UPPER DEVONIAN PALynomorphs FROM 
THE REPRESA AND PHYLLITE-QUARTZITE 
FORMATIONS, MINA DE SÃO DOMINGOS 
REGION, SOUTHEAST PORTUGAL: 
TECTONO STRATIGRAPHIC IMPLICATIONS 

by 
T.A. CUNHA & J.T. OLIVEIRA 1

RESUMO
Na região da Mina de São Domingos, a nordeste 
da Faixa Piritosa portuguesa, as unidades 
litoestratigráficas que ai ocorrem pertencem a dois 
dominios tectonoestratigráficos distintos, i.e, Faixa 
Piritosa e Antiforma do Pulo do Lobo. A 
Formação Filíto-Quartzítica é a unidade mais 
antiga da Faixa Piritosa, e a Formação da Represa 
é a unidade mais recente do flanco sul da Antiforma 
do Pulo do Lobo. A ocorrência de palinomorfo (esporos e acritarcos) do Fameniano superior, em 
ambas as unidades, prova que elas são 
cronoestratigráficamente equivalentes.

Em vários locais da Faixa Piritosa, e também na 
região estudada, tanto uma como outra destas 
formações aparecem sobrepostas ao Complexo 
Vulcano Sedimentar da Faixa Piritosa, de idade 
compreendida entre o Tournaisiano inferior e o 
Viseano superior baixo. Esta sobreposição 
anormal é devido à existência de carreamentos 
intimamente associados à tectónica peculiar que 
afetou a região a partir do Viseano superior.

ABSTRACT
The lithostratigraphic units recognized in the Mina 
de São Domingos, SE of Portugal, belong to two 
distinct tectono-stratigraphic domains, i.e, Pyrite 
Belt and Pulo do Lobo Antiform. The Phyllite- 
Quartzite formation is the oldest unit of the Pyrite 
Belt and the Represa Formation is the upper unit 
of the south flank of the Pulo do Lobo Antiform. 
The occurrence of upper Famenian 
palinomorphs (spores and acritarchs) in both units 
support their time stratigraphic correlation. In se-
veral places of the Pyrite Belt, and also in the 
studied area, either the Phyllite-Quartzite 
Formation or the Represa Formation overlain the 

1 Serviços Geológicos de Portugal. R. Academia das Ciências, 19 2° - P-1200 Lisboa - Portugal 

cano Sedimentary Complex of the Pyrite Belt, 
whose age ranges from lower Tournaisian to lower 
upper Visean. This abnormal superposition is due 
to folded overthrusts related to the thin-skinned 
tectonism which affected the area upper Visean 

Pala VRAS CHAVE 
Faixa Piritosa, Fameniano, palinomorfos, 
carreamentos, Portugal.

KEY WORDS
Pyrite Belt, Famenian, palynomorphs, over-
thrusts, Portugal.

1. INTRODUCTION
One of the main difficulties concerning the geology 
of the South Portuguese Zone, Southern Iberia 
Peninsula, is the lack of reliable fossil associations 
to characterize the age of important segments of the 
lithostratigraphic sequence. In the Pulo do Lobo 
Antiform, where several formations are recognized, 
only the upper unit of the north flank (Horta de 
Torre Formation) has yielded spores and acritarchs 
of middle to upper Famenian age (Oliveira et al., 
1986; Giese et al., 1986). In the Pyrite Belt, age 
control of the stratigraphic sequence is better, but 
still unsatisfactory. From this tectono-stratigraphic 
domain are dated the following part of the 
lithostratigraphic succession: shales and limestone 
lenses of the upper part of the Phyllite-Quartzite 
(PQ) Formation, which provided rare macrofaunas 
and rich conodont assemblages of middle to upper 
Famenian age (Pruvost, 1912; Boogaard, 1963, 
1967; Fantinet et al., 1976; Boogaard & 
Schmerhorn, 1980, 1981); limestone lenses interbedded in the Volcano-Sedimentary (VS) 
Complex yielded conodonts of upper Tournaisian 
age (Boogaard, 1963; Boogaard & Schmerhorn, 
1975); finally, rare conodonts and goniatitess of the
upper part of the VS Complex indicate a lower upper Visean age (Oliveira, 1983; Oliveira & Wagner Gentis, 1983). Givetien spores collected in the PQ Formation of the Rio Tinto region, Spain (Lake et al., 1987) are unique and apparently aberrant. According to these faunal assemblages it is of common usage to consider the PQ Formation of middle to upper Famennian age and the VS Complex of Tournaisian to middle Visean age. This poor biostratigraphic information coupled with impressive tectonic complications offered room to some speculations and controversies. Under these circumstances, stratigraphic and paleontological research may play a fundamental role in the understanding of the regional geology. Recent work in the Mina de São Domingos region, Southeastern Portugal, led to the discovery of upper Devonian palynomorphs in the Represa and the PQ Formations. These age determinations prove to be helpful for the interpretation of the regional tectonic structure and for more global geodynamic reconstructions.

2. LITHOSTRATIGRAPHIC FRAMEWORK

The lithostratigraphic units recognized in the Mina de São Domingos region, belong to two distinct tectono-stratigraphic domains, i.e., Pulo do Lobo Antiform and Pyrite Belt. These domains are separated by a folded overthrust (Fig. 1).

The Represa Formation (Carvalho, 1976), is the upper unit of the southern flank of the Pulo do Lobo Antiform. It is composed of greywackes, quartzwackes, siltstones and shales. Red and green shales, and tuffites appear locally interbedded in the lithological sequence. This formation is deformed and sheared by two coaxial and northwest trending episodes of folding. The stratigraphic units of the Pyrite Belt are, from base to top:

- Phyllite-Quartzite (PQ) Formation - a terrigenous succession of shales with intercalations of quartzite beds and lenses. The stratigraphic thickness is in excess of 300 meters (base not seen). This formation is deformed and sheared by two coaxial and north-west trending episodes of folding.

Figure 1. : Geological map of the Mina de São Domingos region.
quartzite beds and interbedded black shales form, in places, continuous ridges some hundred of metres of length (Fig. 1).

- Volcano-Sedimentary (VS) Complex - this complex is composed of acid and basic volcanics that interfinger with dark and purple shales, tuffites and lenses of jaspers (these lithologies are not differentiated in Fig. 1). The thickness changes from few metres to about 600 metres. Metric thick successions of dark siliceous shales and tuffites that overly continuous beds of quartzites, in Rochona and Moitinho areas (Fig. 1), are considered facies variations of the VS Complex. Tectonic deformation is similar to that of the PQ Formation.

- Freixial Formation - This unit is composed of shales and greywackes that show turbiditic sedimentary structures. However, the greywacke beds may be very thin in places, and in this case the unit is very shally. The Freixial Formation is also affected by two episodes of folding.

3. PALYNOLOGY

The location of palynomorph productive samples in the studied region is shown in Figure 1. Locality F1 corresponds to a well exposed section, that comprises quartzites and black shales of the PQ Formation and dark and black siliceous shales, with interbedded sideritic nodules, of the VS Complex.
Vesicle triangular in filtration through interbedded shales. The proposed by Samples were treated according stratigraphic (Fig. 2). Tectonic deformation does not allow the construction of a representative stratigraphic log.

Samples were treated according to the method proposed by Streel (1964), with minor modifications. The organic residue was concentrated by filtration through a 12 µm metallic net. For darkened palynomorphs, reoxidation operations with a concentrated Schulze Solution were made.

Palynomorphs obtained from the black shales of the PQ Formation are abundant and varied (Fig. 2; Plates 1, 2, 3). The spore assemblage is clearly placed in the LV (lepidophyta-verrucosa) Zone, of the uppermost Famennian, defined in the Ardenne-Rhenish regions of western Europe (Streel et al., 1987). It fits also the Pusillites-lepidophyta Zone of latest Famennian age, defined in the Old Red Sandstone Continent (Richardson & McGregor, 1986). This palynologically inferred age is in good agreement with previous upper Famennian age determinations obtained by means of conodonts and eumycidae from the carbonate lenses and shales that form the upper part of the PQ Formation (Pruvost, 1912; Boogaard, 1963, 1967; Boogaard & Schermerhorn, 1980, 1981; Fantinet et al., 1976; Oliveira et al., 1986). The rich assemblage of acritarchs, although not specific for the upper Famennian, is common in middle to upper Devonian strata. In the acritarch assemblage a new species (Veryhachium sandominguensis n. sp.) has been found and is described in addendum.

The Represa Formation provided a much poor assemblage of palynomorphs (Fig. 3; Plate 4). The spore assemblage has yielded, among others, the characteristic species Rugospora flexuosa (Jushko) Streel in Becker, Bless, Streel & Thorez, 1974 (one specimen from Loc. F4, Plate 4, Fig. 1), Pustiliosporites rugulatus (Taugourdeau-Lante) Lobozieak & Streel, 1981 (one specimen from Loc. F2, Plate 4, Fig. 10) and Grandispora gracilis Hacquebard, 1957 (two specimens from Loc. F3 and F4, Plate 4, Fig. 2). These occurrences combined with the absence of the typical uppermost Famennian species like Retispora lepidophyta or Vallatisporites pusillites (which occurs in the PQ Formation), indicate an early Upper Famennian age for the Represa Formation. This result, although based in a few number of characteristic species, is compatible with other stratigraphic and structural data, as discussed below. The acritarch assemblage of the Represa Formation, like that of the PQ Formation, does not indicate a very precise stratigraphic distribution, but is also common in middle to upper Devonian deposits worldwide.

4. SYSTEMATICS

Group ACITARCHA Evitt 1963

Genus Veryhachium Deunnf 1954

Veryhachium sandominguensis n. sp.

Pl. 3, Fig. 6, 11, 14

Description - Vesicle triangular in outline with sides of approximately equal length, 16-24 µm long. Three long laevigate conical processes, 8-10 µm long, one at each angle of the vesicle are drawn out in the same plane as the sides of vesicle. Near the
base of processes the vesicle is slightly of frankly bulbous. From the bases, the processes taper to a blunted tip. Surface of vesicle is scabrate and wrinkled, with wrinkles asymmetrically disposed, generally not parallel to the sides of vesicle and ending near the base of processes which are not wrinkled.

Remarks - The particular system of ribs asymmetrically disposed, not paralleling the sides of vesicle and the scabrate surface of vesicle, distinguishes this species from the other wrinkled triangular species formerly described.

Specific name - Derived from the name of the locality - Mina de São Domingos - where the species has been described.

Types -

Holotype : Pl. 3, Fig. 6 (660 - L.872/1726)
Paratypes : Pl. 3, Fig. 11 (660 - L.844/0995)
Pl. 3, Fig. 14 (660 - L.832/0353)

Occurrence - Black shales of the upper part of the Phyllite-Quartzite (PQ) Formation - upper Famennian.

5. TECTONO - STRATIGRAPHIC IMPLICATIONS

The occurrence of upper Famennian palynomorphs, particulary spores, in both the Represa and PQ Formations, has important tectono-stratigraphic implications:

a - The age of the turbiditic succession (Gafo and Represa Fm.) has been the aim of some discussion. Work by Pfefferkorn (1968), Schermerhorn (1971), Carvalho et al. (1976) and Salpeteur (1976), has reach the conclusion that this succession stratigraphically overlies the VS Complex and should be of middle to upper Visan age. On the other hand, Oliveira (1982), Silva (1985), Oliveira et al. (1986) and Silva et al. (in press), based on lithostratigraphic and structural data from Mina de São Domingos and Mértola regions, suggested that the Represa Formation is older than the VS Complex, or even the PQ Formation, and should be considered of upper Devonian age. Present work (Fig. 4) confirms the last interpretation and precise the age of the Represa Formation as early upper Famennian.

In the Pulo do Lobo Antiform, a time stratigraphic correlation between the units of the Chança Group (south flank) and the units of the Ferreira-Ficalho Group (north flank) has been suggested (Schermerhorn, 1971; Carvalho et al., 1976; Oliveira et al., 1986, Oliveira, in press). The age obtained for the Represa Formation shows that this unit is coeval of the Horta da Torre Formation (the upper unit of the Ferreira-Ficalho Group). This fact and the strong lithological similarities between the formations of the Chança and Ferreira-Ficalho Groups suggest time stratigraphic correlations between the units of these groups.

b - In the Pyrite Belt occur quartzites and shales that overly the VS Complex apparently in normal stratigraphic order. This has led some authors (Carvalho, 1976; Routhier et al., 1980) to consider that these quartzites and shales are younger than the VS Complex and should be differentiated from those of the PQ Formation. The quartzites and shales of the Mina de São Domingos area were informally designated as Sabina Formation (Carvalho, 1976). Detailed work along the Guadiana river valley, north of Mértola, has shown that quartzites and shales are in allochthonous position over the VS Complex (Silva, 1985; Silva et al., in press). A Gonyoclymenia specimen collected in locality F5 (Fig. 1; Oliveira et al., 1986) and the palynomorphs recovered from locality F1 (Fig. 1), indicate that the Sabina Formation quartzites and shales are of upper Famennian age, that is, older than the VS Complex. This age determination and the strong lithological affinities between the Sabina and the PQ Formations, show that there is no reason to consider the Sabina Formation as a distinctive lithostratigraphic unit. The

\[ \text{EIFELIAN} \quad \text{GIYETIAN} \quad \text{FRASNIAN} \quad \text{FAMENNIAN} \]

- \text{P. rugulatus}
- \text{G. gracilis}
- \text{R. planus}
- \text{R. flexuose}
- \text{V. pusillites}
- \text{R. lepidophyta}

Figure 4. : Stratigraphic distribution of the most characteristic species of the PQ and Represa Formation.
quartzites and shales of the Mina de São Domingos area belong to the PQ Formation and, as in other areas of the Pyrite Belt, they are in allochthonous position over the VS Complex (Fig. 1).

6. CONCLUSIONS

Stratigraphic research in Mina de São Domingos region, Southeast Portugal, led to the discovery of early and late Upper Famennian palynomorphs in the Represa and PQ Formations. From these results it is concluded that the Represa Formation is time stratigraphic equivalent the Horta de Torre Formation which crops out in the north limb of the Pulo do Lobo Antiform. This lateral correlation support previous interpretations by which the terrigenous units of the north and south flanks of this antiform formed a continuous detritic cover. The quartzites and shales of this region are of upper Famennian age and belong to the PQ Formation. Like other quartzites and shales of the Pyrite Belt, these are also allochthonous over the VS Complex, a fact that confirms the thin-skinned style of tectonic deformation for this region (Ribeiro & Silva, 1983 ; Silva et al., in press).

REFERENCES


BOOGAARD, M. van den, 1967 - Geology of the Pombão Region (Southern Portugal). Thesis Rotherdam University.


PLATE I

(all photos are X 1000)

PALYNOMORPHS FROM THE PQ FM. (Loc. Fl)

1, 2 - *Retispora lepidophyta* (Kedo) Playford 1976
   1 - 660 - L.839/0699-0746
   2 - 660 - L.865/0985

3, 6 - *Vallatisporites pusillites* (Kedo) Dolby & Neves 1970
   3 - 664 - L.866/0599-0646
   4 - 660 - L.865/1770

   660 - L.872/1962-2011

5 - *Densosporites spitzbergensis* Playford 1963
   664 - L.844/1363-1314

7 - *Daylidium pentaster* (Staplin) Playford in Playford & Dring 1981
   660 - L.839/1245-1244

   660 - L.865/0648

9 - *Crassiangulina tesselita* J.C.M.P. & V. 1972
   664 - L.832/1160-1052

10 - *Craterisphaeridium sprucegrovensis* (Staplin) Turner 1986

11 - *Veryhachium downiei* Stockmans & Willière 1962
    664 - L.832/0010-0059

12 - *Chomotriletes vedugensis* Naumova 1953
    660 - L.832/0983

13 - *Cymatosphaera* sp.
    660 - L.866/0147-0146
**PLATE 2**

(all photos are X 1000)

**PALYNOMORPHS FROM PQ FM. (Loc. Fl)**

1 - *Diexallophasis remota* (Deunff 1955) Playford 1977  
   664 - L.841/1083-1036

2 - *Duvernaysphaera radiata* Brito 1967  
   664 - L.839/0621-0668

3 - *Duvernaysphaera tenuicingulata* Staplin 1961  
   660 - L.844/0206-0159

4 - *Evitta sommeri* Brito 1967  
   660 - L.866/1272-1321

5 - *Gorgonisphaeridium* sp.  
   660 - L.832/0016-0017

6 - *Micrhystridium stellatum* Deflandre 1945  
   660 - L.844/0579

7 - *Maranhites brasiliensis* Brito 1965  
   660 - L.866/0233

8 - *Maranhites* sp.  
   660 - L.832/0012

9 - *Unellium winslowae* Rauscher 1969  
   660 - L.832/0825-0778

10 - *Pterospermella tenellula* Playford 1981  
    664 - L.841/0945

11 - *Stellinium micropolygonale* (Stock. & Will.) Playford 1977  
    660 - L.844/0461

12, 13, 14 - *Palacanthus ledanoisii* (Deunff) Playford 1977  
    12 - 660 - L.866/1106  
    13 - 660 - L.844/1481  
    14 - 664 - L.865/1325

15 - *Unellium piriforme* Rauscher 1969  
    664 - L.839/2073
1 - *Palacanthus tripus* Martin 1984
664 - L.865/1403-1450

2, 5 - *Umbellasphaeridium saharicum* J.C.M.P.&V. 1972
2 - 664 - L.841/1072-1119
5 - 660 - L.832/0346

3, 4 - *Umbellasphaeridium deflandrei* (Moreau-Benoit 1967)
3 - 664 - L.841/0534-0486
4 - 664 - L.839/1661-1710

6, 11, 14 - *Veryhachium sandominguensis* n. sp.
6 - 660 - L.872/1726-1679 (holotype)
11 - 660 - L.844/0995 (paratype)
14 - 660 - L.832/0353 (paratype)

7 - *Veryhachium colemanii* Playford & Dring 1981
660 - L.832/1670

8 - *Umbellasphaeridium* sp.
664 - L.865/0902-0853. Processes are covered by a thin transparent membrane.

9 - *Veryhachium geometricum* (Deflandre) Deunff 1954
660 - L.844/0773

10, 12, 13 - *Veryhachium pannuceum* Wicander & Loeblich 1977
10 - 660 - L.832/1552
12 - 664 - L.839/2371
13 - 660 - L.844/0168

15, 16 - *Winwaloeusia distracta* (Deunff) Deunff 1977
15 - 664 - L.841/1419-1468
16 - 664 - L.865/1368
PLATE 4

(all photos are X 1000)

PALYNOMORPHS FROM THE REPRESA FM. (Loc. F2, F3, F4)

1 - Rugospora flexuosa (Jushko) Streel in B.B.S.&T. 1974
   Loc. F4 (G2-7b) - L.746/0036

2 - Grandispora gracilis Hacquebard 1957
   Loc. F4 (G2-7b) - L.791/0741-0790

3, 4 - Aneurospora greggsii (McGregor) Streel in B.B.S.&T. 1974
   3 - Loc. F4 (G2-7b) - L.746/0048
   4 - Loc. F4 (G2-7b) - L.746/0034

5 - cf. Retusotriletes planus Dolby & Neves 1970
   Loc. F2 (G2-5b) - L.813/2221-2172

6 - Retusotriletes incohatus Sullivan 1964
   Loc. F2 (G2-5a) - L.724/0212

7 - Pterospermella tenellula Playford 1981
   Loc. F2 (G2-5a) - L.694/1520

8 - Unellium piriforme Rauscher 1969
   Loc. F3 (G2-2) - L.692/0637

9 - Villosacapsula sp.
   Loc. F4 (G2-7b) - L.723/0266-0315

10 - Pustulatisporites rugulatus (Taugourdeau-Lantz) Loboziak & Streel 1981
    Loc. F2 (G2-5a) - L.711/0453-0406

11 - Maranhites mosesii (Sommer) Brito 1967
    Loc. F3 (G2-2) - L.756/1017

12 - Pterospermella sp.
    Loc. F3 (G2-2) - L.713/0019

13 - Auroraspora asperella (Kedo) Van der Zwan 1980
    Loc. F4 (G2-7b) - L.791/1850-1803

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