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PALYNOLOGICAL DATA FROM THE DEVONIAN-CARBONIFEROUS BOUNDARY BEDS IN THE NEW STOCKUM TRENCH II AND THE HASSELBACHTAL BOREHOLE. NORTHERN RHENISH MASSIF, GERMANY

by

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(2 figures and 1 table)

ABSTRACT.- Two new sections displaying the Devonian-Carboniferous Boundary beds at Stockum and in the Hasselbachtal borehole have been palynologically investigated. Twenty eight productive samples have been obtained and the miospore assemblages are assigned to the LN and VI Miospore biozones. *Retispora lepidophyta* diminishes rapidly in numbers at the top of the LN Biozone in both sections thus allowing recognition of typical and transitional LN Biozone assemblages. The LN/VI Biozonal boundary is accurately located within the uppermost 45 cm of the Hangenberg Shales in both sections. The correlation of the miospore data with the goniatite and conodont faunas is discussed.

1.- INTRODUCTION

The miospore stratigraphy of the Devonian-Carboniferous boundary beds in the Northern Rhenish Massif was described in detail by Higgs & Streel (1984). They studied samples from seven selected sections, of these the two most complete sections displaying the LN/VI Miospore Biozone boundary were at Hasselbachtal and Stockum. These two sections are particularly important as they have yielded biostratigraphically diagnostic macrofaunas (goniatites and trilobites) and microfaunas (conodonts and ostracods). In recent years, a new trench at Stockum and a borehole at Hasselbachtal have provided additional suites of palynological samples. The present paper describes the sequence of miospore assemblages from these new samples. The results confirm and refine the earlier palynological dating of these sections and they also allow more detailed correlations with the faunas.

2.- STOCKUM

The Stockum section is situated on the north east flank of the Ebbe anticline of the Sauerland and is composed of several outcrops and trenches located about 1 km from the village of Stockum. The locality has long attracted attention due to the presence of lenticular goniatite bearing limestones in the upper part of the Hangenberg Shales. This goniatite rich limestone interval have been called the Stockum Limestone and it is the stratum typicum for Schmidt's (1924) *Imitoceras* Fauna (now known as the *Acutimitoceras prorsum* Zone) and also Ziegler's (1970) *Protognathodus* conodont fauna. Detailed information on the biostratigraphy of the section was given in Alberti *et al.* (1974) who concluded that the Stockum Limestone was basal Carboniferous in age. As part of the Devonian-Carboniferous Boundary Working Group's review of the Sauerland sections a new trench was opened at Stockum in 1982. The results of the miospore

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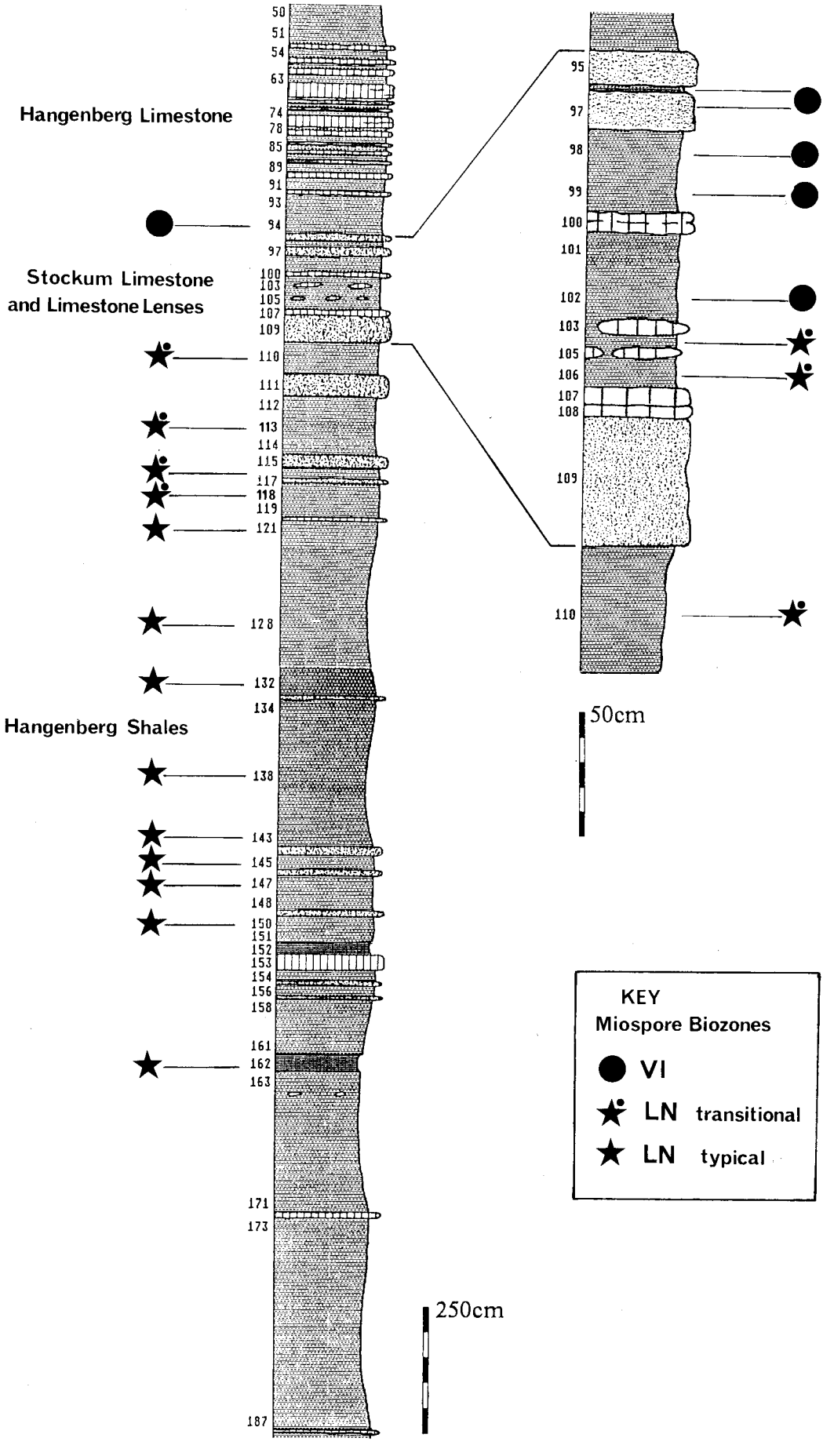

Fig. 1.-Palynology of the new Stockum trench II

studies and goniatite studies were published by Higgs & Streel (1984) and Korn (1984) respectively. The miospore results were not entirely satisfactory due to the evidence of reworking in some of the samples. In order to get more biostratigraphical data a new deeper trench was opened at the site of the former trench II and the Devonian-Carboniferous Boundary interval was resampled by D. Korn and E. Paproth in 1988 and 1989. This paper reports on the sequence of miospore assemblages recovered from these samples and their stratigraphic significance.

Twenty one productive samples have been obtained from the section in the new Stockum trench. The stratigraphical positions of these samples are shown on Figure 1. The sampled interval is 16.5 m in thickness and comprises in ascending order, the upper part of the Hangenberg Shales, the Stockum Limestone lenses and the base of the Hangenberg Limestone.

The productive samples yielded moderately well preserved miospores however the composition of the assemblages was variable both in terms of spore numbers present and in species diversity. The occurrence of the miospore species recorded in each sample is shown in Table 1. The assemblages are assignable to the miospore zonation scheme of Higgs et al. (1988) as described for the late Devonian and early Carboniferous of southern Ireland. The assemblages are described within the framework of this zonation scheme and are assigned either to the *Retispora lepidophyta* - *Verrucosisporites nitidus* (LN) Biozone or to the overlying *Vallatisporites verrucosus* - *Retusotriletes incohatus* (VI) Biozone.

LN BIOZONE

Two distinct types of LN Biozone assemblage can be recognised in the samples studied, - an older more typical LN assemblage and a younger transitional LN assemblage.

LN Biozone assemblages from Beds 162-121

The nine assemblages recorded from this stratigraphical interval are regarded as typical LN assemblages as they are diverse in composition with the zonal species *Retispora lepidophyta* (Kedo) Playford characteristically comprising 5-25 % of the total spore content. Other commonly occurring taxa in these assemblages include, *Vallatisporites hystricosus* (Winslow) Byvscheva, *V. verrucosus* Hacquebard, *Rugospora radiata* (Kedo) Byvscheva, *Diducites versabilis* (Kedo) Van Veen and *Retusotriletes incohatus* Sullivan. The stratigraphically important species *Verrucosisporites nitidus* (Naumova) Playford and *Hymenozonotriletes explanatus* Kedo are consistently present but only in small numbers.

LN Biozone assemblages from Beds 118-104

The six LN assemblages recorded from this 4.5 m interval at the top of the Hangenberg Shales are regarded as somewhat transitional in composition to the overlying VI Biozone. This is because *Retispora lepidophyta* is a rare but consistent element in these assemblages characteristically forming less than 1 % of the total spore content. Although other characteristic taxa of the LN Biozone are present the assemblages tend to be dominated by various species of the genus *Retusotriletes,* particularly *R. incohatus* and *R.* cf. *coniferus* Kedo. In some samples specimens of *Retusotriletes* may comprise more than 50 % of the total spore assemblage.

These atypical LN assemblages have been previously recorded from the top of the Hangenberg Shales at the Hasselbachtal section (Higgs & Streel, 1984, p. 160) in samples Hb 22-23 and Hb 18-19. They have also been recorded in samples from the top of the Old Head Sandstone Formation at the Courceyan stratotype on the Old Head of Kinsale, in southern Ireland, where *Retispora lepidophyta* rapidly diminishes in numbers from >30 % to <1 % over a 6.5 m interval at the top of the LN Biozone.

VI BIOZONE

Six VI Biozone assemblages have been recorded from Beds 102-94. The lowest VI Biozone assemblage from Bed 102 occurs within the interval containing the Stockum Limestone lenses. The VI assemblages differ from the underlying LN assemblages by the absence of *Retispora lepidophyta, Vallatisporites hystricosus, Rugospora radiata,* and several species of the *Diducites* complex assemblages. Overall these VI assemblages tend to be restricted in composition and specimens of *Retusotriletes* dominate these assemblages.

The LN/VI Biozonal Boundary can be placed in the 20 cm interval between Beds 104 and 102.

Table 1.- Miospore distribution in the Stockum trench II and the Hasselbachtal borehole

Samples / Species	Stockum																			Hasselbachtal Bh1						
	94	96	97	98	99	102	104	106	110	113	116	118	121	128	132	138	143	145	147	150	162	26.95	27.30	27.90	28.80	29.50	30.40	31.05
Apiculiretusispora verrucosa									•	•	•	•											•		•		•	•
Auroraspora corporiga	•			•	•	•																•					•	
Auroraspora evanida																		•					•	•			•	
Auroraspora macra	•						•	•				•		•	•	•	•	•					•	•	•	•	•	
Auroraspora torquata									•																			
Bascaudaspora mishkinensis	•	•			•			•	•	•												•	•		•	•		
Calamospora spp.																												
Camptotriletes paprothii	•						•	•	•	•	•	•	•			•	•	•		•		•	•	•	•	•	•	
Convolutispora caliginosa				•				•			•									•		•	•				•	
Convolutispora vermiformis				•							•			•	•	•							•					
Corbulispora cancellata			•				•					•	•										•				•	
Corystisporites costatus																							•					
Crassispora catenata									•					•									•	•	•	•		•
Crassispora maculosa		•						•																				
Cymbosporites minutus			•				•	•					•			•	•		•	•			•				•	
Cyrtospora cristifer								•				•																
Dictyotriletes trivialis	•						•	•	•		•		•			•	•		•				•		•			
Diducites mucronatus								•					•					•										
Diducites plicabilis														•	•									•	•	•		
Diducites versabilis									•		•	•	•	•	•	•							•	•	•	•	•	
Emphanisporites rotatus																•	•						•					
Endoculeospora gradzinskii								•											•									
Grandispora cornuta								•																			•	
Grandispora echinata						•	•	•	•			•	•	•	•	•	•						•	•	•	•		•
Hymenozonotriletes explanatus							•	•		•	•	•	•	•	•	•	•	•		•		•		•	•	•	•	•
Knoxisporites literatus						•														•	•						•	•
Lophozonotriletes concentricus																							•				•	
Lophozonotriletes curvatus													•														•	
Lophozonotriletes excisus										•			•							•								
Plicatispora scolecophora					•			•			•	•						•				•	•	•	•		•	
Punctatisporites minutus	•	•				•		•		•	•			•	•			•			•	•	•		•	•	•	
Pustulatisporites dolbii				•	•		•	•			•	•						•					•					
Raistrickia minor						•	•										•						•					
Raistrickia variabilis								•	•	•			•	•									•				•	•
Retispora lepidophyta							•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•
Retusotriletes communis			•				•	•				•	•											•	•	•		
Retusotriletes coniferus	•		•				•	•	•	•	•	•	•	•		•		•		•			•	•	•	•	•	•
Retusotriletes crassus							•		•				•				•						•	•				
Retusotriletes incohatus	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
Rugospora radiata							•	•		•		•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•
Rugospora lactucosa							•					•										•		•	•	•		
Spelaeotriletes crenulatus	•						•		•	•			•			•	•	•					•		•	•	•	
Spelaeotriletes cumulus	•							•															•					
Tumulispora malevkensis	•			•	•	•	•	•	•	•	•	•		•	•	•	•				•	•	•		•	•	•	
Tumulispora rarituberculata							•		•	•													•		•	•	•	
Vallatisporites hystricosus								•	•	•		•	•	•	•	•	•	•	•				•	•	•	•	•	•
Vallatisporites pusillites					•	•	•	•			•	•	•			•		•	•	•			•	•			•	
Vallatisporites verrucosus						•	•	•	•		•		•	•	•	•	•	•	•	•				•	•	•	•	•
Verruciretusispora famenensis												•																
Verrucosisporites mesogrumosus																				•								
Verrucosisporites nitidus			•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•
Verrucosisporites oppressus			•					•		•	•	•	•	•		•	•	•	•	•	•		•	•	•	•	•	

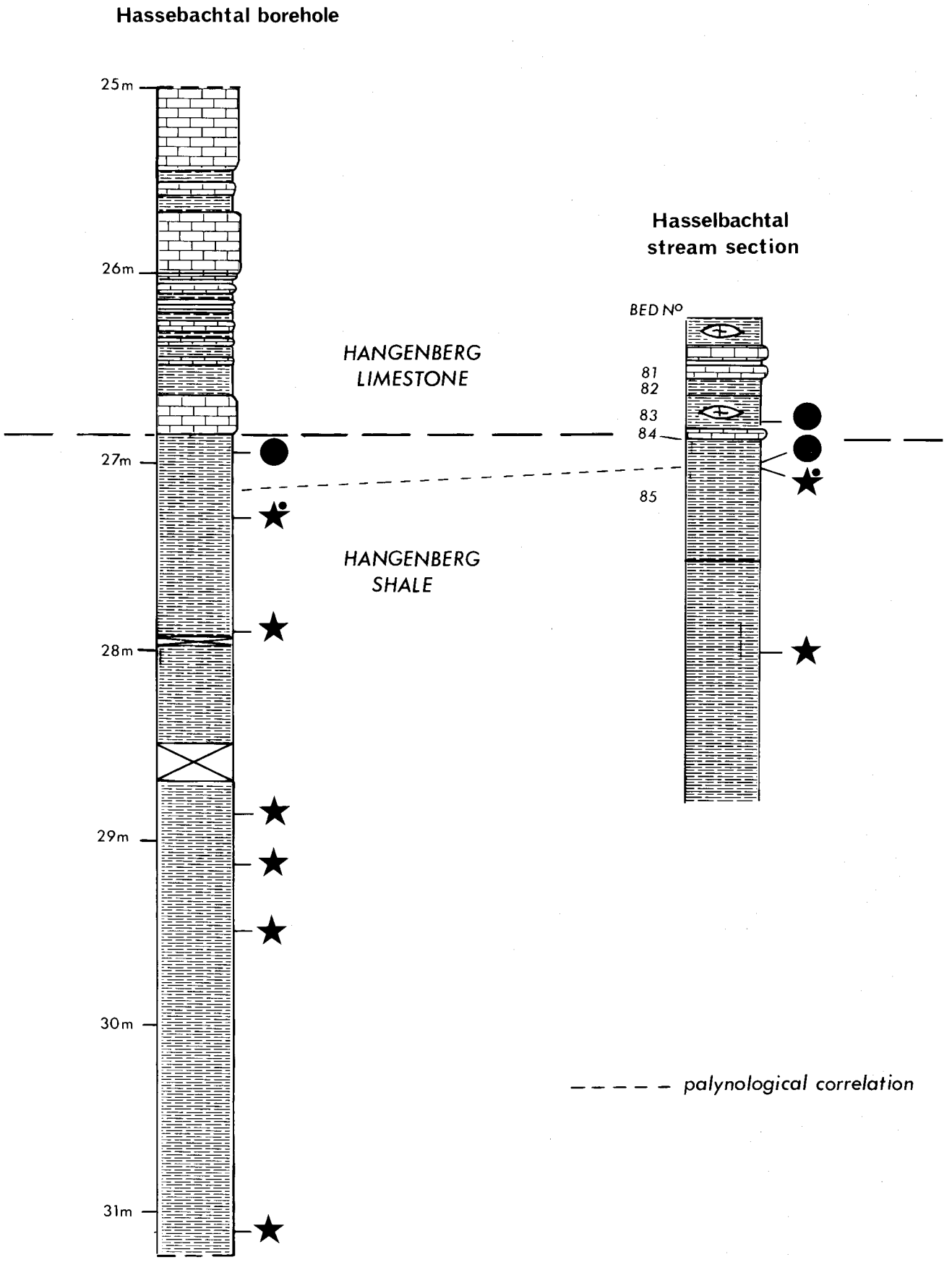

Fig. 2.- Palynology of the Hasselbachtal borehole compared to the upper part of the Hasselbachtal stream section

3.- HASSELBACHTAL BOREHOLE

The Hasselbachtal Borehole drilled in 1987 was sited about 70 m from the Hasselbachtal stream section (see Becker *et al.,* 1984, for location). The borehole cored a section through the Hangenberg Limestone and the Hangenberg Shale and eight productive samples have been obtained from the Devonian-Carboniferous Boundary beds. Figure 2 shows the stratigraphy of the interval studied and the positions of the productive samples. The miospore assemblages obtained are well preserved and allow fine resolution of the LN/VI Miospore Biozonal boundary.

LN BIOZONE

Seven LN Biozone assemblages have been obtained from the 31.05 m-27.30 m interval in the upper part of the Hangenberg Shales. The majority of the assemblages are diverse in composition with the zonal species *Retispora lepidophyta* comprising 10-20 % of the spore content. However the presence of this species is noticeably diminished in the highest sample (27.30 m) where it is less than 2 % of the overall assemblage. This highest LN assemblage which occurs 45 cm below the basal bed of the Hangenberg Limestone (about bed 84 of the stream section) is characteristically dominated by specimens of *Retusotriletes* (>50 %), and can therefore be regarded as a transitional LN assemblage.

VI BIOZONE

A single VI Biozone assemblage was obtained from level 26.95 m which is 10 cm below the base of the Hangenberg Limestone. The assemblage is relatively sparse in composition (12 species). *Retispora lepidophyta* and *Vallatisporites hystricosus* are absent and the assemblage is dominated by simple acamerate taxa belonging to the genera *Retusotriletes, Puntatisporites, Plicatispora* and *Convolutispora.*

The LN/VI Biozone boundary can be confidently recognized in the Hasselbachtal Borehole, it can be placed in the interval between 27.30 m and 26.95 m. Stratigraphically this miospore boundary falls in the 10-45 cm interval below the base of the Hangenberg Limestone. The positioning of this boundary correlates closely with that found in the nearby stream section (see Fig. 2) where the LN/VI occurs 14 cm below the base of the limestone (Bed 84).

4.- BIOSTRATIGRAPHICAL DISCUSSION

At Stockum, Alberti *et al.* (1974, fig. 2) depicted the horizon of the Stockum Limestone bearing the *Acutimitoceras* fauna as a single bed (Bed c). They recorded in Bed c the younger *Protognathodus* conodont fauna (with *P. kuehni,* now equivalent to the *sulcata* Zone, of Carboniferous age) and also the *Archegonus drewerensis* trilobite fauna. The above faunas were obtained from their Trench I dug in less than 10 m distance to the NE (into the forest) from the road side outcrop Böschung, the type locality for the goniatite fauna. They also identified Bed c in their Trench II dug at about 100 m east of the Böschung but without recording any of the faunal characteristics found in Trench I. It seems that the Trench II was not originally made deep enough to reveal all the heavily wheathered limestone nodules.

The new, deeper, Trench II, studied here, has exposed several levels of limestone and limestone nodules in the interval between Beds 100 and 107, however the precise identification of the Bed c of Alberti *et al.* (1974) is not straightforward.

Recent studies of the goniatite faunas from these limestone levels in the new Stockum Trench II (D. Korn) has shown that an *Acutimitoceras* fauna from Bed 103 (which contains also the older *Protognathodus* fauna, known as late *praesulcata* Zone of uppermost Devonian age) closely resembles the fauna obtained from the Stockum Limestone of the Stockum Böschung Trench I. Therefore, based on the goniatite evidence, Bed 103 should be regarded as the Stockum Limestone in the new Trench II (Clausen *et al.,* in press, Abb. 2). But based on conodont evidence, Bed 103 is still Devonian (late *praesulcata* Zone) when the Stockum Limestone of the Böschung Trench I should be considered as Carboniferous in age (*sulcata* Zone).

The LN/VI Miospore Biozone boundary which occurs, as stated earlier, at about the level of Bed 103 in the new Trench II, was found (Higgs & Streel, 1984) at least 40 cm below Bed c (Stockum Limestone of Alberti *et al.,* 1974) in the old Trench I, on top of a more sandy bed (Bed a), known as Bed 109 in Trench II. On miospore evidence, we either have to invoke local high condensation of sediment in Trench I compared to Trench II (Beds

104-108, 30 cm thick, being condensed) or invoke this part of the sequence to be missing in Trench I. Therefore, Bed 103 might well be slightly older than Bed c with their *Acutimitoceras* fauna being respectively uppermost Devonian (with late *praesulcata* Zone) in Trench II and lowermost Carboniferous in age (with *sulcata* Zone) in Trench I.

The LN/VI Miospore Biozone boundary in Stockum would then occur in a very similar situation as noticed in Hasselbachtal section (Becker *et. al.*, 1984, fig. 5) where this event is known before (stratigraphically below) the appearance of the basal Carboniferous *sulcata* Zone.

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