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PALYNOLOGICAL AGE FOR THE LOWER PART OF THE HANGENBERG SHALES IN SAUERLAND, GERMANY[1]

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(2 figures)

ABSTRACT. New palynological data has been obtained from several levels in the lower part of the Hangenberg Shales at Hasselbachtal, Stockum and Oberrödinghausen in the Northern Rhenish Slate Mountains. In addition, several old miospore assemblages from the Hangenberg Shale equivalent at Riescheid have been restudied and reappraised. In all cases the miospore data show that the lower part of the Hangenberg Shales, including the Hangenberg Black Shale level, can be assigned to the late Devonian LN miospore Biozone. It is also shown that the LE / LN miospore Biozone boundary occurs at or very close to the base of the Hangenberg Shales. Therefore this miospore boundary can be correlated approximately with the lower/middle *praesulcata* conodont Biozone boundary and also the top of the *Wocklumeria* or upper *paradoxa* cephalopod Biozone. Previous assignments of LL miospore assemblages from the Hangenberg Shales are now considered to be incorrect. The reasons for this are discussed, but it is best explained by strong overprinting of reworked LL Biozone species into early LN Biozone assemblages. In the light of the new evidence, the suggestion that the boundary between the Wocklum Limestone and the Hangenberg Shales is diachronous is no longer tenable.

KEY-WORDS: Miospores, Devonian/Carboniferous boundary, Sauerland, Germany.

RESUME. Age palynologique de la partie inférieure des Schistes de Hangenberg dans le Sauerland, Allemagne. De nouvelles données palynologiques ont été obtenues dans plusieurs niveaux de la partie inférieure des Schistes de Hangenberg, à Hasselbachtal, Stockum et Oberrödinghausen dans le Nord du Massif schisteux rhénan. De plus, quelques anciens assemblages de miospores provenant de couches équivalentes aux Schistes de Hangenberg à Riescheid ont été reétudiés et rediscutés. Dans tous les cas les données relatives aux miospores montrent que la partie inférieure des Schistes de Hangenberg, y compris le niveau des Schistes noirs de Hangenberg, peut être attribuée à la Biozone à miospore LN du Dévonien tardif. Il est aussi démontré que la limite entre les Biozones à miospores LE/LN se situe à la base, ou très près de la base, des Schistes de Hangenberg. Pour cette raison, la limite basée sur les miospores peut être corrélée approximativement avec la limite entre les Biozones à conodontes *praesulcata*, inférieure et moyenne et aussi avec le sommet des Biozones à Céphalopodes à *Wocklumeria* ou *paradoxa* supérieur. Les attributions antérieures d'assemblage de miospores de la Biozone LL aux Schistes de Hangenberg sont considérées maintenant comme incorrectes. Les raisons en sont discutées, mais la meilleure explication est qu'elles résultent d'une forte influence des espèces remaniées de la Biozone LL dans des assemblages du début de la Biozone LN. A la lumière de ces nouvelles évidences, la suggestion que la limite entre le Calcaire de Wocklum et les Schistes de Hangenberg pourrait être diachronique, ne peut plus être défendue.

MOTS-CLE: Miospores, limite Dévonien/Carbonifère, Sauerland, Allemagne.

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1. INTRODUCTION

Previous palynological studies of the Hangenberg Shales in the Northern Rhenish Slate Mountains of Sauerland have been carried out by Paproth & Streel (1971), Higgs & Streel (1984), and Higgs *et al.* (1993). These studies have focused primarily on documenting the successive miospore assemblages within the upper part of the Hangenberg Shales with the main objective of correlating the spore biozones with the level of the Devonian/Carboniferous boundary (as defined by the appearence of the conodont *Siphonodella sulcata*). In comparison, relatively little palynological work has been undertaken on the lower part of the Hangenberg Shales. What miospore assemblages have been recorded have proved to be unusual in composition and difficult to interpret. Consequently, some rather conflicting biozonal ages have been assigned to this stratigraphical interval (Paproth & Streel 1971, Higgs & Streel 1984). This conflicting biostratigraphic evidence has contributed to the debate about whether the base of the Hangenberg Shales was a synchronous or diachronous event in the Northern Rhenish region.

The new palynological samples were collected by Dr. Eva Paproth and Dr. Dieter Korn from measured sections at Hasselbachtal, Oberrödinghausen, Stockum and Oese, and the location of these sections can be found in Higgs & Streel (1984). With the exception of the Oese samples, all the samples yielded miospores. The stratigraphical position of the productive samples is shown on fig. 1 and additional stratigraphical information is given in the text. In general, the samples yielded moderately to poorly preserved miospores, and the composition of each assemblage is rather variable both in terms of species

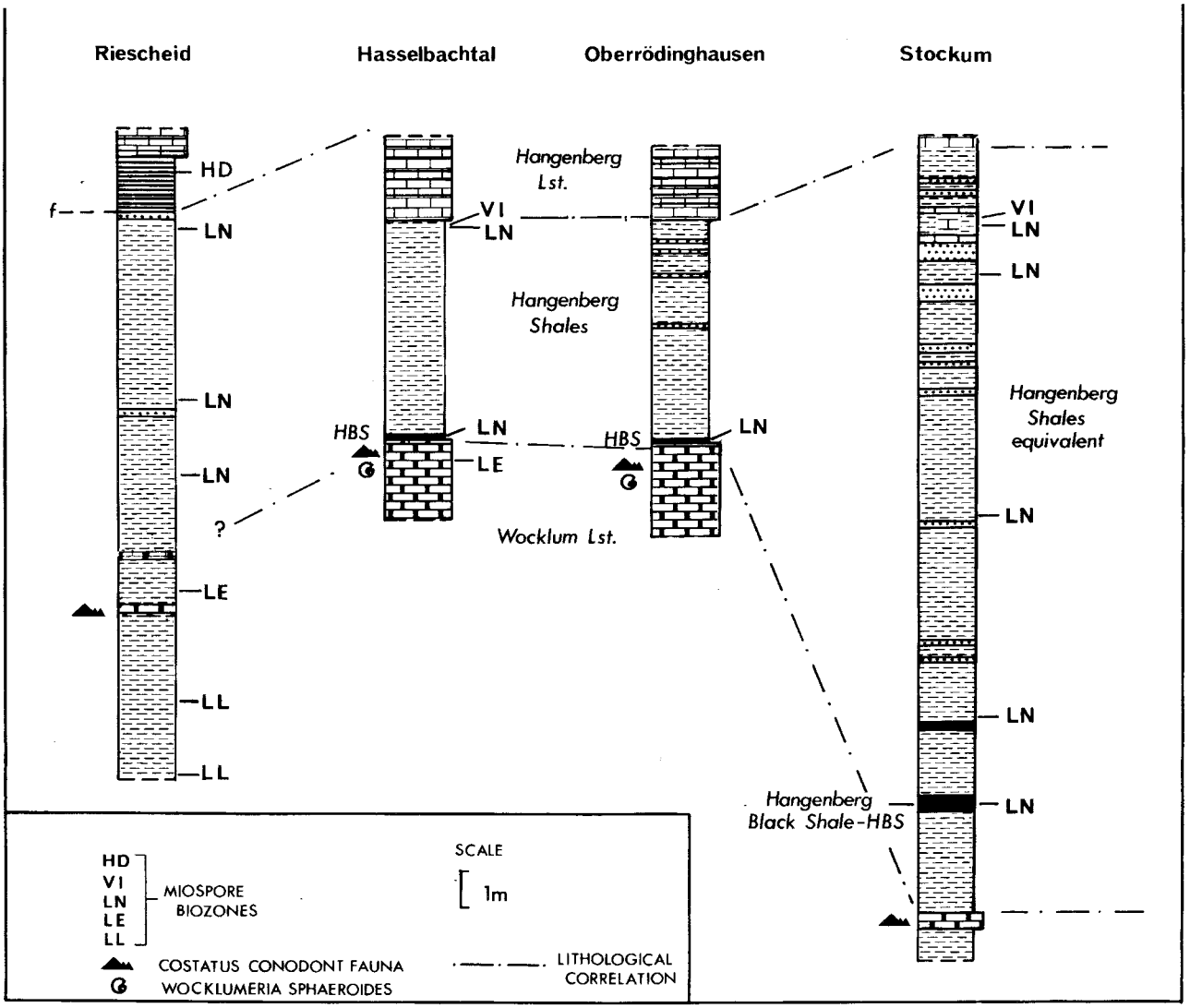

Fig. 1.- Palynostratigraphy of the Hangenberg Shales in the four sections investigated.

diversity and miospore abundance. The spore assemblages recorded are assigned to the late Devonian and early Carboniferous miospore zonation as described by Higgs *et al.* (1988).

2. HASSELBACHTAL

This biostratigraphy of this important section was described in detail by Becker *et al.* (1988) and this section has since been designated an auxillary stratotype for the Devonian-Carboniferous boundary, (see Becker & Paproth, 1993). Higgs & Streel (1984) described the succession of miospore assemblages from the upper part of the Hangenberg Shales and the lower part of the Hangenberg Limestone. The LN/VI miospore Biozone boundary was pinpointed at 14 cm below the top of the shales and immediately below the appearence of *Siphonodella sulcata.* However, the lower and middle parts of the Hangengerg Shales were not palynologically dated. An older LE miospore Biozone assemblage was however recorded from 0.5 m below the top of the underlying Wocklum Limestone. Recently, Higgs *et al* .(1993) have described palynological data from the nearby Hasselbachtal Borehole sequence. In this study seven LN miospore Biozone assemblages were recorded from the middle and upper parts of the Hangenberg Shales, with the lowest LN Biozonal assemblage coming from a borehole depth of 31.05 m, approximately 0.75 m above the base of the shales.

The above evidence indicates that the basal part of the Hangenberg Shales at Hasselbachtal could either be LE or LN Biozone in age. To resolve this problem several samples were investigated from the basal part of the shales exposed on the southern flank of the Hasselbachtal stream section. However, only one productive sample was obtained and this came from Bed 115 - the Hangenberg Black Shale interval (see Becker & Paproth 1993).

The sample was collected from the 5-22 cm interval above the base of the shales and it yielded a small number of miospores of limited species diversity, however the following species are present, *Retispora lepidophyta, Rugospora radiata, Tumulispora malevkensis, Hymenozonotriletes explanatus, Knoxisporites literatus, Bascaudaspora mischkinensis,* and significantly two specimens of *Verrucosisporites nitidus.* Both of these specimens have small (3µm) verrucate ornament and fall within the lower part of the morphological range of this species. This assemblage is assigned to the LN miospore Biozone. This evidence shows that the lower part of the Hangenberg shales at Hasselbachtal is exclusively LN Biozone in age.

3. OBERRODINGHAUSEN

Previous palynological studies of the Hangenberg Shales at Oberrödinghausen have been carried out by Paproth & Streel (1971) on samples from the classic railway cutting section and by Higgs & Streel (1984) on samples from the nearby borehole. In both studies assemblages from the Hangenberg shales were considered to be unusual in composition. For instance, Paproth & Streel (1971, p. 365) described these assemblages as containing «a mixture of spore associations». In addition, Higgs & Streel (1984 p. 163) commented on the occurrence of some typical LN Biozonal species such as *Vallatisporites verrucosus* and *Lophozonotriletes triangulatus.* However, the absence of convincing specimens of *Verrucosisporites nitidus* precluded an assignment to the LN Biozone for these assemblages. Consequently, these unusual assemblages were assigned to the older LL Biozone by Higgs & Streel (1984).

In the present study, two new samples have been investigated from the basal part of the Hangenberg Shales in the railway cutting section. These samples are from 10 cm and 30 cm above the base of the Hangenberg Black Shale interval. Both samples yielded relatively sparse assemblages of limited species diversity. However, stratigraphically significant species include, *Retispora lepidophyta, Rugospora radiata, Vallatisporites hystricosus, Knoxisporites literatus* and rare specimens of *Hymenozonotriletes explanatus* and *Verrucosisporites nitidus.* The presence of these latter two species indicates that the previous assignment to the LL Biozone is incorrect and instead these basal lower Hangenberg Shale assemblages belong to the LN Biozone. This discovery prompted a reexamination of the material in the Oberrödinghausen Borehole and a few rare specimens of *Verrucosisporites nitidus* possessing small verrucate ornament were found. The presence of this species plus the earlier record of *Vallatisporites verrucosus* and *Lophozonotriletes triangulatus* (Higgs & Streel 1984, p. 163) allows a more appropriate assignment to the LN Biozone for these Hangenberg Shale samples.

4. STOCKUM

Higgs *et al.,* (1993) described the miospore succession from the Hangenberg Shales in the Stockum Trench 2. The Hangenberg Shale equivalent sequence is particularly thick here (see Fig. 1) and contains the famous Stockum Limestone lenses near the top. Besides locating the LN/VI Biozonal boundary at the level of the Stockum Limestone lenses, Higgs *et al.* (1993) also reported the presence

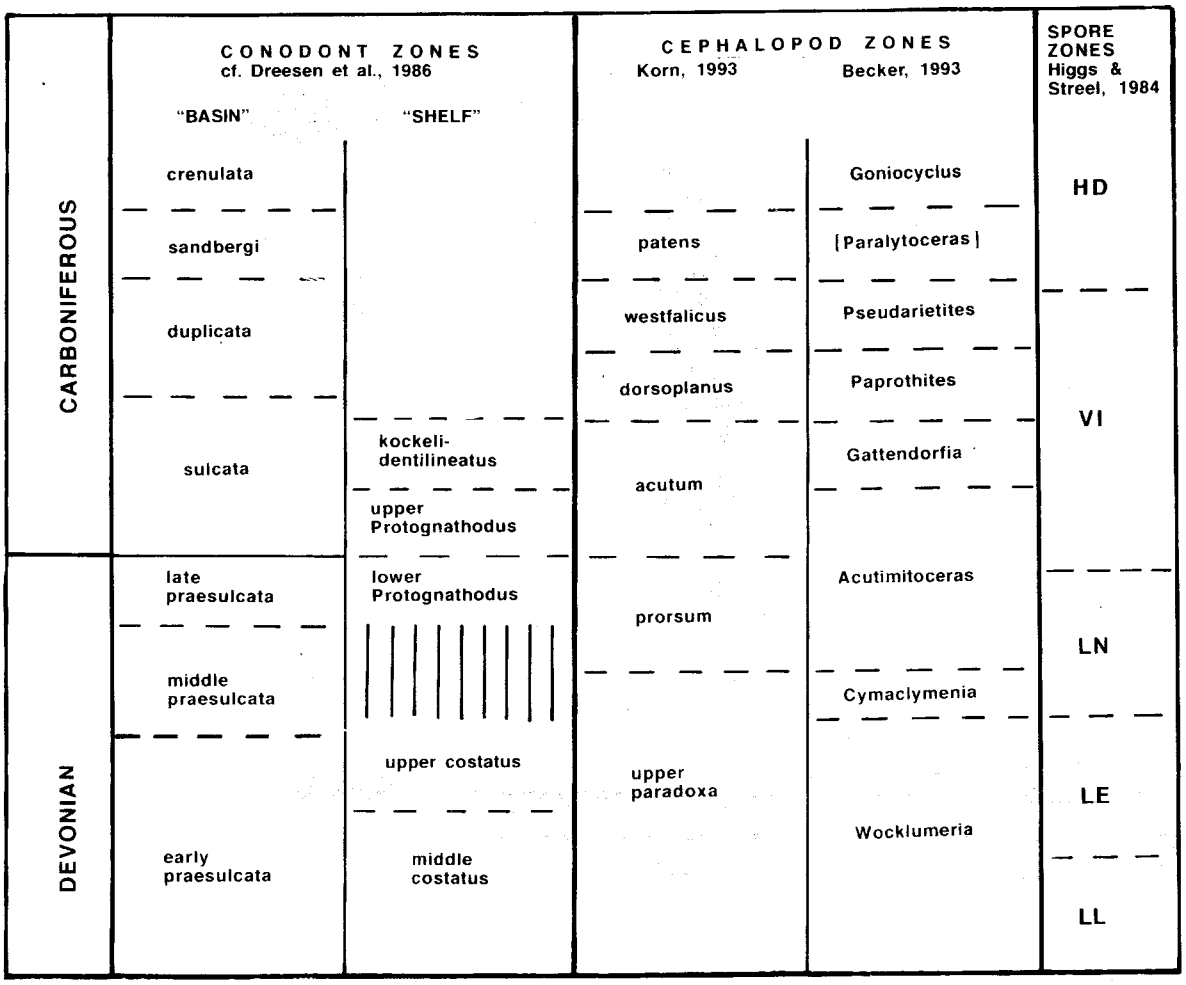

Fig. 2.- Correlation of the conodont, cephalopod, and miospore zonations in the late Devonian and arly Carboniferous of the Sauerland (modified from Bless *et al.*, 1993).

of thirteen LN Biozonal assemblages from the underlying shales. The lowest LN Biozonal assemblage being recorded from the Hangenberg Black Shale (Bed 162) which occurs just above the base of the Hangenberg Shale interval. This assemblage is limited in composition but nevertheless contains the zonal species *Retispora lepidophyta* and *Verrucosisporites nitidus.* The palynological results from the Stockum Trench indicate that virtually all of the Hangenberg Shales are of LN Biozone age.

5. RIESCHEID

The palynology of the Riescheid succession was described by Higgs & Streel (1984). In the fifteen metres of grey/green silty shales below the faulted contact with the black Alum Shales a succession of LL and LE Biozonal assemblages were recorded. The LE miospore assemblages were reported from the upper ten metres of the shales. Although well preserved and diverse in composition Higgs & Streel (1984 p. 159 and Table 1) noted some unusual features in these assemblages, such as the presence of *Vallatisporites verrucosus* and *Verrucosisporites tuberculatus.* Therefore all of these assemblages have now been reexamined and reevaluated in the present study. The assemblages from levels 1 m, 4-5 m and 6-7 m below the top of the shales were found to contain several specimens of *Verrucosisporites nitidus.* It is clear that that some of these specimens had been previously misidentified as *V. tuberculatus* by Higgs & Streel. This was confirmed at a C.I.M.P. meeting in Krakow in 1990 when the authors had the opportunity to examine type material of *V. tuberculatus* and were able to determine that the Rieschied specimens were not *V. tuberculatus* but were in fact small verrucate forms of *V. nitidus.* The above three assemblages are now assigned to the LN Biozone. The assemblage from the 10 m level does not contain any specimens of *V. nitidus* and is therefore retained in the LE Biozone.

A summary of the revised palynostratigraphy at Riescheid is shown in Fig. 1. The lowest 2.5 m of exposed shales (between 12.5 and 15 m) are assigned to the LL Biozone. The LE Biozone occurs at the 10 m interval, close to a level with carbonate lenses containing a *costatus* Zone conodont fauna (Lane & Ziegler in Paproth & Streel 1982). The upper 7 m of the shales are now assigned to the LN Biozone.

6. DISCUSSION

The question arises why were the original spore assemblages from the lower part of the Hangenberg Shales assigned to the older LL Biozone? This question has already been discussed in some detail by Bless *et al.* (1993) and the answer appears to be due to : (1) The presence of reworked LL Biozone taxa such as, *Ancyrospora capillata, Retispora macroreticulata, Endosporites admirandus, Teichertospora torquata, Apiculiretusispora verrucosa,* (2) The presence of a Biometric Zone D population of *Retispora lepidophyta*, (3) The apparent absence of diagnostic LE and LN Biozone zonal species.

The possibility of the reworking of older spores was raised by Paproth & Streel (1971) and by Higgs & Streel (1984). More recently Bless *et al.* (1993, p.697) have outlined a palaeoenvironmental model for the Northern Rhenish region in which erosional processes might have reworked abundant LL Biozone sediments seawards, with these reworked LL Biozone miospores outnumbering and overprinting the contemporaneous LN Biozone microflora. The affect of this reworking would be most marked in the basal LN Biozone assemblages where the zonal species *Verrucosisporites nitidus* typically occurs in small numbers and is also typically represented by small verrucate forms (see Higgs *et al.* 1988, p. 12). In such circumstances as these, the lower Hangenberg Shale assemblages have previously been incorrectly assigned to the older LL Biozone.

It is now clear from the new palynological evidence that the lower part of the Hangenberg shales including the Hangenberg Black Shale (containing the goniatite *Cymaclymenia evoluta*) can be correlated with the lower part of the LN Biozone. In terms of conodont zonation this equates with the middle *praesulcata* Zone.(see Fig. 2) The LE/LN Biozone boundary occurs at or just below the base of the Hangenberg shales. Conodonts from this stratigraphic interval at Hasselbachtal, Oberrödinghausen and Stockum (see Fig. I) indicate the LE/LN miospore Biozone boundary correlates with an upper *costatus* conodont fauna and corresponds to the early to middle *praesulcata* conodont Zone boundary. In terms of goniatites this miospore biozonal boundary approximately equates with the top of the *Wocklumeria* Zone of Becker *et al.* (1993) and within the upper *paradoxa* Zone of Korn (1993). The previous suggestion that the base of the Hangenberg Shales in the Northern Rhenish Slate Mountains may be a diachronous boundary is no longer tenable.

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