Hainaut, Belgique). Bulletin de la Société Belge de Géologie, de Paléontologie et de Hydrologie, 75, pp. 233-242.

STOCKMANS, F., WILLIÈRE, Y. (1969). Acritarches du Famennien inférieur. Mémoires de la Classe des Sciences, Académie Royale de Belgique, Collection in 8º, 2 série, 38, 63 pp.

STOCKMANS, F., WILLIÈRE, Y. (1974). Acritarches de la "Tranchée de Senzeille" (Frasnien supérieur et Famennien inférieur). Bulletin d'Institut Royal des Sciences Naturales de Belgique, Sciences de la Terre, 41, 79 pp.

STREEL, M. (1964). Une association de spores du Givétien inférieur de la Vesdre, à Goé (Belgique). Annales de la Société Géologique de Belgique, 87, pp. 1-30.

STREEL, M. (1967). Associations de spores du Dévonien Inférieur belge et leur signification stratigraphique Annales de la Société Géologique de Belgique, 90, pp. 11-54.

STREEL, M. (1973). Corrélations palynologiques dans le Tournaisien du synclinorium de Namur. Bulletin de la Société Géologique de Belgique, 82, pp. 397-415.

STREEL, M. (1996). Middle and Upper Devonian miospores. In: Palynology: Principles and applications. JANSONIUS J., MCGREGOR D.C, (eds.), American Association of Stratigraphic Palynologist, Found, Vol. 2, pp. 575-587.

STREEL, M. (1999). Quantitative palynology of Famennian events in the Ardenne-Rhine regions. In: North Gondwana: Mid-Paleozoic terranes, stratigraphy and biota. R. FEIST, J.A. TALENT,

A. DAURER (Eds.). Abhandlungen de Geologischen Bundesanstalt, 54, pp. 201-212.

STREEL, M., HIGGS, K., LOBOZIAK, S., RIEGEL, W., STEEMANS, PH. (1987). Spore stratigraphy and correlation with faunas and floras in the type marine Devonian of the Ardenne-Rhenish regions. Review of Palaeobotany and Palynology, 50, pp. 211-229.

STREEL, M., LOBOZIAK, S., (1987). Nouvelle datation par miospores du Givetien Frasnien des sediments non marins du sondage de Booischot (Bassin de Campine, Belgique). Bull. Soc. Geol. Belg. 96, pp. 99-106.

STREEL, M., LOBOZIAK, S. (1996). Middle and Upper Devonian miospores. In: Jansonius, J., McGregor, D.C. (Eds.), Palynology: Principles and Applications, Am. Assoc. Stratigr. Palynol. Found. 2, 575-587.

STREEL, M., TRAVERSE, A. (1978). Spores from the Devonian-Mississippian transition near the Horseshoe Curve section, Altoona, Pennsylvania, U.S.A. Review of Palaeobotany and Palynology, 26, pp. 21-39.

SULLIVAN, H.J. (1964). Miospores from the Drybrook Sandstone and associated measures in the Forest of Dean Basin, Gloucestershire. Palaeontology, 7, pp. 351- 392.

SULLIVAN, H.J. (1968). A Tournaisian spore flora from the Cementstone Group of Ayrshire, Scotland. Palaeontology, 11, pp. 116-131.

TAPPAN, H. (1980). The paleobiology of plant protists. W.H. Freeman, Co., 1028 pp.

TAUGOURDEAU-LANTZ, J. (1968). Premier aperçu sur les Tasmanacées françaises. Bulletin de la Siciété Géologique de France, Septime série, 7, pp. 159-167.

THUSU, B. (1973). Acritarchs of the Middle Silurian Rochester Formation of southern Ontario. Palaeontology, 16, pp. 799-826.

TURNAU, E. (1975). Microflora of the Famennian and Tournaisian deposits from boreholes of northern Poland. Acta Geologica Polonica, 25, pp. 505-527.

TURNAU, E. (1978). Spore zonation of uppermost Devonian and Lower Carboniferous deposits of western Pomerania (N. Poland). Mededelingen Rijks Geologische Dienst, 30, 35 pp.

TURNAU, E. (1985). Devonian-Carboniferous boundary in the borehole Kowala 1 (southern Holy Cross Mts., Poland); spores. Bulletin de l Acadé mie Polonaise dês Sciences. Sé rie des Sciences de la Terre, 33, pp. 1-5.

TURNAU, E. (1990). Poziomy sporowe Famenu i Turneju z otworu wiertniczego Kowala 1. Kwartalnik Geologiczny, 34, pp. 291-304.

TURNAU, E. (1996). Miospore stratigraphy of Middle Devonian deposits from western Pomerania. Review of Palaeobotany and Palynology, 93, pp. 107-125; Amsterdam.

TURNAU, E., RACKI, G. (1999). Givetian palynostratigraphy and palynofacies: new data from the Bodzentyn Syncline (Holy Cross Mountains, central Poland). Review of Palaeobotany and Palynology, 106, pp. 237- 271.

TURNER, N., SPINNER, E., SOANES, C. (1989). Further studies of the palynology of the Upper Devonian-Lower Carboniferous transition strata at Burrington Combe, Somerset, England. Pollen et Spores, 31, pp. 289-315.

TURNER, R.E. (1986). New and revised acritarch taxa from the Upper Devonian (Frasnian) of Alberta, Canada. Canadian Journal of Erath Sciences, 23, pp. 599-607.

UTTING, J. (1987). Palynology of the Lower Carboniferous Windsor Group and Windsor-Canso boundary beds of Nova Scotia, and their equivalents in Quebec, New Brunswick and Newfoundland. Bulletin of the Geological Survey of Canada, 374, 93 pp.

UTTING, J., KEPPIE, J.D.,, GILES, P.S. (1989). Palynology and stratigraphy of the Lower Carboniferous Horton Group, Nova Scotia. In: Contributions to Canadian paleontology. Bulletin of the Geological Survey of Canada, 396, pp. 117-143.

VACHARD, D. LAVEINE, J.P. ZHANG, S.Z. DENG G., LEMOIGNE, Y. (1991). Calcareous microfossils (foraminifers, algae, pseudoalgae) from the Uppermost Viséan of Jiu Hu near Guangzhou (Canton), People's Republic of China. Geobios, 24, 4, pp. 675–681.

VANGUESTAINE, M. (1978). Acritarches du Famennien supérieur du sondage de Tohogne (Belgique) et corrélation biostratigraphique transcontinentale. Palinología, número extraordinario, 1, pp. 481-489.

VANGUESTAINE, M., DECLAIRFAYT, T., ROUARTH, A., SMEESTERS, A. (1983). Zonation par acritarches du Frasnien supérieur-Famennien inférieur dans les basins de Dinant, Namur, Herve et Campine (Devonien supérieur de Belgique). Annales de la Société géologique de Belgique, 106, pp. 121-171.

VAN DER LAAR, H.G.M., FERMONT, W.J.J. (1989). On shore Carboniferous Palynology of The Netherlands. Meded. Rijks Geol. Dienst, 43,1: 36-52

VAN DER ZWAN, C.J. (1980). Aspects of Late Devonian and Early Carboniferous palynology of southern Ireland. III. Palynology of Devonian-Carboniferous transition sequences with special reference to the Bantry Bay area, Co. Cork. Review of Palaeobotany and Palynology, 30, pp. 165-286.

VAN DER ZWAN, C.J., VAN VEEN, P.M. (1978). The Devonian-Carboniferous transition sequence in southern Ireland: integration of paleogeography and palynology. Palinología, número extraordinario, 1, pp. 469-479.

VAN VEEN, P.M. (1981). Aspects of Late Devonian and Early Carboniferous palynology of southern Ireland. IV. Morphological variation within Diducites, a new form-genus to accomodate (sic) camerate spores with two-layered outer wall. Review of Palaeobotany and Palynology, 31, pp. 261-287.

WICANDER, E.R. (1974). Upper Devonian-Lower Mississippian acritarchs and prasinophycean algae from Ohio, U.S.A. Palaeontographica, Abt. B, 148, pp. 9-43.

WICANDER, R., LOEBLICH, A. (1977). Organic-walled microphytoplankton and its stratigraphic significance from the Upper Devonian Antrim Shale, Indiana, U.S.A. Palaeontographica, Abt. B, 160, pp. 129-165.

WICANDER, R., PLAYFORD, G. (1985). Acritarchs and spores from the Upper Devonian Lime Creek Formation, Iowa, U.S.A. Micropaleontology, 31, pp. 97-138.

WICANDER, R., PLAYFORD, G., ROBERTSON, E.B. (1999). Stratigraphic and paleogeographic significance of an Upper Ordovician acritarch flora from the Maquoketa Shale, northwestern Missouri, U.S.A. Journal of Paleontology, Memoir of the Paleontological Society, 51, 38 pp.

WICANDER, R., WOOD, G.D. (1981). Systematics and biostratigraphy of the organic-walled microphytoplankton from the Middle Devonian (Givetian) Silica Formation, Ohio, U.S.A. American Association of Stratigraphic Palynologist, Contribution Series, 8, 137 pp.

WILLIAMS, G.L., FENSOME, R.A., MILLER, M.A., SARJEANT, W.A.S. (2000). A glossary of the terminology applied to dinoflagellates, acritarchs and prasinophytes, with emphasis on fossils: third edition. American Association of Stratigraphic Palynologist, Contribution Series, 37, 370 pp.

WINSLOW, M.R. (1962). Plant spores and other microfossils from upper and lower Mississippian rocks of Ohio. United Stades Geological Survey, Profesional Paper, 364, 93 pp.

WOOD, G.D. (1984). A stratigraphic, paleoecologic, and paleobiogeographic review of the acritarchs Umbellasphaeridium deflandrei and Umbellasphaeridium saharicum. In: Compte Rendu 9th International Congress on Carboniferous Stratigraphy and Geology, Washington, Champaign-Urbana, 1979. P.K. Sutherland,, W.L. Manger. (eds.). Southern Illinois University Press, pp. 191-211.

VILLE DE GOYET F. DE, BREUER P., GERRIENNE P., PRESTIANNI C., STEEMANS P., STREEL M. (2007). Middle Devonian (Givetian) megaspores from Belgium (Ronquières) and Libya (A1-69 borehole). In: STEEMANS P., JAVAUX E. (eds.), Recent Advances in Palynology.- Carnets de Géologie / Notebooks on Geology, Brest, Memoir 2007/01, Abstract 11, pp. 70-75 (CG2007-M01/11).

WELLMAN, C. H., KERP, H., HASS, H. (2006). Spores of the Rhynie chert plant Aglaophyton (Rhynia) major (Kidston, Lang) Edwards, 1986. Review of Palaeobotany and Palynology 142, pp. 229–50.

WOOD, G.D., GABRIEL, A.M., LAWSON, J.C. (1996). Palynological techniques-processing and microscopy. In: Palynology: Principles and applications. JANSONIUS J., MCGREGOR D.C, (eds.), American Association of Stratigraphic Palynologist, Found, Vol 1, pp. 29-50.

PLATE 1

Plate captions list the taxonomic name of the figured specimen, followed by the formation, sample number, slide number and microscopic coordinates.

Fig. 1. *Calamospora liquida* KOSANKE, 1950; PQ Formation, borehole CP2, sample 1, 41.5 m, slide 1a, 1325-148.

Fig. 2. *Leiotriletes* sp.; Godinho Formation, borehole SD 34, sample 474.5m, slide 3, 1132-58.

Fig. 3. *Leiotriletes* sp.; Godinho Formation, borehole SD 34, sample 474.5m, slide 1,1235-115.

Fig. 4. *Leiotriletes struniensis* MOREAU-BENOIT, 1979; Neves Formation, borehole SJ 17, sample 388.0m, slide 1, 1245-146.

Fig. 5. *Plicatispora quasilabrata* (HIGGS) HIGGS, CLAYTON & KEEGAN, 1988; Tercenas Formation, sample 284, slide 3a, 1265-165.

Fig. 6. *Plicatispora scolecophora* (NEVES & IOANNIDES) HIGGS, CLAYTON & KEEGAN, 1988; Tercenas Formation, sample 313, slide 1, 1285-255.

Fig. 7. *Punctatisporites planus* HACQUEBARD, 1957; Tercenas Formation, sample 46, slide 1, 1446-60.

Fig. 8. *Punctatisporites minutus* KOSANKE, 1950; Tercenas Formation, sample 283, slide 1c, 1385-165.

Fig. 9. *Punctatisporites minutus* KOSANKE, 1950; Neves Formation, borehole SJ 17, sample 388.0m, slide 3, 1416-75.

Fig. 10. *Retusotriletes triangulatus* (STREEL) STREEL, 1964; PQ Formation, Borehole SD 34, 914.6m, slide 2, 1088-125.

Fig. 11. *Punctatisporites irrasus* HACQUEBARD, 1957; PQ Formation, borehole CP2, sample 41.5m, slide 1b, 1365-75.

Fig. 12. *Retusotriletes planus* DOLBY & NEVES, 1970; PQ Formation, borehole CP2, sample 170.0m, slide 1, 1365-75.

Fig. 13. *Retusotriletes planus* DOLBY & NEVES, 1970; Horta da Torre Formation, sample HT7, slide1a, 1334-215.

Fig. 14. *Retusotriletes planus* DOLBY & NEVES, 1970; Horta da Torre Formation, sample HT8, slide5, 1425-156.

Fig. 15. *Retusotriletes rugulatus* RIEGEL, 1973; PQ Formation, Borehole SD 34, 914.6m, 1145-58.

Fig. 16. *Retusotriletes incohatus* SULLIVAN, 1964; Tercenas Formation, sample 284, slide 1, 1240-105.

Fig. 17. *Retusotriletes crassus* CLAYTON, JOHNSTON, SEVASTOPULO & SMITH, 1980; Tercenas Formation, sample 219, slide 1c, 1270-150.

Fig. 18. *Retusotriletes phillipsii* CLENDENING, EAMES &WOOD, 1980; PQ Formation, sample HT7, slide 4a, 1075-135.

Fig. 19. *Retusotriletes phillipsii* CLENDENING, EAMES &WOOD, 1980; PQ Formation, borehole CP2, sample 41.5m, slide 2, 1168-212.

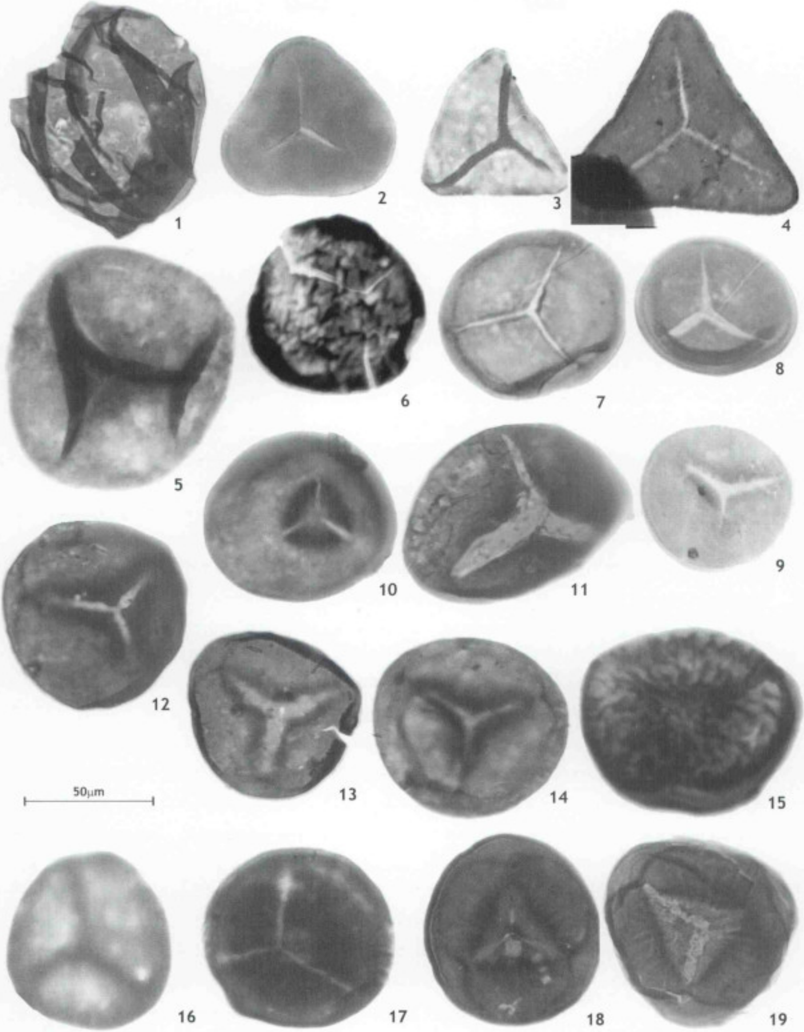
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Plate 2

Fig. 1. *Acanthotriletes echinatus* (KNOX) POTONIÉ & KREMP, 1955; Brejeira Formation, sample 240, slide b1, 1378-140.

Fig. 2. *Acanthotriletes persibus* HIGGS, 1975; Murração Formation, sample 9, slide 1, 1210-92.

Fig. 3. *Anapiculatisporites concinnus* PLAYFORD, 1962; Brejeira Formation, sample 372, slide 4, 1300-235.

Fig. 4. *Anaplanisporites baccatus* (HOFFMEISTER, STAPLIN & MALLOY) SMITH & BUTTERWORTH, 1967; Brejeira Formation, sample 242, slide 2, 1420-215.

Fig. 5. *Apiculiretusispora fructicosa* HIGGS, 1975; PQ Formation, borehole CP2 sample 41.5m, slide 1b, 1234-88.

Fig. 6. *Apiculiretusispora fructicosa* HIGGS, 1975;PQ Formation, borehole CP2 sample 41.5m, slide 2, 1145-175.

Fig. 7. *Apiculiretusispora fructicosa* HIGGS, 1975; Horta da Torre Formation, sample HT7, slide 1a, 1245-278.

Fig. 8. *Apiculiretusispora fructicosa* HIGGS, 1975;Horta da Torre Formation, sample HT7, slide 3a, 1055-210.

Fig. 9. *Apiculiretusispora brandtii* STREEL, 1964; Ribeira de Limas Formation, sample RL3, slide 3, 1436-112.

Fig. 10. *Granulatisporites microgranifer* IBRAHIM 1933; Bordalete Formation, sample 226, slide 1, 1053-215.

Fig. 11. *Camptotriletes paprothii* HIGGS & STREEL, 1984; Tercenas Formation, sample 283, slide 1, 11355-80.

Fig. 12. *Crassispora catenata* HIGGS, 1975; Bordalete Formation, sample 46, slide 1, 1335-140.

Fig. 13. *Cadiospora magna* KOSANKE 1950; Brejeira Formation, Sample 62, slide 1,1254-175.

Fig. 14. *Crassispora kosankei* POTONIÉ & KREMP emend BHARADWAJ 1957; Quebradas Formation, sample 387, slide 2, 1230-95.

Fig. 15. *Crassispora maculosa* (KNOX) SULLIVAN, 1964; Brejeira Formation, sample 242, slide 8, 1425-220.

Fig. 16. *Crassispora maculosa* (KNOX) SULLIVAN, 1964; Godinho Formation, borehole SD 34, sample 444.8m, slide 2, 1335-127.

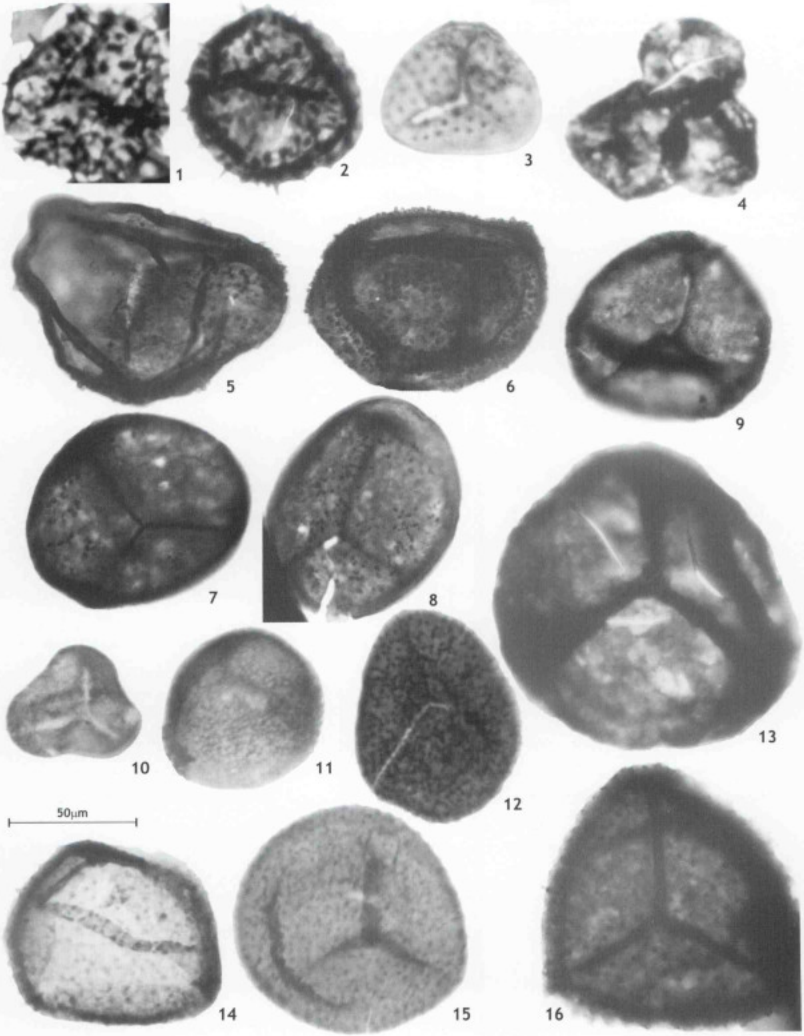
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Plate 3

Fig. 1. *Lophotriletes commissuralis* (KOSANKE) POTONIÉ & KREMP, 1955; Bordalete Formation sample 142, slide 5, 1105-195.

Fig. 2. *Lophotriletes gibbosus* (IBRAHIM) POTONIÉ & KREMP, 1954; Brejeira Formation, sample 372, slide 1, 1150-150.

Fig. 3. *Lophotriletes gibbosus* (IBRAHIM) POTONIÉ & KREMP, 1954; Brejeira Formation, sample 372, slide 1, 1165-75.

Fig. 4. *Neoraistrickia cymosa* HIGGS, CLAYTON & KEEGAN, 1988; Bordalete Formation, sample 147, slide 4, 1215-235.

Fig. 5. *Neoraistrickia cymosa* HIGGS, CLAYTON & KEEGAN, 1988;Bordalete Formation, sample 147, slide 1b, 1205-170.

Fig. 6. *Neoraistrickia logani* (WINSLOW) COLEMAN & CLAYTON, 1987; Bordalete Formation, sample 147, slide 2c, 1100-240.

Fig. 7. *Neoraistrickia logani* (WINSLOW) COLEMAN & CLAYTON, 1987; Bordalete Formation, sample 147, slide 1, 1055-82.

Fig. 8. *Pustulatisporites dolbii* HIGGS, CLAYTON & KEEGAN, 1988; Bordalete Formation, sample 48, slide 4, 1345-26.

Fig. 9. *Raistrickia aculeata* KOSANKE 1950; Brejeira Formation, Sample 63, slide 1, 1385-200.

Fig. 10. *Raistrickia clavata* HACQUEBARD emend. PLAYFORD, 1964; Bordalete Formation, sample 334, slide 1, 1425-123.

Fig. 11. *Raistrickia variabilis* DOLBY & NEVES, 1970; Bordalete Formation, sample 48, slide 1, 1382-225.

Fig. 12. *Raistrickia fulva* ARTUZ 1957; Quebradas Formation, sample 200, slide 1, 1430-205 .

Fig. 13. *Raistrickia nigra* LOVE 1960; Murração Formation, sample 379, slide 1, 1455-73.

Fig. 14. *Raistrickia nigra* LOVE 1960; MDS1 Borehole, VSC, sample 359. 40m, slide 1, 1380-180.

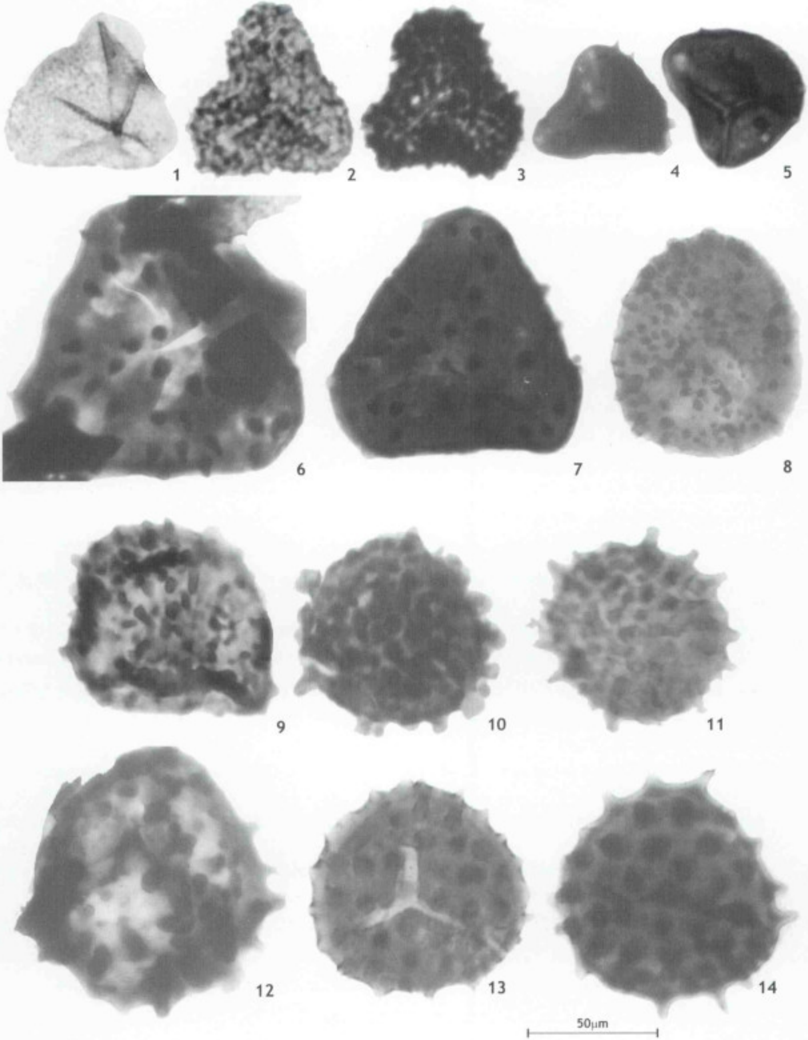
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Plate 4

Fig. 1. *Schopfites claviger* SULLIVAN emend. HIGGS, CLAYTON & KEEGAN, 1988; Murração Formation, sample 378, slide 1, 1365-80.

Fig. 2. *Schopfites delicatus* HIGGS, 1975; Murração Formation, sample 372, slide 1, 1235-156.

Fig. 3. *Verruciretusispora loboziakii* HIGGS & FINUCANE, 2002; Gafo Formation, sample 13, slide 4, 1345-148.

Fig. 4. *Umbonatisporites distinctus* CLAYTON 1971; Bordalete Formation, sample 336, slide 3, 1245-148.

Fig. 5. *Verrucosisporites bulliferus* RICHARDSON & MCGREGOR, 1986, Ribeira de Limas Formation, Sample 3, slide 1, 1190-218.

Fig. 6. *Verrucosisporites congestus* PLAYFORD, 1964; Bordalete Formation, sample 147, slide 1, 1025-107.

Fig. 7. *Verrucosisporites congestus* PLAYFORD, 1964; Bordalete Formation, sample 147, slide 3, 1300-105.

Fig. 8. *Verrucosisporites irregularis* PHILLIPS & CLAYTON, 1980; Bordalete Formation, sample 147, slide 2, 1146-220.

Fig. 9. *Verrucosisporites nitidus* (Naumova) PLAYFORD 1964; Tercenas Formation, sample 338, slide 1, 1110-110.

Fig. 10. *Verrucosisporites nitidus* (Naumova) PLAYFORD 1964; Bordalete Formation, sample 147, slide 1, 1180-63.

Fig. 11. *Verrucosisporites premnus* RICHARDSON, 1965; Ribeira de Limas Formation, sample RL1, slide 1, 1275-225.

Fig. 12. *Verrucosisporites scurrus* (NAUMOVA) MCGREGOR & CAMFIELD, 1982; Gafo Formation, sample 13, slide 4, 1125-100.

Fig. 13. *Verrucosisporites scurrus* (NAUMOVA) MCGREGOR & CAMFIELD, 1982; Ribeira de Limas Formation, sample RL3, slide 3, 1078-110.

Fig. 14. *Waltzispora polita* (HOFFMEISTER, STAPLIN & MALLOY) SMITH & BUTTERWORTH, 1967; Brejeira Formation, sample 229, slide 1, 1324-56.

Fig. 15. *Waltzispora polita* (HOFFMEISTER, STAPLIN & MALLOY) SMITH & BUTTERWORTH, 1967; Murração Formation, sample 302, slide 1, 1360-80.

Fig. 16. *Acinosporites lindlarensis* RIEGEL, 1968; PQ Formation, borehole M1, sample 126.3m, slide 1, 1115-45.

Fig. 17. *Convolutispora major* (KEDO) TURNAU, 1978; Graça Formation, borehole SO 28, sample 472.7m, slide 5, 1140-210.

Fig. 18. *Convolutispora cerebra* BUTTERWORTH & WILLIAMS, 1958; Murração Formation, sample 309, slide 1, 1473-145.

Fig. 19. *Convolutispora florida* HOFFMEISTER, STAPLIN & MALLOY, 1955; Quebradas Formation, sample 387, slide 1, 1342-115.

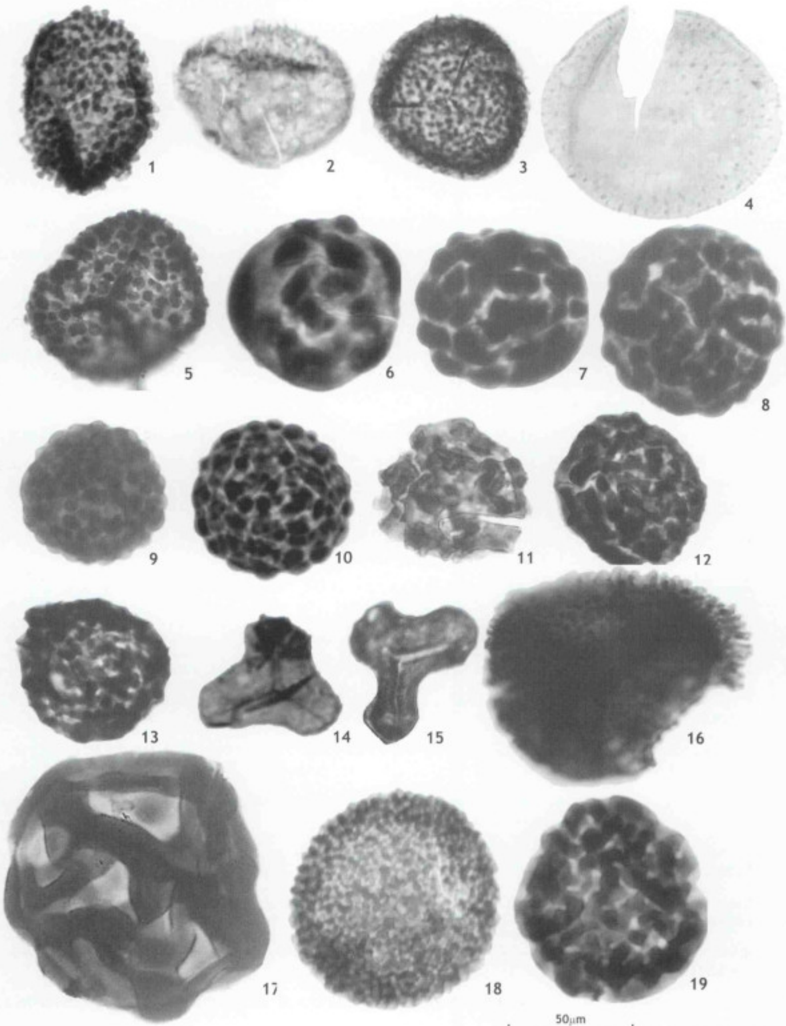
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Plate 5

Fig. 1. *Corbulispora* sp.; Graça Formation, borehole SO 28, sample 472.7m, slide 1, 1334-158.

Fig. 2. *Dictyotriletes fimbriatus* (WINSLOW) KAISER, 1970; Tercenas Formation, sample 105, slide 1, 1055-98.

Fig. 3. *Dictyotriletes probireticulatus* (IBRAHIM) BUTTERWORTH & MAHDI 1981; Brejeira Formation, sample 238,b,1, 1350-110.

Fig. 4. *Dictyotriletes proprius* PLAYFORD, 1978; IGM 0322; Graça Formation, borehole SO 28, sample 472.7m, slide 2, 1362-82.

Fig. 5. *Emphanisporites annulatus* MCGREGOR, 1961; Ribeira de Limas Formation, samle RL3, slide 2, 1468-125.

Fig. 6. *Emphanisporites hibernicus* CLAYTON, HIGGS & KEEGAN, 1977; Neves Formation, borehole SJ17, sample 388.0m, slide 2, 1155-88.

Fig. 7. *Emphanisporites rotatus* MCGREGOR EMEND MCGREGOR,1973; Represa Formation, borehole MP 3, sample 36.60m, slide 2, 1335-160.

Fig. 8. *Emphanisporites rotatus* MCGREGOR EMEND MCGREGOR, 1973; Tercenas Formation, sample 106, slide 3, 1055-98.

Fig. 9. *Microreticulatisporites concavus* BUTTERWORTH & WILLIAMS, 1958; Godinho Formation, borehole borehole SO 28, sample 472, slide 5, 1105-135.

Fig. 10. *Microreticulatisporites concavus* BUTTERWORTH & WILLIAMS, 1958; Murração Formation, sample 372, slide 1, 1305-60.

Fig. 11. *Tripartites vetustus* SCHEMEL 1950; Godinho Formation, borehole SD 34, sample 444.8m, slide 2, 1265-75.

Fig. 12. *Triquitrites bransonii* WILSON & HOFFMEISTER, 1956; Brejeira Formation, sample 242, slide 1, 1200-173.

Fig. 13. *Triquitrites tribullatus* (IBRAHIM) SCHOPF, WILSON & BENTALL, 1944; Brejeira Formation, sample 242, slide 2, 1200-240.

Fig. 14. *Diatomozonotriletes franklinii* MCGREGOR & CAMFIELD, 1982; PQ Formation, borehole M-1, sample 126.3m, slide 2, 1135-185.

Fig. 15. *Diatomozonotriletes cervicornutus* (STAPLIN) PLAYFORD, 1963; Murração Formation, sample 9, slide 2, 1312-235.

Fig. 16. *Diatomozonotriletes rarus* PLAYFORD, 1962; Godinho Formation, borehole SD 34, sample 474.5m, slide 2, 1275-100.

Fig. 17. *Diatomozonotriletes rarus* PLAYFORD, 1962; Godinho Formation, borehole SD 34, sample 474.5m, slide 3, 1098-140.

Fig. 18. *Aneurospora greggsii* (MCGREGOR) STREEL in BECKER, BLESS, STREEL & THOREZ, 1974, Gafo Formation, sample 13, slide 3, 1290-100.

Fig. 19. *Aneurospora greggsii* (MCGREGOR) STREEL in BECKER, BLESS, STREEL & THOREZ, 1974; PQ Formation, borehole M-1, sample 126.3m, slide 1, 1425-110.

Fig. 20. *Aneurospora greggsii* (MCGREGOR) STREEL in BECKER, BLESS, STREEL & THOREZ, 1974;Gafo Formation, sample 13, slide 1, 1050-75.

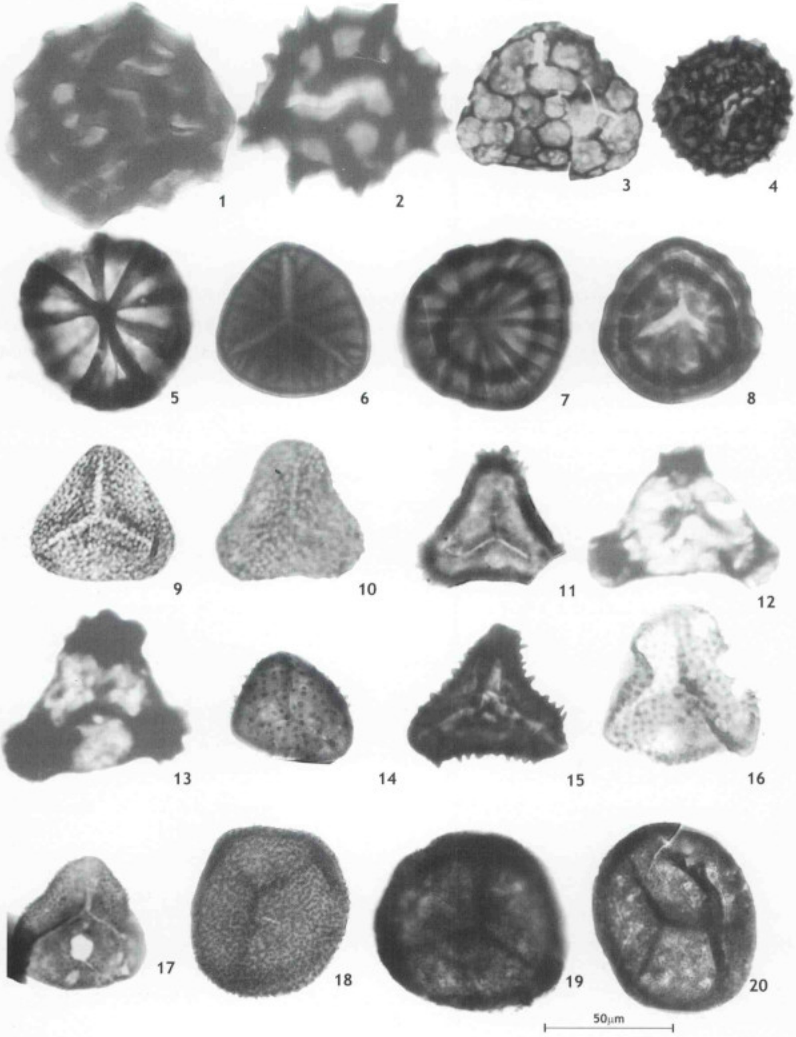
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Plate 6

Fig. 1. *Bellispores nitidus* (Horst) SULLIVAN 1964; Murração Formation, sample 229, slide 2, 1368-210.

Fig. 2. *Bellispores nitidus* (Horst) SULLIVAN 1964; Mértola Formation, borehole SQ 14, sample 391. 6m, slide 1, 1050-146

Fig. 3. *Knoxisporites concentricus* (BYVSCHEVA) PLAYFORD & MCGREGOR, 1993; Tercenas Formation, sample 106, slide 1, 1225-88.

Fig. 4. *Knoxisporites concentricus* (BYVSCHEVA) PLAYFORD & MCGREGOR, 1993; Tercenas Formation, sample 284, slide 2, 1238-205.

Fig. 5. *Knoxisporites literatus* (WALTZ) PLAYFORD, 1963;Quebradas Formation, sample 388, slide 1, 1340-83.

Fig. 6. *Knoxisporites hederatus* (ISHCHENKO) PLAYFORD, 1962; Graça Formation, borehole SO 28, sample 472.7m, slide 2, 1268-80.

Fig. 7. *Knoxisporites hederatus* (ISHCHENKO) PLAYFORD, 1962; Graça Formation, borehole SO 28, sample 472.7m, slide 2, 1355-175.

Fig. 8. *Koxisporites ruhlandii* DOUBINGER & RAUSCHER, 1966; Graça Formation, borehole SO 28, sample 472.7m, slide 5, 1475-123.

Fig. 9. *Koxisporites ruhlandii* DOUBINGER & RAUSCHER, 1966;Graça Formation, borehole SO 28, sample 472.7m, slide 1, 1155-235.

Fig. 10. *Knoxisporites triradiatus* HOFFMEISTER, STAPLIN & MALLOY sensu SULLIVAN 1964; Murração Formation, Sample 9, slide 3, 1058-86.

Fig. 11. *Knoxisporites triradiatus* HOFFMEISTER, STAPLIN & MALLOY sensu SULLIVAN 1964; Graça Formation, Borehole SO 28, sample 472.7m, slide 5, 1485-200.

Fig. 12. *Knoxisporites* cf. *triradiatus* HOFFMEISTER, STAPLIN & MALLOY sensu SULLIVAN, 1964; Bordalete Formation, sample 147, slide 2, 1145-120.

Fig. 13. *Knoxisporites* cf. *triradiatus* HOFFMEISTER, STAPLIN & MALLOY sensu SULLIVAN, 1964; Quebradas Formation, sample 388, slide 2, 1390-115.

Fig. 14. *Knoxisporites stephanephorus* LOVE 1960; Murração Formation, sample 379, slide 1, 1082-240.

Fig. 15. *Knoxisporites stephanephorus* LOVE, 1960; Graça Formation, borehole SO 28, sample 472.7m, slide 5, 1473-68.

Fig. 16. *Rotaspora fracta* (SCHEMEL) SMITH & BUTTERWORTH, 1967; Mértola Formation, borehole SD 34, Sample 284.2m, slide 1, 1173-95.

Fig. 17. *Rotaspora knoxi* BUTTERWORTH & WILLIAMs, 1958; Murração Formation, sample 29, slide 2, 1035-168.

Fig. 18. *Reticulatisporites reticulatus* (IBRAHIM) IBRAHIM 1933; Quebradas Formation, sample 195, slide 1, 1364-35.

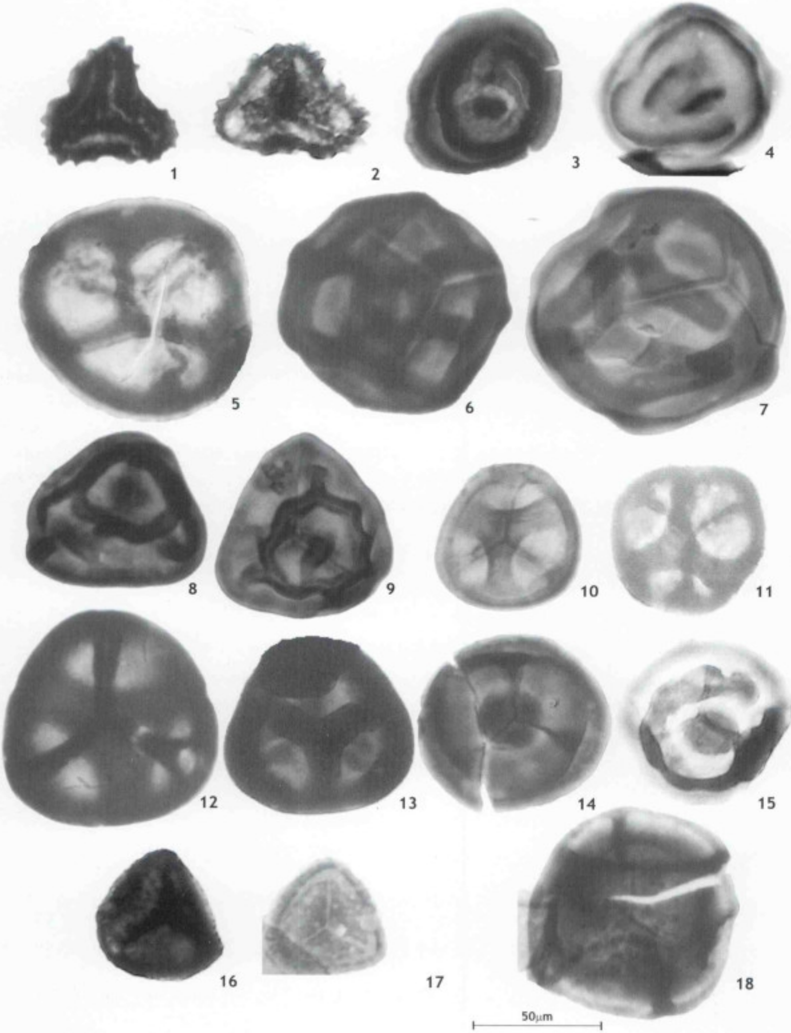
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PLATE 7

Fig. 1. *Secarisporites remotus* NEVES, 1961; Bordalete Formation, sample 147, slide 1, 1123-35.

Fig. 2. *Reticulatisporites polygonalis* (IBRAHIM) SMITH & BUTTERWORTH, 1967; Quebradas Formation, sample 388, slide 4, 1215-152.

Fig. 3. *Reticulatisporites peltatus* PLAYFORD, 1962; Brejeira Formation, sample 229, slide 1, 1435-157.

Fig. 4. *Savitrisporites nux* (BUTTERWORTH & WILLIAMS) SMITH & BUTTERWORTH 1967; Murração Formation, Sample 387, slide 2, 1160-255;

Fig. 5. *Savitrisporites nux* (BUTTERWORTH & WILLIAMS) SMITH & BUTTERWORTH 1967; Mértola Formation, Borehole SQ 14, sample 391.6m, slide 1, 1228-210.

Fig. 6. *Savitrisporites nux* (BUTTERWORTH & WILLIAMS) SMITH & BUTTERWORTH 1967; Quebradas Formation, sample 387, slide 2, 1160-255.

Fig. 7. *Savitrisporites concavus* MARSHALL & SMITH, 1964; Brejeira Formation, sample 226, slide 2, 1055-188.

Fig. 8. *Savitrisporites* sp. A; Quebradas Formation, sample 387, slide 2, 1332-150.

Fig. 9. *Savitrisporites* sp. A; Quebradas Formation, sample 387, slide 2, 1414-145.

Fig. 10. *Tumulispora rarituberculata* (LUBER) PLAYFORD 1991; Bordalete Formation, sample 324, slide 1, 1465-138.

Fig. 11. *Tumulispora rarituberculata* (LUBER) PLAYFORD 1991; Bordalete Formation, sample 324, slide 1, 1098-105.

Fig. 12. *Tumulispora rarituberculata* (LUBER) PLAYFORD 1991;Bordalete Formation, sample 46, slide 2, 1300-206.

Fig. 13. *Tumulispora rarituberculata* (LUBER) PLAYFORD 1991;Bordalete Formation, sample 46, slide 2, 1300-105.

Fig. 14. *Archaeozonotriletes chulus* (CRAMER) RICHARDSON & LISTER, 1969; PQ Formation, borehole M-1, sample 126.3m, 1210-145.

Fig. 15. *Chelinospora concinna* ALLEN, 1965, Ribeira de Limas Formation, sample 1, slide 1, 1320-205.

Fig. 16. *Cymbosporites magnificus* (McGregor) McGregor & Camfield, 1982; Ribeira de Limas Formation, sample RL3, slide 2, 1458-124.

Fig. 17. *Cymbosporites magnificus* (McGregor) McGregor & Camfield, 1982; PQ Formation, borehole M-1, sample 126.3m, slide 2, 1425-112.

Fig. 18. *Cyrtospora cristifera* (Luber) emend. VAN DER ZWAN 1979; Bordalete Formation, sample 147, slide 3, 1155-120.

Fig. 19. *Cyrtospora cristifera* (LUBER) emend. VAN DER ZWAN 1979; Bordalete Formation, sample 290, slide 3, 1232-54.

Fig. 20. *Cyrtospora cristifera* (LUBER) emend. VAN DER ZWAN 1979; Bordalete Formation, sample 216, slide 2c, 1198-120, equatorial.

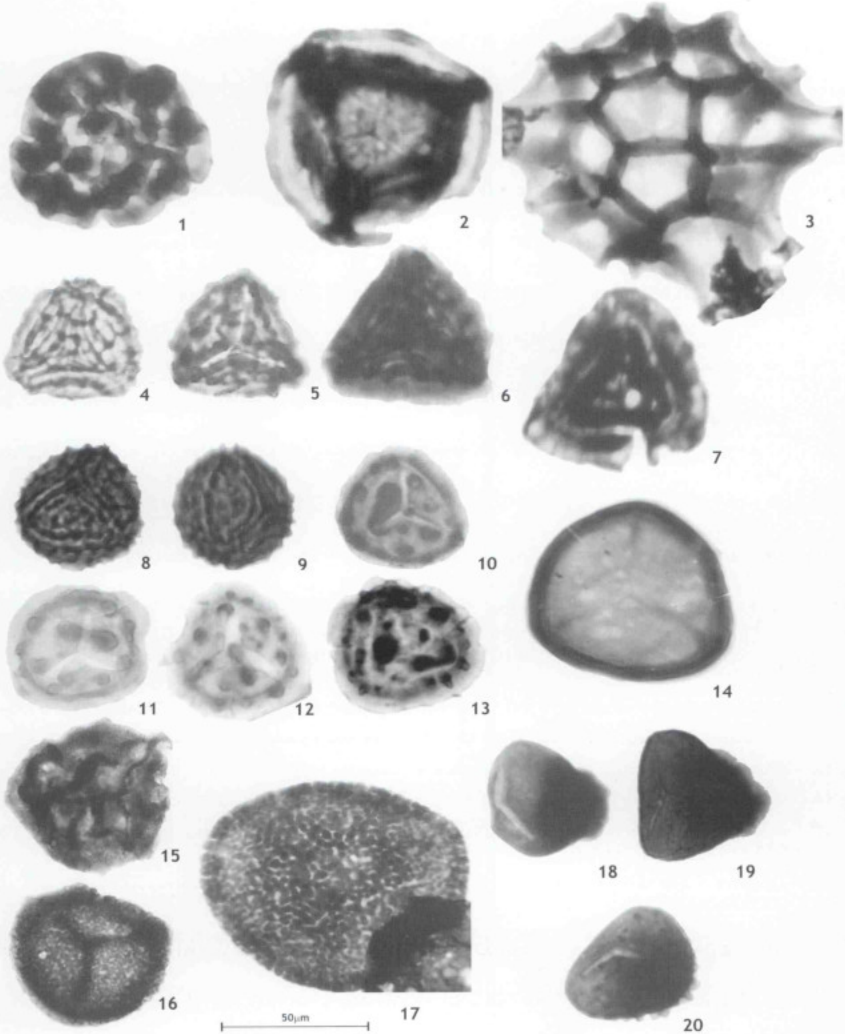
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PLATE 8

Fig. 1. *Cristatisporites* sp. cf. *C. inusitatus* (ALLEN) MCGREGOR & CAMFIELD, 1982, Ribeira de Limas Formation, sample RL3, slide 3, 1260-228.

Fig. 2. *Camarozonotriletes sextantii* MCGREGOR & CAMFIELD, 1976; PQ Formation, borehole M-1, sample 126.3m, slide 2, 1365-175.

Fig. 3. *Cingulizonates loricatus* (LOOSE) BUTTERWORTH & SMITH, 1964; Brejeira Formation, sample 240, slide b1,1465-80.

Fig. 4. *Cirratriradites saturni* (IBRAHIM) SCHOPF, WILSON & BENTALL, 1944; Brejeira Formation, sample 266, slide 1, 1260-87.

Fig. 5. *Cristatisporites indignabundus* (LOOSE) STAPLIN & JANSONIUS, 196; Brejeira Formation, sample 242, slide 5, 1470-250.

Fig. 6. *Cristatisporites triangulatus* (ALLEN) MCGREGOR & CAMFIELD, 1982; Represa Formation, borehole MP3, sample 36.60m, slide 1, 1090-180.

Fig. 7. *Cristatisporites triangulatus* (ALLEN) MCGREGOR & CAMFIELD, 1982; Neves Formation, borehole SJ17, sample 388.0m, slide 1, 1380-145.

Fig. 8. *Cristatisporites triangulatus* (ALLEN) MCGREGOR & CAMFIELD, 1982; Gafo Formation, sample 13, slide 2, 1315-165.

Fig. 9. *Densosporites annulatus* (LOOSE) SMITH & BUTTERWORTH, 1967; Brejeira Formation, sample 229, slide 2, 1340-225.

Fig. 10. *Densosporites rarispinosum* PLAYFORD, 1962; Godinho Formation, borehole SD 34, sample 474. 5m, slide 1, 1095-58.

Fig. 11. *Densosporites rarispinosum* PLAYFORD, 1962; Godinho Formation, Borehole SD 34, sample 474. 5m, slide 2, 1342-195.

Fig. 12. *Densosporites rarispinosum* PLAYFORD, 1962; Godinho Formation, Borehole SD 34, sample 474. 5m, slide 1, 1270-255.

Fig. 13. *Densosporites spitbergensis* PLAYFORD, 1963; Tercenas Formation, sample 105, slide 1, 1480-97.

Fig. 14. *Indotrirradites explanatus* (LUBER) KEDO 1963; Tercenas Formation, sample 106, slide b2, 1391-165.

Fig. 15. *Kraeuselisporites fasciatus* HIGGS, 1975; Bordalete Formation, sample 147, slide 2, 1305-105.

Fig. 16. *Indotriradites mitratus* (HIGGS) HIGGS, 1996; Bordalete Formation, sample 147, slide 3, 1150-241.

Fig. 17. *Radiizonates aligerens* (KNOX) STAPLIN & JANSONIUS 1964; Brejeira Formation, sample 242, slide 5, 1240-210.

Fig. 18. *Lycospora pusilla* (IBRAHIM) SCHOPF, WILSON & BENTALL 1944; Murração Formation, Sample 280, slide 1,1220-175.

Fig. 19. *Lycospora pusilla* (IBRAHIM) SCHOPF, WILSON & BENTALL 1944; MDS1 Borehole, VSC, sample 255, 30m, slide 1, 1155-75.

Fig. 20. *Vallatisporites microspinosus* CLAYTON, HIGGS & KEEGAN, 1988; Bordalete Formation, sample 147, slide 4, 1320-170.

Fig. 21. *Vallatisporites verrucosus* HACQUEBARD,1957;Bordalete Fm, sample 147, slide 2, 1205-48.

Fig. 22. *Vallatisporites verrucosus* HACQUEBARD, 1957; Bordalete Fm, Sample 147, slide 2, 1330-155.

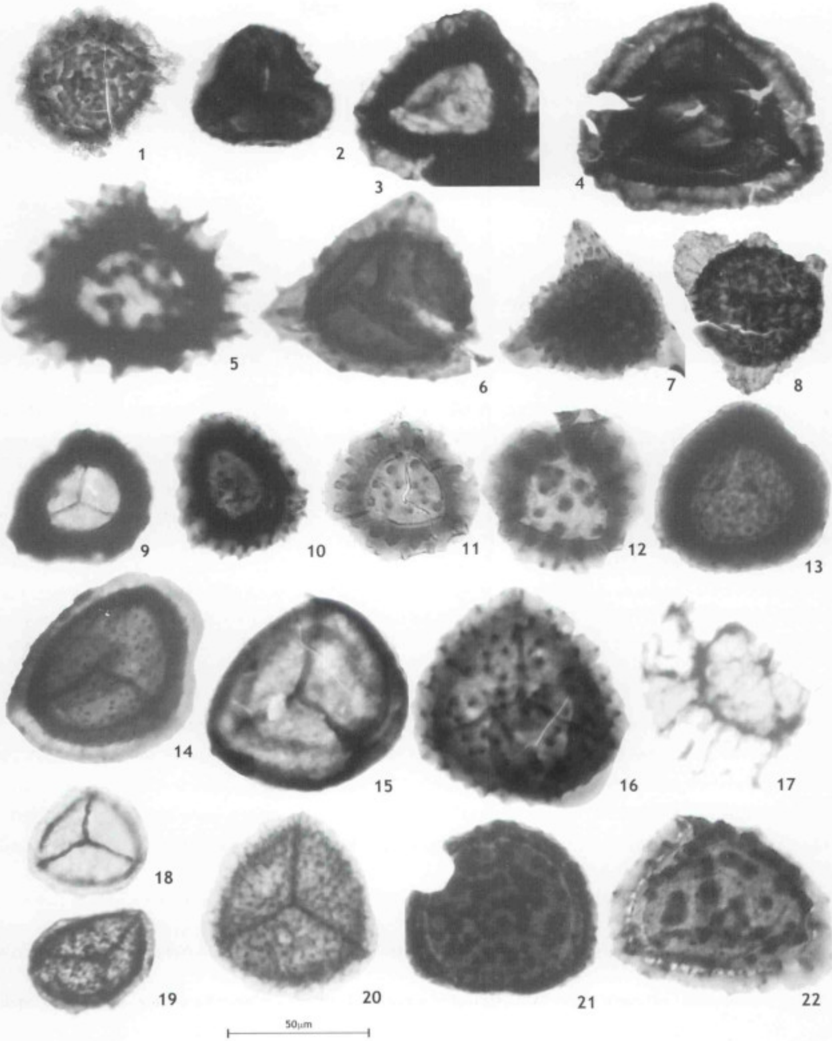
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Plate 9

Fig. 1. *Vallatisporites pusillites* (KEDO) DOLBY & NEVES, 1970; Tercenas Formation, sample 283, slide c1, 1155-182.

Fig. 2. *Vallatisporites pusillites* (KEDO) DOLBY & NEVES, 1970; PQ Formation, borehole CA 1, sample 323, slide 1, 1138-155.

Fig. 3. *Vallatisporites hystricosus* (WINSLOW) BYVSCHEVA, 1985; PQ Formation, borehole SD 34, sample 941.8 m, slide 1, 1225-115.

Fig. 4. *Auroraspora corporiga* HIGGS, CLAYTON & KEEGAN, 1988; Tercenas Formation, sample 399, slide 1, 1464-198.

Fig. 5. *Ancyrospora? andevalensis* GONZÁLEZ, PLAYFORD & MORENO, 2008; PQ Formation, borehole CP2, sample 41.5m, slide 1, 1225-40.

Fig. 6. *Ancyrospora? andevalensis* GONZÁLEZ, MORENO & PLAYFORD, 2005; Horta da Torre Formation, sample 8, slide 1, 1440-120.

Fig. 7. *Auroraspora macra* SULLIVAN, 1968; Tercenas Formation, sample 399, slide 1, 1164-93.

Fig. 8. *Auroraspora macra* SULLIVAN, 1968;Tercenas Formation, sample 399, slide 1, 1460-198.

Fig. 9. *Diducites mucronatus* (KEDO) emend. VAN VEEN, 1981; Tercenas Formation, sample 400, slide 2, 1275-242.

Fig. 10. *Diducites poljessicus* (KEDO) emend. VAN VEEN, 1981; Tercenas Formation, sample 400, slide 1, 1291-205.

Fig. 11. *Diducites versabilis* (KEDO) emend. VAN VEEN, 1981; Tercenas Formation, sample 400, slide 1, 1346-170.

Fig. 12. *Cristicavatispora dispersa* GONZÁLEZ, PLAYFORD & MORENO, 2005; Represa Formation, sample EM4, slide 1, 1225-185.

Fig. 13. *Cristicavatispora dispersa* GONZÁLEZ, PLAYFORD & MORENO, 2005; Tercenas Formation, sample 284, slide 1, 1325-32.

Fig. 14. *Cristicavatispora dispersa* GONZÁLEZ, PLAYFORD & MORENO, 2005; Sta Iria Formation, sample MM7, slide 1, 1223-35.

Fig. 15. *Endoculeospora gradzinskii* TURNAU, 1975; PQ Formation, borehole CP2, sample 41.5m, slide 2, 1045-88.

Fig. 16. *Diducites versabilis (*Kedo) emend. VAN VEEN, 1981; PQ Formation, borehole CP2, sample 41.5m, slide 2, 1465-220.

Fig. 17. *Endoculeospora gradzinskii* TURNAU, 1975; PQ Formation, borehole CP2, sample 41.5m, slide 2, 1332-175.

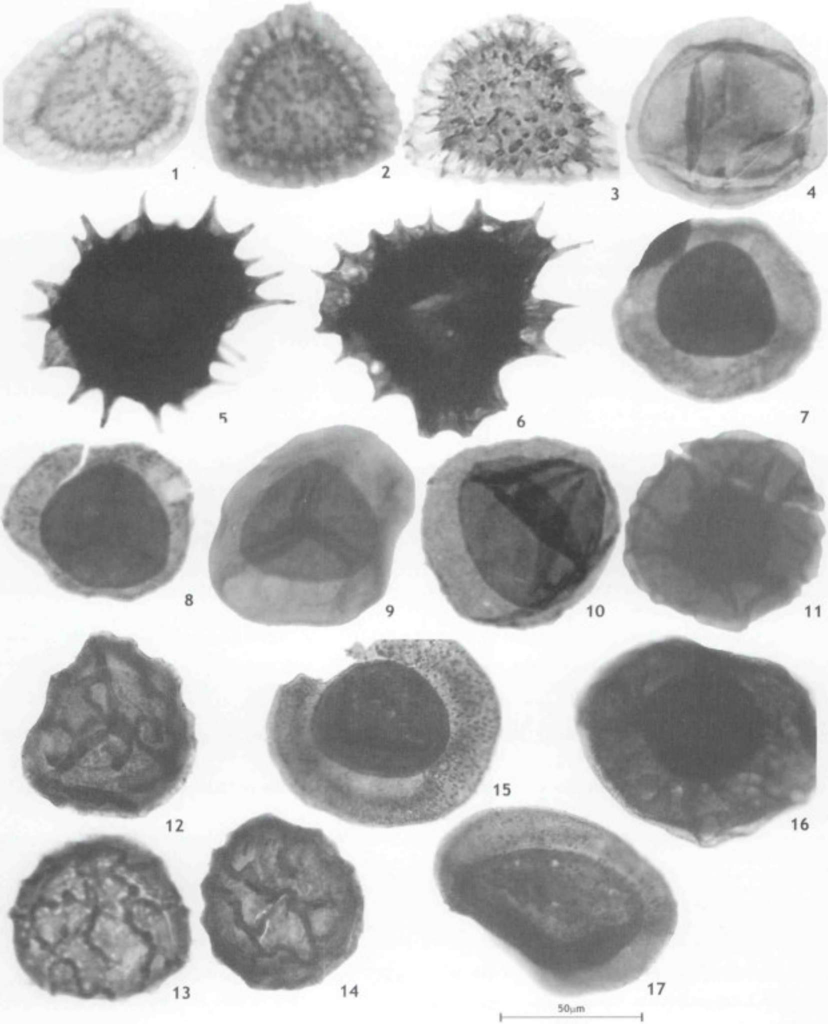
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PLATE 10

Fig. 1. *Endosporites globiformis* (IBRAHIM) SCHOPF, WILSON & BENTALL, 1944; Brejeira Formation, sample 22, slide 4, 1320-137.

Fig. 2. *Endosporites tuberosus* GONZÁLEZ, MORENO & PLAYFORD, 2005; Neves Formation, borehole SJ 17, 388.0m, slide 2, 1238-98.

Fig. 3. *Endosporites tuberosus* GONZÁLEZ, MORENO & PLAYFORD, 2005; Bordalete Formation, sample 334, slide 1, 1490-70.

Fig. 4. *Epigruspora regularis* GONZÁLEZ, MORENO & PLAYFORD, 2005; Neves Formation, borehole SJ 17, 388.0m, slide 2, 1291-170.

Fig. 5. *Epigruspora regularis* GONZÁLEZ, MORENO & PLAYFORD, 2005; Neves Formation, borehole SJ 17, 388.0m, slide 1, 1250-112.

Fig. 6. *Epigruspora regularis* GONZÁLEZ, MORENO & PLAYFORD, 2005; Neves Formation, borehole SJ 17, 388.0m, slide 1, 1088-175.

Fig. 7. *Geminospora spongiata* HIGGS, CLAYTON & KEEGAN, 1988; Tercenas Formation, sample 105, slide 1, 1245-230.

Fig. 8. *Geminospora lemurata* BALME emend. PLAYFORD, 1983; Neves Formation, borehole SJ 17, 388.0m, slide 1, 1325-10.

Fig. 9. *Geminospora lemurata* BALME emend. PLAYFORD, 1983; PQ Formation, borehole CP2, sample 170.0 m, slide 1, 1165-115.

Fig. 10. *Grandispora cornuta* HIGGS 1975; PQ Formation, borehole CP2, sample 170.0 m, slide 1, 1242-105.

Fig. 11. *Grandispora cornuta* HIGGS 1975; PQ Formation, borehole CP2, sample 170.0 m, slide 1, 1340-165.

Fig. 12. *Grandispora cornuta* HIGGS 1975; Represa Formation, borehole MP3, sample 36.60m, slide 1, 1305-225.

Fig. 13. *Grandispora cornuta* HIGGS 1975; Represa Formation, sample EM1, slide 1, 1474-65.

Fig. 14. *Grandispora cornuta* HIGGS 1975; PQ Formation, borehole CP2, sample 170.0 m, slide 2, 1126-55.

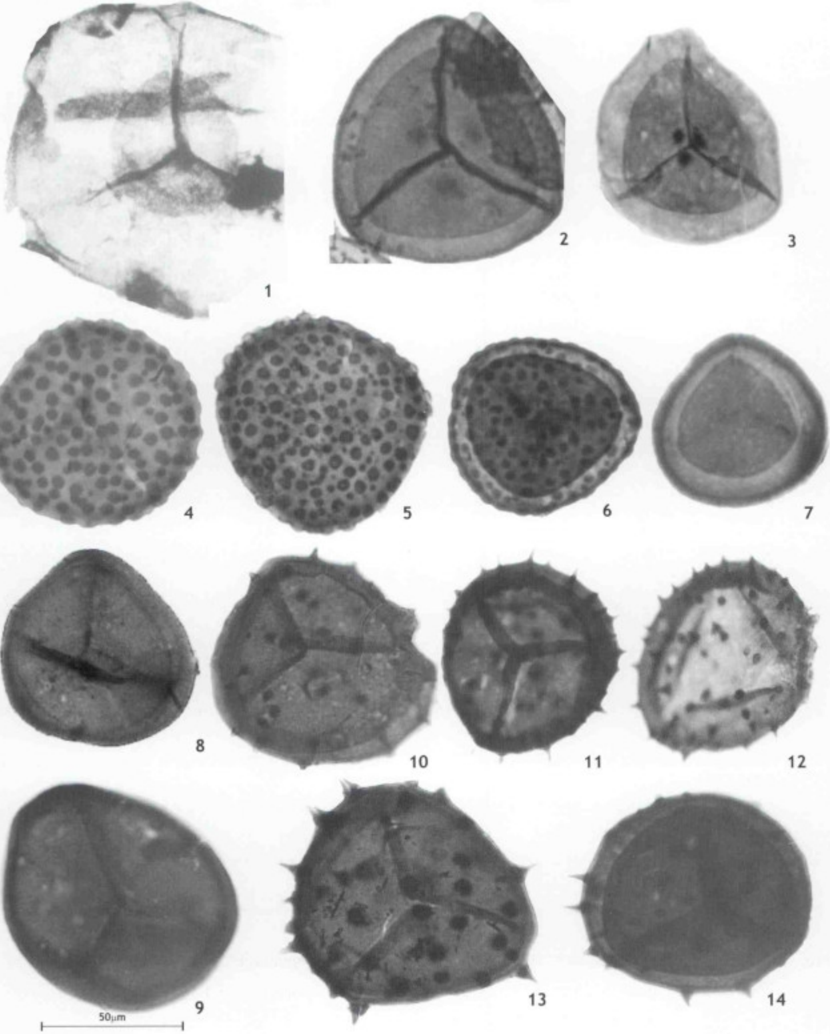
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PLATE 11

Fig. 1. *Grandispora echinata* HACQUEBARD emend. UTTING, 1987; Represa Formation, sample EM1, slide 1, 1226-142.

Fig. 2. *Grandispora echinata* HACQUEBARD emend. UTTING, 1987; Horta da Torre Formation, sample HT8, slide 2, 1015-246.

Fig. 3. *Grandispora echinata* HACQUEBARD emend. UTTING, 1987; Horta da Torre Formation, sample HT7, slide 2b, 1255-125.

Fig. 4. *Grandispora echinata* HACQUEBARD emend. UTTING, 1987; Neves Formation, borehole SJ 17, 388.0m, slide 3, 1275-127.

Fig. 5. *Grandispora echinata* HACQUEBARD emend. UTTING, 1987; Represa Formation, sample EM4, slide 1a, 1088-125.

Fig. 6. *Grandispora acuta* HIGGS, HIGGS, AVKHIMOVITCH, LOBOZIAK, MAZIANE-SERRAJ, STEMPIEN-SALEK & STREEL 2000; Tercenas Formation, sample 106, slide 4, 1390-145.

Fig. 7. *Grandispora acuta* HIGGS, HIGGS, AVKHIMOVITCH, LOBOZIAK, MAZIANE-SERRAJ, STEMPIEN-SALEK & STREEL 2000; Tercenas Formation, sample 106, slide 4, 1390-145.

Fig. 8. *Retispora lepidophyta* (Kedo) PLAYFORD 1976; Tercenas Formation, sample 6, slide 4, 1420-140;

Fig. 9. *Retispora lepidophyta* (Kedo) PLAYFORD 1976; Tercenas Formation, sample 105, slide 1, 1350-210;

Fig. 10. *Retispora lepidophyta* (Kedo) PLAYFORD 1976; Neves Formation, borehole SJ 17, sample 388.0m, slide 1, 1041-164.

Fig. 11. *Retispora macroreticulata* (KEDO) BYVSHEVA, 1985; PQ Formation, borehole CP2, sample 170.0 m, slide 1, 1095-155.

Fig. 12. *Retispora macroreticulata* (KEDO) BYVSHEVA, 1985; PQ Formation, borehole CP2, sample 170.0 m, slide 2, 1425-150.

Fig. 13. *Grandispora variospinosa* MCGREGOR & CAMFIELD, 1982; PQ Formation, borehole M1, sample 135.0m, slide 1, 1224-140.

Fig. 14. *Grandispora protea* (NAUMOVA) MOREAU-BENOIT, 1980; PQ Formation, borehole M1, sample 135.0m, slide 2, 1465-75.

Fig. 15. *Rugospora explicata* GONZALEZ, PLAYFORD &MORENO, 2005; PQ Formation, borehole CP2, sample 170.0 m, slide 1b, 1232-45.

Fig. 16. *Rugospora explicata* GONZALEZ, PLAYFORD &MORENO, 2005; Horta da Torre Formation, Sample 7, slide 3, 1505-200.

Fig. 17. *Rugospora explicata* GONZALEZ, PLAYFORD &MORENO, 2005; Represa Formation, sample EM1, slide 1, 1145-75.

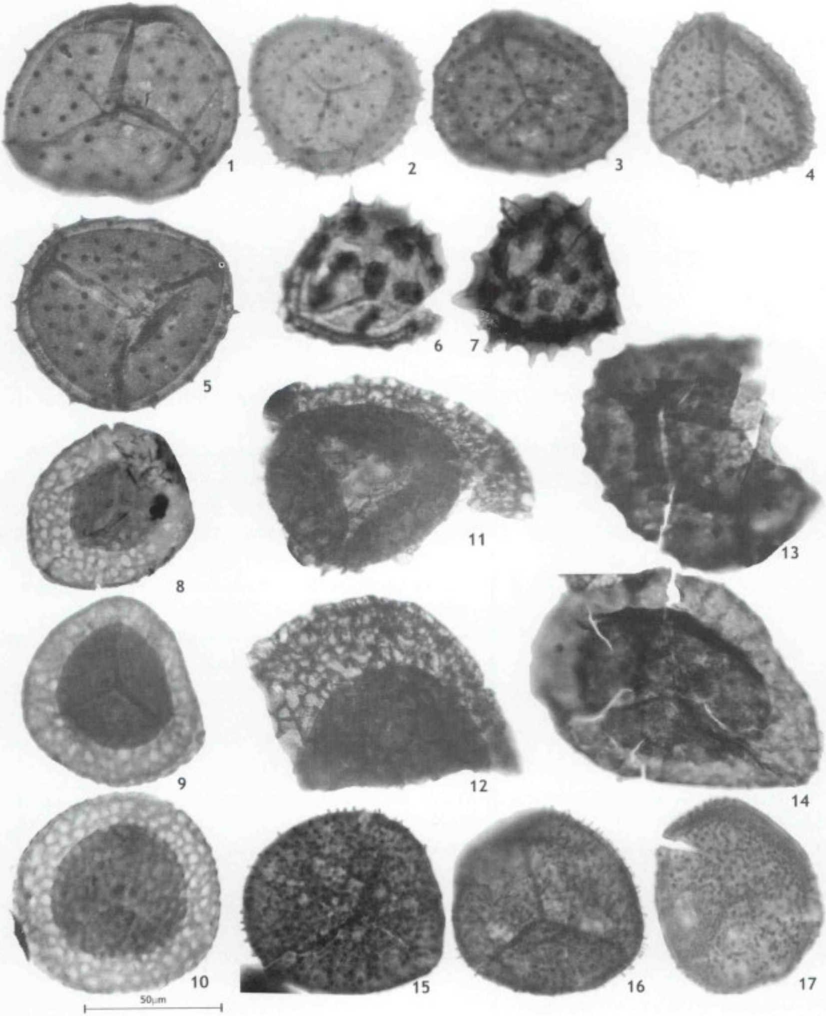
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PLATE 12

Fig. 1. *Rugospora flexuosa* (JUSHKO) STREEL, 1974; Horta da Torre Formation, Sample HT7, slide 1a, 1390-105.

Fig. 2. *Rugospora flexuosa* (JUSHKO) STREEL, 1974; PQ Formation, borehole CP2, sample 170.0 m, slide 2, 1075-198.

Fig. 3. *Spelaeotriletes arenaceus* NEVES & OWENS, 1966; Graça Formation, borehole SO 28, sample 472.7m, slide 1, 1120-140.

Fig. 4. *Spelaeotriletes arenaceus* NEVES & OWENS, 1966; Graça Formation, borehole SO 28, sample 472.7m, slide 1, 1225-175.

Fig. 5. *Spelaeotriletes balteatus* (PLAYFORD) HIGGS 1975; Bordalete Formation, sample 147, slide 4, 1345-195.

Fig. 6. *Spelaeotriletes pretiosus* (PLAYFORD) NEVES & BELT 1970; Bordalete Formation, sample 247, slide 4, 1354-65.

Fig. 7. *Spelaeotriletes pretiosus* (PLAYFORD) NEVES & BELT 1970; Graça Formation, borehole SO 28, sample 472.7m, slide 5, 1065-120.

Fig. 8. *Teichertospora iberica* GONZALEZ, PLAYFORD & MORENO, 2005; Horta da Torre Formation, sample 7, slide 2b, 1450-185.

Fig. 9. *Teichertospora iberica* GONZALEZ, PLAYFORD & MORENO, 2005; Neves Formation, borehole SJ 17, sample 388.0m, slide 1, 1335-75.

Fig. 10. *Aratrisporites saharaensis* Loboziak, Clayton & Owens, 1986; Neves Formation, borehole SJ 17, sample 388.0m, slide 1, 1215-130.

Fig. 11. *Latosporites* sp. A sensu OWENS, 1971; Tercenas Formation, sample 284, slide 2, 1420-105.

Fig. 12. *Propisporites laevigatus* NEVES, 1961; Murração Formation, sample 279, slide 1, 1215-132.

Fig. 13. *Thymospora pseudothiessenii* (KOSANKE) WILSON & VENKATACHALA 1963; Brejeira Formation, Sample 63, slide 1, 1220-185.

Fig. 14. *Thymospora pseudothiessenii* (KOSANKE) WILSON & VENKATACHALA 1963;Brejeira Formation, Sample 63, slide 1, 1315-170.

Fig. 15. *Thymospora obscura* (KOSANKE) WILSON & VENKATACHALA 1963; Brejeira Formation, sample 63, slide 4, 1045-65.

Fig. 16. *Colatisporites decorus* (BHARADWAJ & VENKATACHALA) WILLIAMS in NEVES et al., 1973; Tercenas Formation, sample 106, slide 4, 1455-187.

Fig. 17. *Torispora securis* BALME 1952; Brejeira Formation, Sample 63, slide 1, 1135-185.

Fig. 18. *Torispora securis* BALME 1952;Brejeira Formation, sample 63, slide 3, 1215-216.

Fig. 19. *Florinites junior* POTONIÉ & KREMP 1954; Brejeira Formation, Sample 229, slide 3, 1145-100.

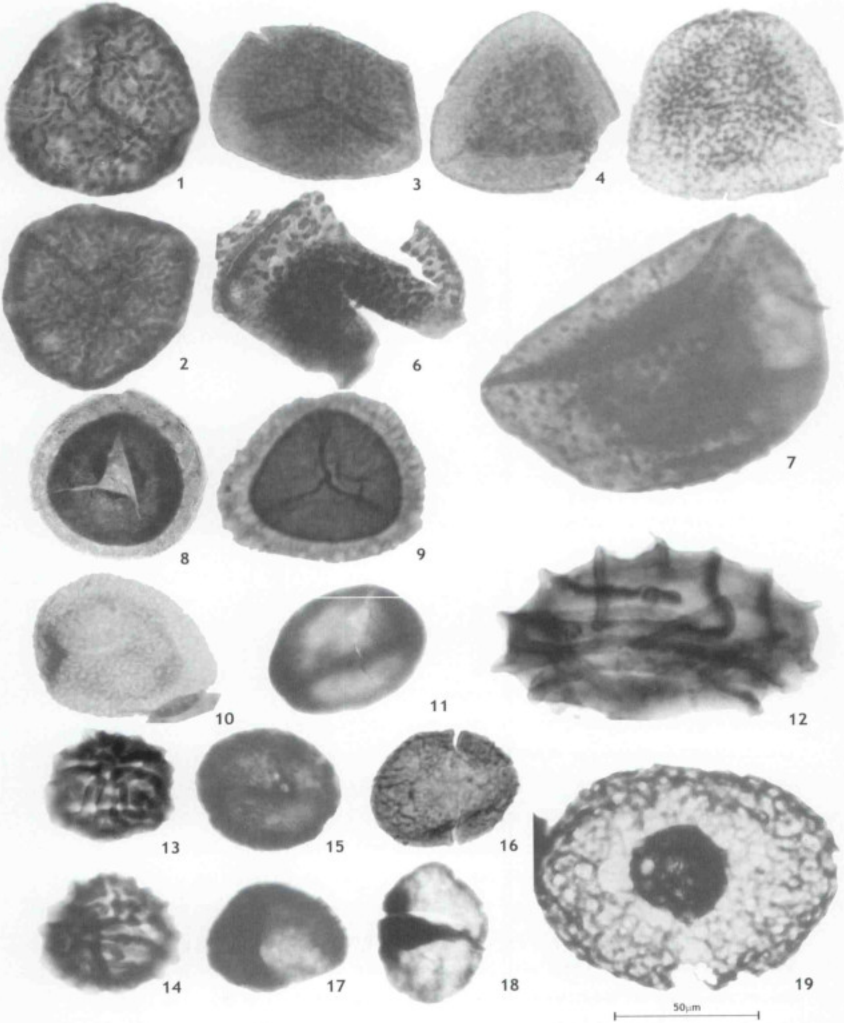
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Plate 13

Fig. 1. *Leiosphaeridia* spp.; Tercenas Formation, sample 105, slide 1, 1405-125.

Fig. 2. *Tasmanites* spp.; PQ Formation, borehole CP2, sample 170,0m, slide 2, 1472-65.

Fig. 3. *Cymatiosphaera perimembrana* STAPLIN, 1961;Tercenas Formation, sample 106, slide 1, 1196-150.

Fig. 4. *Dictyotidium litum* COLBATH, 1990; PQ Formation, sample EM4, slide 2b, 1130-180.

Fig. 5. *Maranhites brasiliensis* BRITO, 1965; Neves Formation, sample 388, 0 m, slide 1, 1385-120.

Fig. 6. *Maranhites brasiliensis* BRITO, 1965; Neves Formation, sample 388, 0 m, slide 1, 1268-175.

Fig. 7. *Maranhites britoii* STOCKMANS & WILLIERE, 1969; Neves Formation, sample 388, 0 m, slide 1, 1255-40.

Fig. 8. *Maranhites gallicus* TAUGOURDEAU-LANTZ, 1968; Neves Formation, sample 388, 0 m, slide 1, 1285-165.

Fig. 9. *Maranhites gallicus* TAUGOURDEAU-LANTZ, 1968; Neves Formation, sample 388, 0 m, slide 1, 11375-95.

Fig. 10. *Maranhites britoii* STOCKMANS & WILLIERE, 1969; Neves Formation, sample 388, 0 m, slide 1, 1232-125.

Fig. 11. *Maranhites mosesii* (SOMMER) BRITO, 1967; Neves Formation, sample 388, 0 m, slide 1, 1328-115.

Fig. 12. *Maranhites mosesii* (SOMMER) BRITO, 1967; Neves Formation, sample 388, 0 m, slide 1, 1280-55.

Fig. 13. *Maranhites mosesii* (SOMMER) BRITO, 1967; Neves Formation, sample 388, 0 m, slide 1,1320-45.

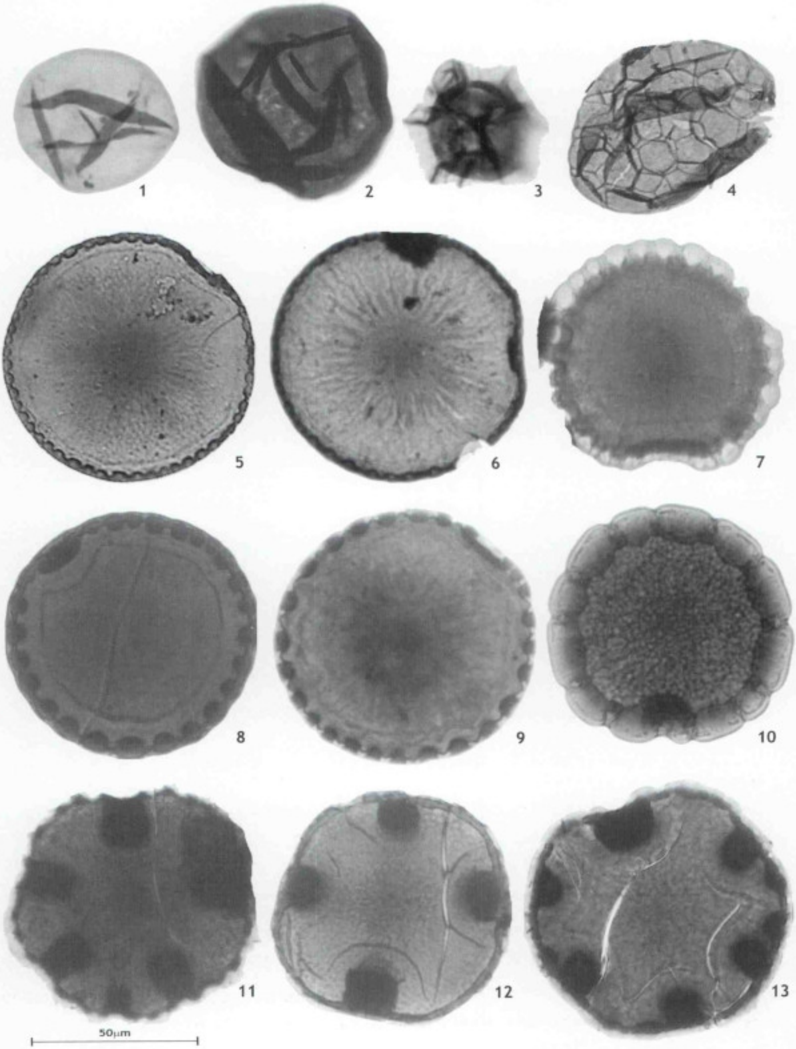
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Plate 14

Fig. 1. *Maranhites multioculus* GONZÁLEZ, MORENO & PLAYFORD, 2005;Neves Formation, sample 388, 0 m, slide 1, 1235-68.

Fig. 2. *Maranhites multioculus* GONZÁLEZ, MORENO & PLAYFORD, 2005; Neves Formation, sample 388, 0 m, slide 1, 1375-155.

Fig. 3. *Maranhites multioculus* GONZÁLEZ, MORENO & PLAYFORD, 2005; Neves Formation, sample 388, 0 m, slide 1, 1224-170.

Fig. 4. *Maranhites perplexus* WICANDER & PLAYFORD, 1985; Neves Formation, sample 388, 0 m, slide 1, 1225-50.

Fig. 5. *Maranhites perplexus* WICANDER & PLAYFORD, 1985; Neves Formation, sample 388, 0 m, slide 1, 1445-220.

Fig. 6. *Maranhites perplexus* WICANDER & PLAYFORD, 1985; Neves Formation, sample 388, 0 m, slide 1, 1228-165.

Fig. 7. *Maranhites perplexus* WICANDER & PLAYFORD, 1985; Neves Formation, sample 388, 0 m, slide 1, 1158-98.

Fig. 8. *Maranhites* sp. A; Neves Formation, sample 388, 0 m, slide 1, 1255-125.

Fig. 9. *Maranhites* sp. B; Neves Formation, sample 388, 0 m, slide 1, 1345-70.

Fig. 10. *Pterospermella euriptio* MARTIN, 1984; Tercenas Formation, sample 105, slide 2, 1472-65.

Fig. 11. *Pterospermella euriptio* MARTIN, 1984; PQ Formation, sample EM4, slide 2, 1025-190.

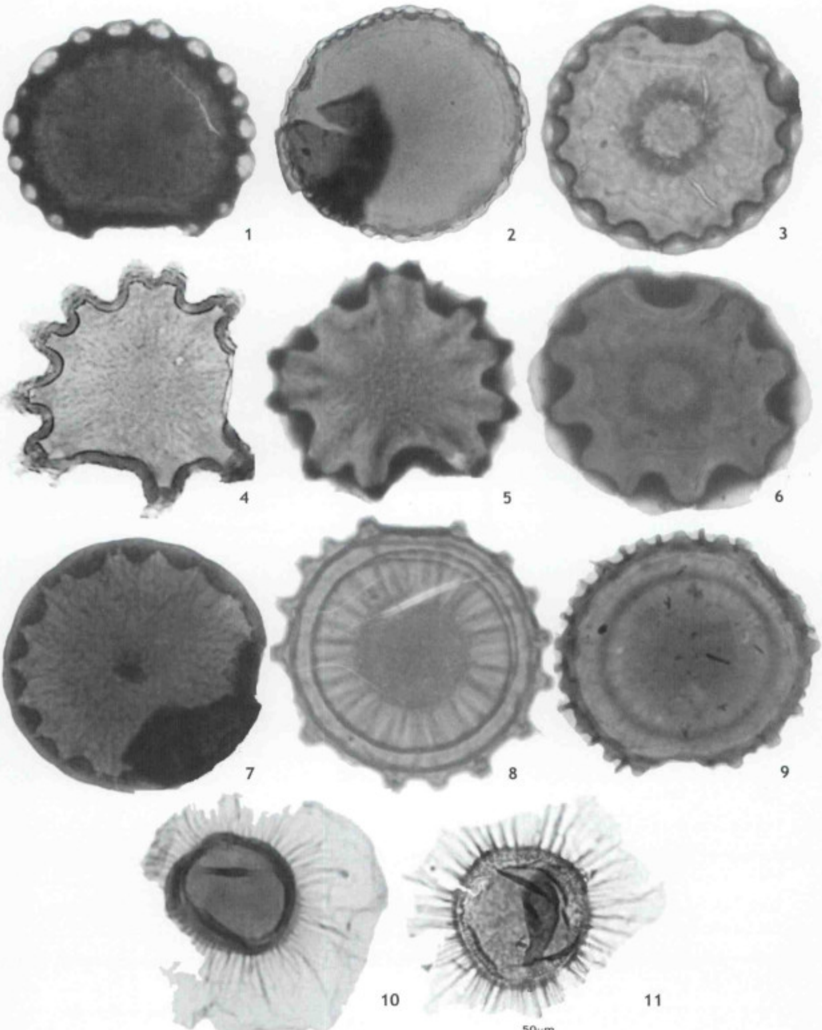
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Plate 15

Fig. 1. *Duvernaysphaera radiata* BRITO, 1967; Tercenas Formation, sample 106, slide 2b, 1295-241.

Fig. 2. *Duvernaysphaera radiata* BRITO, 1967; Tercenas Formation, sample 106, slide 1, 1505-45.

Fig. 3. *Duvernaysphaera stellata* DEUNFF, 1964; Tercenas Formation, sample 106, slide 1, 1478-100.

Fig. 4. *Duvernaysphaera tessella* DEUNFF, 1964; Tercenas Formation, sample 106, slide 2c, 1218-170.

Fig. 5. *Chomotriletes vedugensis* NAUMOVA, 1953; Neves Formation, sample 388, 0 m, slide 1, 1290-195.

Fig. 6. *Crassiangulina tesselita* JARDINÉ, COMBAZ, MAGLOIRE, PENINGUEL & VACHEY, 1972; Horta da Torre Formation, sample 8, slide 5, 1145-88.

Fig. 7. *Crassiangulina tesselita* JARDINÉ, COMBAZ, MAGLOIRE, PENINGUEL & VACHEY, 1972; Horta da Torre Formation, sample 8, slide 5, 1175-155.

Fig. 8. *Crassiangulina tesselita* JARDINÉ, COMBAZ, MAGLOIRE, PENINGUEL & VACHEY, 1972; PQ Formation, sample EM4, slide 2 a, 1325-90.

Fig. 9. *Crassiangulina tesselita* JARDINÉ, COMBAZ, MAGLOIRE, PENINGUEL & VACHEY, 1972; PQ Formation, sample EM4, slide 2 b, 1275-45.

Fig. 10. *Craterisphaeridium sprucegrovense* (STAPLIN) TURNER, 1986; Horta da Torre Formation, sample 7, slide 1a, 1400-80.

Fig. 11. *Craterisphaeridium sprucegrovense* (STAPLIN) TURNER, 1986; Horta da Torre Formation, sample 7, slide 2b, 1320-115.

Fig. 12. *Craterisphaeridium sprucegrovense* (STAPLIN) TURNER, 1986; Horta da Torre Formation, sample 7, slide 2b, 1320-115 (1250x).

Fig. 13. *Deltotosoma* sp.; PQ Formation, sample EM4, slide 2, 1165-135.

Fig. 14. *Daillydium pentaster* (STAPLIN) emend. PLAYFORD IN PLAYFORD & DRING, 1981; PQ Formation, sample EM4, slide 2 b, 1300-98.

Fig. 15. *Daillydium pentaster* (STAPLIN) emend. PLAYFORD IN PLAYFORD & DRING, 1981; PQ Formation, sample EM4, slide 5, 1435-120.

Fig. 16. *Dupliciradiatum crassum* GONZÁLEZ, MORENO & PLAYFORD, 2005; Neves Formation, sample 388, 0 m, slide 1, 1375-85.

Fig. 17. *Dupliciradiatum crassum* GONZÁLEZ, MORENO & PLAYFORD, 2005; Neves Formation, sample 388, 0 m, slide 1, 1256-215.

Fig. 18. *Dupliciradiatum tenue* GONZÁLEZ, MORENO & PLAYFORD, 2005; Neves Formation, sample 388, 0 m, slide 1, 1445-125.

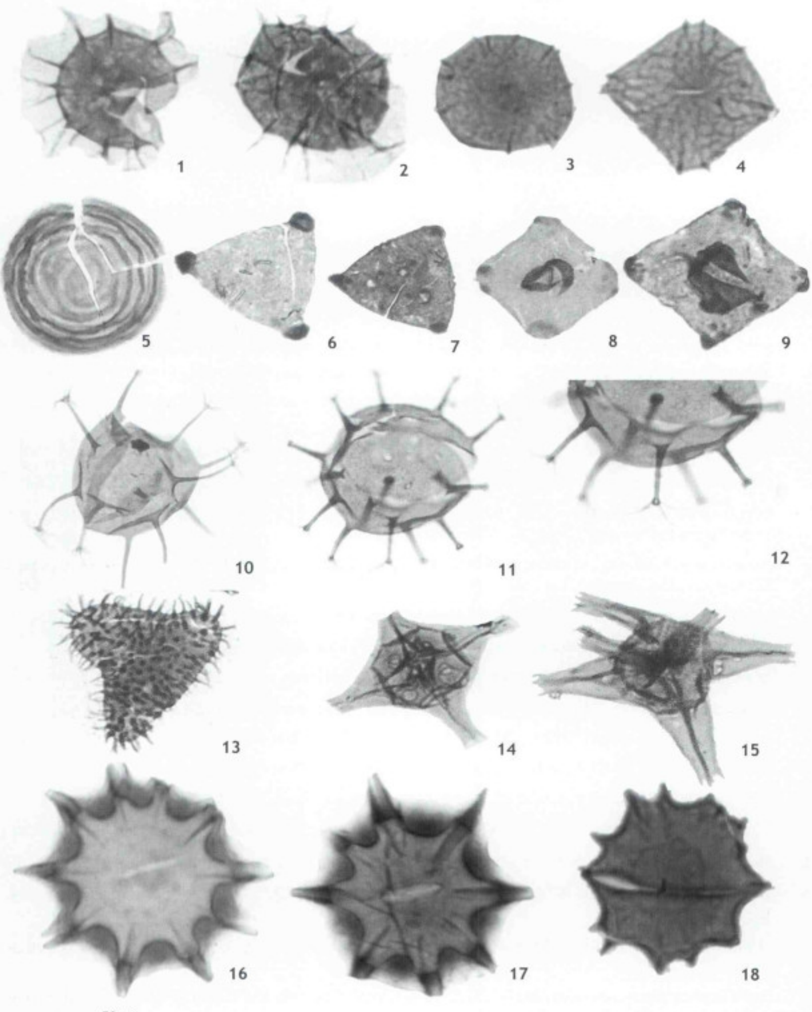
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Plate 16

Fig. 1. *Gorgonisphaeridium ohioense* (WINSLOW) WICANDER, 1974; Horta da Torre Formation, sample 7, slide 1b, 1382-195.

Fig. 2. *Gorgonisphaeridium ohioense* (WINSLOW) WICANDER, 1974; Horta da Torre Formation, sample 7, slide 2a, 1448-154.

Fig. 3. *Gorgonisphaeridium plerispinosum* WICANDER, 1974; PQ Formation, sample EM4, slide 1 d, 1215-180.

Fig. 4. *Gorgonisphaeridium plerispinosum* WICANDER, 1974; PQ Formation, sample EM4, slide 2 a, 1025-154.

Fig. 5. *Hologinella horologia* (STAPLIN) JARDINÉ, COMBAZ, MAGLOIRE, PENINGUEL & VACHEY, 1972; Horta da Torre Formation, sample 7, slide 2b, 1290-131.

Fig. 6. *Hologinella horologia* (STAPLIN) JARDINÉ, COMBAZ, MAGLOIRE, PENINGUEL & VACHEY, 1972; Horta da Torre Formation, sample 8, slide 2b, 1120-185.

Fig. 7. *Micrhystridium stellatum* DEFLANDRE, 1945; PQ Formation, sample EM4, slide 2a, 1085-95.

Fig. 8. *Micrhystridium stellatum* DEFLANDRE, 1945; Horta da Torre Formation, sample 8, slide 3, 134-224.

Fig. 9. *Palacanthus ledanoisii* (DEUNFF) PLAYFORD, 1977; PQ Formation, sample EM4, slide 2a, 1125-145.

Fig. 10. *Palacanthus ledanoisii* (DEUNFF) PLAYFORD, 1977; PQ Formation, sample EM4, slide 2b, 1032-135.

Fig. 11. *Palacanthus tripus* MARTIN, 1984; PQ Formation, sample EM4, slide 2a, 1335-215.

Fig. 12. *Palacanthus tripus* MARTIN, 1984; PQ Formation, sample EM4, slide 1b, 1245-105.

Fig. 13. *Navifusa bacilla* (DEUNFF) PLAYFORD, 1977; Neves Formation, sample 388, 0 m, slide 1, 1455-125.

Fig. 14. *Stellinium comptum* WICANDER & LOEBLICH, 1977; Horta da Torre Formation, sample 8, slide 1, 1030-65.

Fig. 15. *Stellinium comptum* WICANDER & LOEBLICH, 1977; Horta da Torre Formation, sample 7, slide 2b, 1010-85.

Fig. 16. *Stellinium micropolygonale* (STOCKMANS & WILLIÈRE) PLAYFORD, 1977; PQ Formation, sample EM4, slide 1b, 1245-105.

Fig. 17. *Stellinium micropolygonale* (STOCKMANS & WILLIÈRE) PLAYFORD, 1977; Horta da Torre Formation, sample 7, slide 2b, 1285-45.

Fig. 18. *Umbellasphaeridium saharicum* JARDINÉ, COMBAZ, MAGLOIRE, PENINGUEL & VACHEY, 1972; Tercenas Formation, sample 106, slide 1, 1478-125.

Fig. 19. *Umbellasphaeridium deflandrei* (MOREAU-BENOIT) JARDINÉ, COMBAZ, MAGLOIRE, PENIGUEL & VACHEY, 1972; Neves Formation, sample 388, 0 m, slide 1, 1315-218.

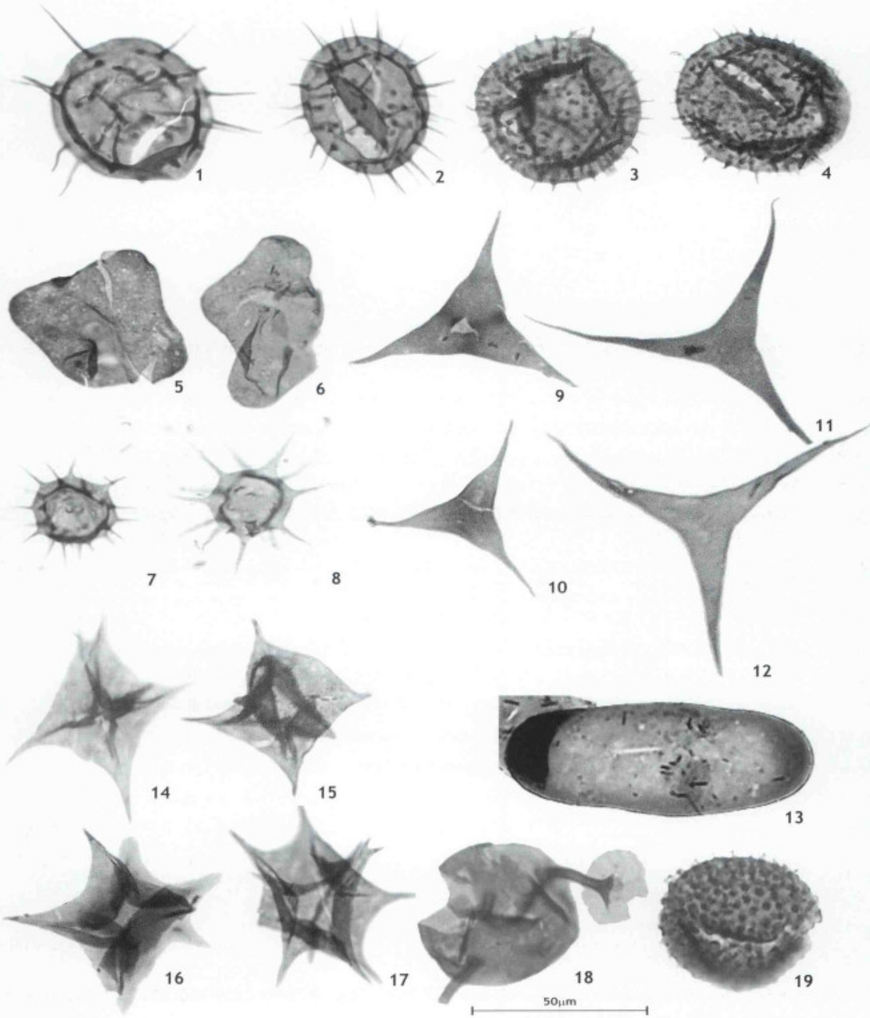
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PLATE 17

Fig. 1. *Unellium piriforme* RAUSCHER, 1969; Horta da Torre Formation, sample 7, slide 4a, 1245-160.

Fig. 2. *Veryhachium downiei* STOCKMANS & WILLIÈRE, 1962; PQ Formation, borehole MSD 1, sample 42,60m, slide 1, 1120-110.

Fig. 3. *Veryhachium downiei* STOCKMANS & WILLIÈRE, 1962; Horta da Torre Formation, sample 7, slide 2a, 1433-95.

Fig. 4. *Veryhachium downiei* STOCKMANS & WILLIÈRE, 1962; Santa Iria Formation, sample 7, slide 1, 1070-215.

Fig. 5. *Veryhachium pannuceum* WICANDER & LOEBLICH, 1977; Horta da Torre Formation, sample 8, slide 2a, 1255-125.

Fig. 6. *Veryhachium pannuceum* WICANDER & LOEBLICH, 1977; Horta da Torre Formation, sample 8, slide 2a, 1015-85.

Fig. 7. *Veryhachium pannuceum* WICANDER & LOEBLICH, 1977; PQ Formation, sample EM4, slide 1 c, 1345-82.

Fig. 8. *Veryhachium polyaster* STAPLIN, 1961; Horta da Torre Formation, sample 7, slide 3a, 1175-215.

Fig. 9. *Veryhachium trispinosum* (EISENACK) STOCKMANS &WILLIÈRE, 1962 "complex"; PQ Formation, sample EM4, slide 1 a, 1152-85.

Fig. 10. *Veryhachium trispinosum* (EISENACK) STOCKMANS &WILLIÈRE, 1962 "complex"; PQ Formation, sample EM4, slide 2 a, 1100-133.

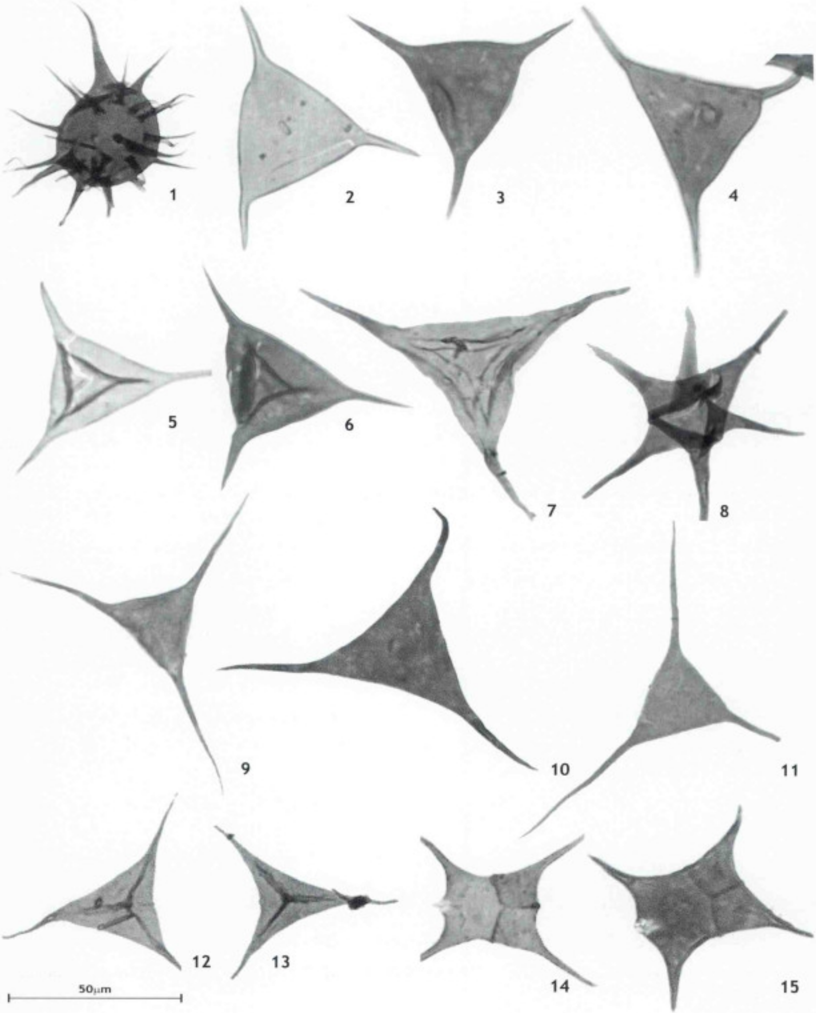
Fig. 11. *Veryhachium trispinosum* (EISENACK) STOCKMANS &WILLIÈRE, 1962 "complex"; Horta da Torre Formation, sample 8, slide 2, 1373-120.

Fig. 12. *Veryhachium* sp. A; PQ Formation, sample EM4, slide 5 a, 1045-100.

Fig. 13. *Veryhachium* sp. A; PQ Formation, sample EM4, slide 5 b, 1128-215.

Fig. 14. *Winwaloeusia repagulata* GONZÁLEZ, MORENO & PLAYFORD, 2005; Horta da Torre Formation, sample 7, slide 2a, 1235-125.

Fig. 15. *Winwaloeusia repagulata* GONZÁLEZ, MORENO & PLAYFORD, 2005; PQ Formation, sample EM4, slide 3 a, 1225-58.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Ministério da Economia e da Inovação

SECRETARIA DE ESTADO DA INDÚSTRIA E DA INOVAÇÃO

INSTITUTO NACIONAL DE ENGENHARIA, TECNOLOGIA E INOVAÇÃO