DEVONIAN AND CARBONIFEROUS PALYNOSTRATIGRAPHY OF THE SOUTH PORTUGUESE ZONE, PORTUGAL - AN OVERVIEW

Zélia Pereira[1*], João Matos[2], Paulo Fernandes[3] and José Tomás Oliveira[4]

1. INETI, Geology Department
Rua da Amieira, 4465-965 S. Mamede Infesta, Portugal
2. INETI, Economic Geology Department
Rua Frei Amador Arrais 3, Ap.104, 7801-902 Beja, Portugal
3. CIMA, Centro de Investigação Marinha e Ambiental
Universidade do Algarve, 8005-139, Faro, Portugal
4. INETI, Geology Department
Estrada Portela, Zambujal Alfragide, Ap.7586, 2720-866 Amadora, Portugal
*corresponding author: zelia.pereira@ineti.pt

SUMMARY

The South Portuguese Zone (SPZ) represents the southern branch of the Iberian Variscides, and comprehends the following geologic domains: Pulo do Lobo Antiform, Pyrite Belt, Baixo Alentejo Flysch Group and Southwest Portugal. An overview of all the palynostratigraphic data recovered from those domains of SPZ and a comparative study of the palynostratigraphic records within the South Portuguese Zone is presented.

Keywords: Devonian, Carboniferous, Palynostratigraphy, South Portuguese Zone

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INTRODUCTION

The South Portuguese Zone (SPZ) represents the southern branch of the Iberian Variscides. It is almost entirely composed of Upper Palaeozoic sedimentary rocks of late Devonian to the Moscovian (Late Carboniferous) age. The following geological domains are recognised in the SPZ: Pulo do Lobo Antiform, Pyrite Belt, Baixo Alentejo Flysch Group and Southwest Portugal (Bordeira and Aljezur Anticlines). The boundary between the Pulo do Lobo Antiform and the Ossa Morena Zone, a major shear zone, is in several places underlined by the Beja-Acebuches Ophiolite, a remnant of an oceanic realm closure. The Pulo do Lobo Antiform is currently interpreted as a Variscan paleo-accretionary prism. The Pyrite Belt was part of a late Devonian shallow siliciclastic sea that underwent crustal extention during the late Devonian (Strunian) and the Early Carboniferous giving rise to an impressive bimodal volcanism. The Baixo Alentejo Flysch Group is composed of southwestward prograding sandy turbidites of Late Viséan to Moscovian age that filled a foreland basin. Finally, the Southwest Portugal Sector still part of the siliciclastic sea during the late Devonian, evolved to a distal carbonate/shale platform that only during the Moscovian became part of the Variscan orogeny.

The rock succession of the SPZ attracted researchers particularly because of its famous ore deposits of polymetallic massive sulphides that occur in the Iberian Pyrite Belt. Geological research was mainly concentrated on lithostratigraphy, petrology and geochemistry. More recently, biostratigraphy, sedimentary geology, physical volcanism and sediment geochemistry deserved more attention and are now current fields of research.

PALYNOSTRATIGRAPHIC OVERVIEW

This paper presents an overview of all the results achieved up to now in the palynostratigraphy of the SPZ. All the data available in terms of stratigraphic sections, boreholes and spot samples, complemented with sediment geochemistry and organic matter maturation will be included in a future database called PALYNOBASE. Palynostratigraphy represents nowadays the best tool to date the SPZ lithostratigraphic units, allowing reliable stratigraphic correlations across the basins and giving support to structural, palaeogeographic and geodynamic interpretations.

Palynological studies of the ZPS 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 et al., 1989). At that time palynostratigraphic work was also undertaken in the Spanish part of the Pulo do Lobo Antiform (Giese et al., 1988; Lake, 1991). In the next years more focussed projects on the biostratigraphy were developed. A detailed palynostratigraphic study in the Bordeira and Aljezur Anticlines allowed the establishment of 12 miospore biozones, with 47 late Devonian and more than 200 Carboniferous miospore species documented (Pereira et al., 1994;

Pereira et al., 1995; Pereira 1997; 1999). These palynostratigraphic results proved to fit well, in terms of age, with the local ammonoids biozonation (Korn, 1997).

The first complete palynostratigraphic study in the Portuguese part of the Pyrite Belt was the investigation of the Neves Corvo lithological succession, where all the local rock units were accurately dated, ending a long standing stratigraphic controversy and giving a major contribution to the interpretation of the local tectonic structure and ore genesis (Oliveira et al., 1997; Pereira et al., 2001; Pereira et al., 2004; Oliveira et al., 2004). These studies allowed the following main conclusions: the pre-volcanic detritic substrate is of Late Famennian age; the age of the Volcanic Sedimentary Complex (VSC) ranges from the Latest Famennian (Late Strunian) to the early Late Viséan; the Mértola Formation flysch sedimentation started during the Late Viséan; the recognition of three stratigraphic hiatuses embracing the: Early to Middle Strunian, the Tournaisian and the TC miospore Biozone of Early Visean age in close relationship with a southwestward progressive unconformity; and the precision of the biostratigraphic dating of the massive sulphide orebodies that are intercalated in Latest Famennian (Late Strunian) black shales. These age determinations lead to the conclusion that all of the lithostratigraphic units are involved in a pile of tectonic sheets.

This style of tectonic structures was recently proved in other regions of the Pyrite Belt, namely the Albernoa, Serra Branca and Mina de São Domingos complex antiformal strutures (Oliveira et al., 2005; Matos et al., 2006).

The units of the Pulo do Lobo Antiform were recently investigated (Pereira et al., 2006, Figure 1). The clear stratigraphic correlations among the units of both limbs of this antiform suggests that these units were part of the same sedimentary basin that appears to have been superimposed over an acretionary prism, now preserved in the Pulo do Lobo Fm.

The stratigraphic palynology of the Baixo Alentejo Flysch Group (BAFG), although still very incomplete, was also established. The Mértola Formation was tested for palynomorphs in several regions: in the Neves Corvo mine, Mértola town, Azenhas section in Guadiana River, Bens Farm, amongst others, giving a late Viséan age (work in progress). Two miospores biozones of late Viséan age were identified in the Mértola Fm.

Palynological data of Mira Formation is scarce at the moment, only one miospore biozone assigned to the Lower Serpukovian, was identified in the Castro Marim region (unpublished data).

The Brejeira Formation revealed 5 miospore biozones, ranging from the Early Bashkirian to Late Moscovian age (Pereira 1997; 1999). These miospore ages are consistent with ammonoid data recovered from all the Baixo Alentejo Flysch Group units (Korn, 1999).

CONCLUSIONS

Comparison of the palynostratigraphic records of the South Portuguese Zone (Oliveira et al., 1997; Oliveira et al., 2004; Pereira, 1999; Pereira et al., 2003a; Pereira et al. 2004b) indicates a number of similarities and allow the following conclusions (Fig. 1):

1. Early Frasnian miospores assemblages were recovered from the Phyllite-Quartzite Group of Pyrite Belt, in Puebla de Guzman 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 Formations of Pulo do Lobo Antiform (Pereira et al., 2006).
2. Late Famennian assemblages in SPZ have a consistent presence of the miospore species *Cristicavatispora dispersa, Rugospora explicata* and *Teichertospora iberica*. Those assemblages were recovered from Phyllite-Quartzite Group and the Volcano Sedimentary Complex (Iberian Pyrite Belt) and in the Horta da Torre, Santa Iria and Represa Formations, the upper units of the Pulo do Lobo Antiform.
3. Analogous Late Strunnian miospore assemblages were recovered from the upper part of the Phyllite-Quartzite Group (Cunha and Oliveira, 1989; Oliveira et al., 2004; Oliveira et al., 2005; Matos et al., 2006), from the Volcano Sedimentary Complex (VSC) in Spain (Gonzalez, 2005) of the Pyrite Belt and also from the Tercenas Formation in Southwest Portugal (Bordeira and Aljezur Anticlines).
4. Similarities on the Upper Devonian assemblages, allow the inference that the Pulo do Lobo, the Iberian Pyrite Belt basin and the Tercenas Formation (Southwest Portugal), were part of the same paleogeographic realm during the late Devonian.

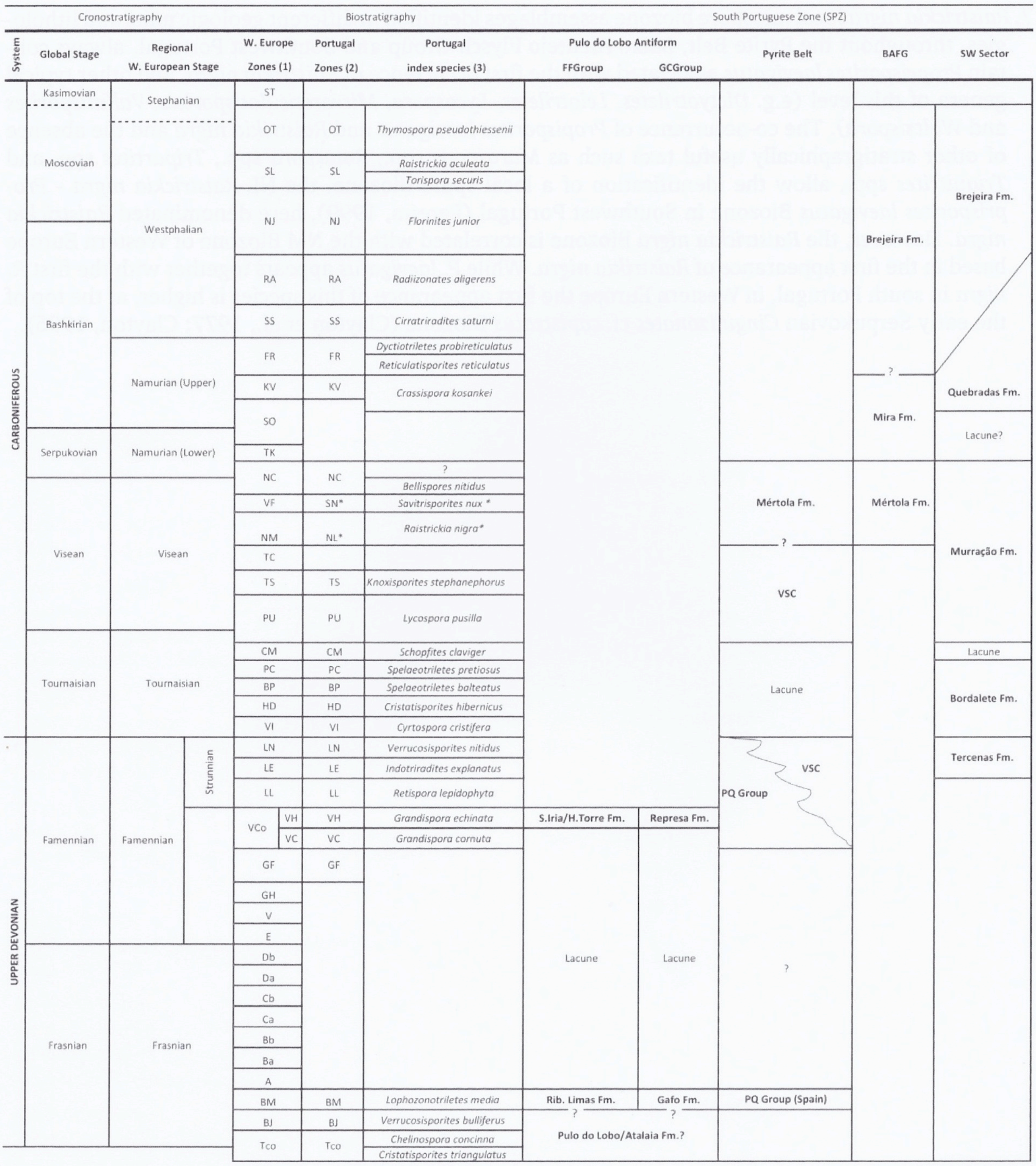

Fig. 1 Comparison of the palynostratigraphic age results obtained in SPZ domains.
(1) Clayton et al, 1977; Clayton, 1996; Higgs et al., 2002; Streel et al, 1987
(2) Pereira, 1999;
(3) Present paper.

5. Records of Tournaisian palynomorphs from the Bordalete Formation in Southwest Portugal and reworked Tournaisian associations in the VSC of the Pyrite Belt show the presence of the same species.

6. The VSC of the Pyrite Belt yielded 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, the same assemblages were recorded from the Baixo Alentejo Flysch Group.

7. *Raistrickia nigra* local miospore biozone assemblages identified in different geologic units and lithologies, throughout the Pyrite Belt, Baixo Alentejo Flysch Group and Southwest Portugal, always contain *Proprisporites laevigatus* associated with the first occurrence of *Raistrikia nigra,* and other typical genera of this level (e.g. *Dictyotriletes, Leiotriletes, Lycospora, Microreticulatisporites, Vallatisporites* and *Waltzispora)*. The co-occurrence of *Propisporites laevigatus* and *Raistrikia nigra* and the absence of other stratigraphically useful taxa such as *Murospora* spp., *Rotaspora* spp., *Tripartites* spp. and *Triquitrites* spp., allow the identification of a local spore biozone, the NL *Raistrickia nigra - Proprisporites laevigatus* Biozone in Southwest Portugal (Pereira, 1999), here denominated *Raistrickia nigra*. However, the *Raistrickia nigra* Biozone is correlated with the NM Biozone of Western Europe based in the first appearance of *Raistrikia nigra*. While *P. laevigatus* appears together with the first *R. nigra* in south Portugal, in Western Europe the first appearance of this species is higher, at the top of the early Serpukovian *Cingulizonates* cf. *capistratus* Biozone (Clayton et al., 1977; Clayton, 1996).