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OVERVIEW OF THE STRATIGRAPHY AND INITIAL QUANTITATIVE BIOGEOGRAPHICAL RESULTS FROM THE DEVONIAN OF THE ALBERGARIA-A-VELHA UNIT (OSSA-MORENA ZONE, W PORTUGAL)

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Abstract. The Albergaria-a-Velha Unit is one of several tectonostratigraphic units along the metamorphic belt comprised in the Porto-Tomar Shear Zone (Ossa-Morena Zone, W Portugal). The strong deformation and low grade metamorphism preclude straightforward interpretations as to its original sedimentary facies, but the rare preserved sequences and palynology results point to discontinuous Lower Devonian to Lower Carboniferous turbidite and possibly pro-delta deposits. The diversified Upper Devonian acritarch assemblages allow a biogeographical correlation with a Laurussian Realm. This is in contrast with the Gondwanan affinity of the assemblages from the South Portuguese Zone (now geographically close).

■ Gondwana, Laurussia, Ossa-Morena Zone, South Portuguese Zone, Porto-Tomar shear zone, Albergaria-a-Velha Unit, Devonian, acritarch cluster analysis, Portugal.

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Introduction

Geological setting

The Albergaria-a-Velha Unit constitutes one of several tectonostratigraphic out-of-sequence units of the metamorphic belt along the Porto-Coimbra-Tomar shear zone (Ossa-Morena Zone, Iberian Massif , W Portugal) (Chaminé et al. 2003, 2007). It is imbricated in the Late Proterozoic (Beetsma 1995) black-greenish phyllites of this metamorphic belt (Arada Unit).

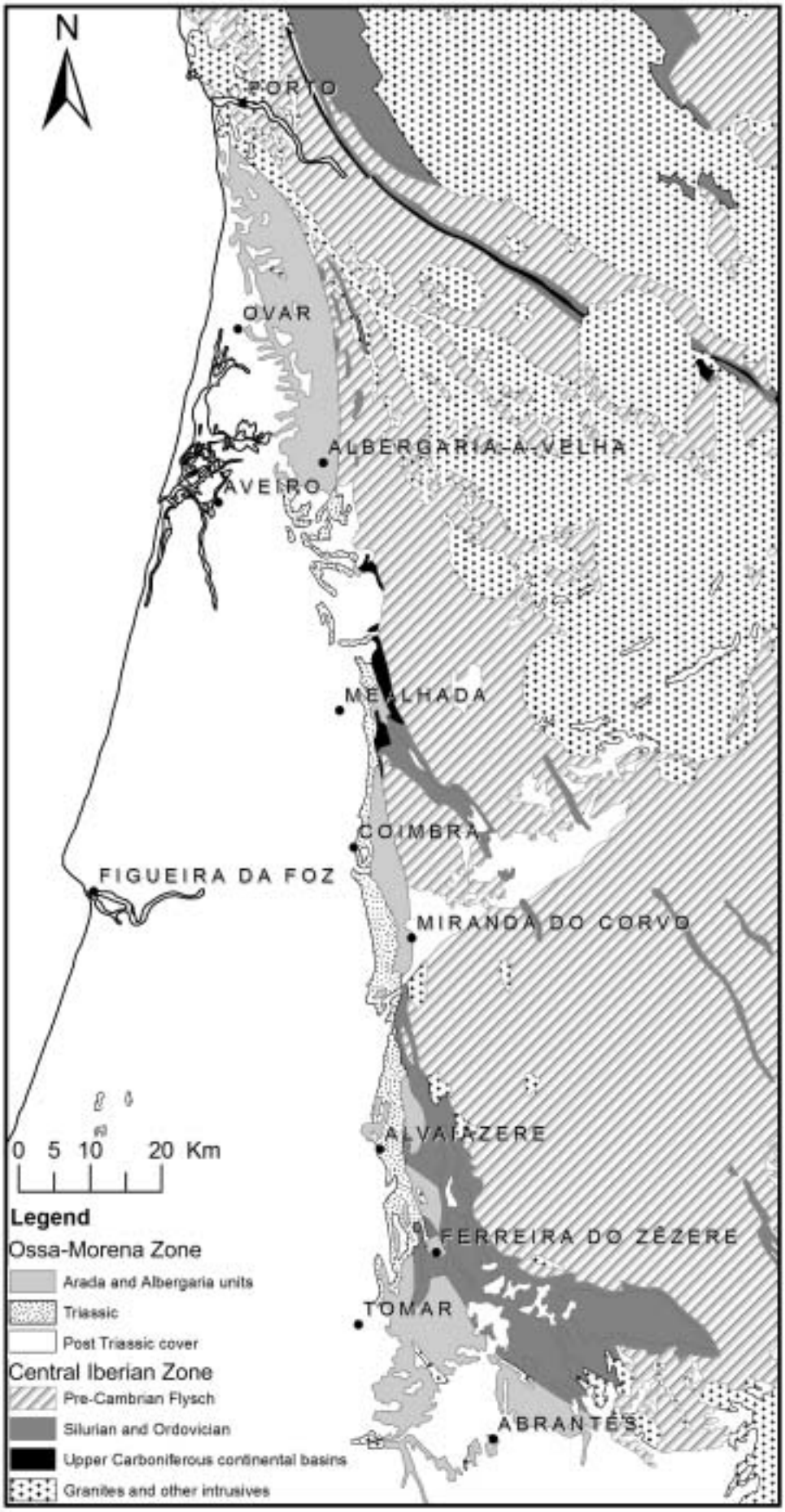
Stratigraphy and facies

The Albergaria-a-Velha Unit is composed of several dispersed outcrops of pelitic metasediments and rare fine sandstones. The older, Upper Devonian, part of the unit is composed solely of black and dark grey shales while the younger, Lower Carboniferous part consists of shales, siltstones and rare fine sandstones. There are rare occurrences of Late Silurian/Early Devonian pelitic rocks. Most of the sedimentary information is obliterated by an intense deformation and metamorphism, but the few preserved sections indicate that the original facies were probably turbiditic and in some areas pro-delta type deposits also seem to be present.

Palynological assemblages

Previous work

Preservation of the palynological assemblages in this study area is usually poor to moderate, but some assemblages contain particularly abundant and diversified acritarchs. So far the oldest palynological assemblages found are Late Silurian/Lower Devonian, briefly described from a very restricted area by Machado et al. (2007). Acri-



Text-fig. 1 Simplified geological map of NW Portugal (adapted from Portuguese Geological Survey 1:500.000 lithological map).

tarchs found include *Ammonidium* cf. *microcladum* (Downie) Lister, 1970; aff. *Goniosphaeridium polygonale* (Eisenack) Fensome et al., 1990; *Micrhystridium* cf. *stellatum* Deflandre, 1945; *Multiplicisphaeridium* cf. *fisherii* (Cramer) Lister, 1970; *Florisphaeridium* sp. Lister 1970 and *Helosphaeridium* (?) *clavispinulosum* Lister, 1970; and later described spores and cryptospores cf. *Scylaspora kozlica* (Dufka) Richardson et al., 2001 cf. *Retusotriletes abundo* Rodriguez, 1978; cf. *Scylaspora* ? *vetusta* (Rodriguez) Richardson et al., 2001 and *Apiculiretusispora* cf. *perfecta* Steemans, 1989.

The better studied assemblages originate from the Upper Devonian black shales of the classic locality of the Albergaria-a-Velha area. The diversified assemblage contains over 25 different acritarch and prasinophyte species, preliminary results were published by Machado et al. (2008). Qualitative analysis of the assemblage points to a close affinity with the Laurussian late Devonian marine Realm, in contrast with the Late Devonian assemblages from the South Portuguese Zone which show clear affinities with North Gondwana, as suggested by Clayton et al. (2002). Previous work by Vavrdová and Isaacson (1999) included late Devonian acritarch assemblages of the Represa and Phyllite-Quartzite formations described in Cunha and Oliveira (1989) as belonging to the Gondwanan Realm. The affinity of the Albergaria-a-Velha shales is indicated by the presence of *Cymatiosphaera perimembrana* Staplin, 1961; *Villosacapsula* cf. *ceratoides* (Stockmans et Willière) Martin, 1981; *Winwaloeusia* cf. *ranulaeforma* Martin, 1984 and other acritarch genera and species described from Central and Northern Europe (especially the Belgium – Ardennes-Rhenish Massif) and Eastern USA and a complete absence, so far, of species of *Umbellasphaerdium* Jardiné et al., 1972; *Crassiangulina* Jardiné et al., 1972; *Horologinella* Cookson et Eisenack, 1962 and *Schizocystia* Cookson et Eisenack, 1962 (common Gondwanan genera).

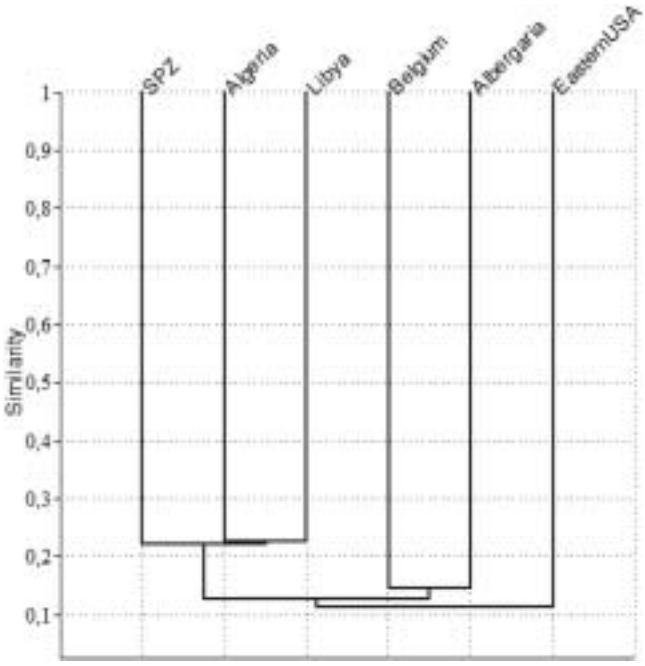
Cluster analysis

With the aim of testing the initial qualitative results, we performed a cluster analysis using the data obtained so far from the Albergaria-a-Velha black shales and data available in the literature from the following areas:

- Belgium: Martin (1981, 1985) and Stockmans and Willière (1969, 1974),
- Eastern USA: Clayton et al. (2002); Molyneaux et al. (1984); Wicander (1974, 1983); Wicander and Loeblich (1977) and Wicander and Playford (1985),
- Libya: El-Mehdawi (1998); Clayton et al. (2002); Moreau-Benoit (1984); Paris et al. (1985) and Streel et al. (1988),
- Algeria: Clayton et al. (2002) and Jardiné et al. (1972, 1974), and
- South Portuguese Zone: Clayton et al. (2002); Cunha and Oliveira (1989); González et al. (2005) and Pereira (1999).

We used PAST – Paleontological Statistics Freeware to perform the analysis and chose a Paired group algorithm with Jaccard similarity measure. The similarity cluster diagram (Text-fig.2) and correlation matrix (Table 1) show a very close relationship between the Libyan and Algerian assemblages, as already reported in Clayton et al. (2002). The similarity of the South Portuguese Zone with these two areas is evident and even greater than suggested earlier by Clayton et al. (2002). The Albergaria-a-Velha assemblage clusters closely with the Belgium assemblages and to a lesser extent to those of Eastern USA. In general the Albergaria-a-Velha assemblage shows a greater similarity to the Laurussian Realm, contrasting with the North Gondwanan assemblages.

It has to be mentioned that all the clusters' cut-off points are close to the base of the diagram which suggests a low degree of diversification (Text-fig. 2). This is probably an artefact of the chosen algorithm, but also a result of a still incomplete database. Nevertheless, general groups of assemblages can be defined and thus paleobiogeographical interpretations can be attempted.



Text-fig. 2 Cluster diagram of the considered acritarch assemblages. Paired group, Jaccard measure.

Conclusions

The Albergaria-a-Velha Unit comprises several areas of Devonian and Carboniferous metasediments which are difficult to correlate in time and space due to the strong deformation and low grade metamorphism. Nevertheless, randomly preserved short–sequences and their palynological content allow a general reconstruction of the original depositional setting in specific time periods and areas. The moderately preserved and diversified acritarch assemblages allow broader correlations with neighbouring terranes.

A quantified comparison of assemblages is a powerful method for the identification of groups and to infer on their biogeography. It is particularly useful when used in combination with the identification of index species for different Realms.

Table 1
Similarity and distance indices matrix for the considered assemblages.

	EasternUSA	SPZ	Algeria	Libya	Belgium	Albergaria
EasternUSA	1	0,14554	0,094527	0,13089	0,1124	0,080808
SPZ	0,14554	1	0,22222	0,21649	0,16667	0,13861
Algeria	0,094527	0,22222	1	0,22368	0,10811	0,11111
Libya	0,13089	0,21649	0,22368	1	0,11806	0,11538
Belgium	0,1124	0,16667	0,10811	0,11806	1	0,14493
Albergaria	0,080808	0,13861	0,11111	0,11538	0,14493	1

Further analysis of the spore and acritarch assemblages of this unit and complementary studies on its organic petrology will allow a better understanding of the stratigraphy and of local and regional paleogeography.

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