REWORKED MIOSPORES IN THE OESE (STOP 2) AND OBERRÖDINGHAUSEN (STOP 3) AREA

(after BLESS *et al.*, 1993)

The presence of reworked miospores derived from the "PLm-i zone" (= "middle" LV zone according to Streel, 1986 fig. 3) was already noticed by Paproth & Streel (1970). Higgs & Streel (1984) assigned these assemblages to the LL zone, but mentioned the anomalous presence of *Lophozonotriletes triangulatus* and *Vallatisporites verrucosus,* two taxa which normally appear in the younger LE zone in Ireland (Higgs & Streel, 1984). The same is true at Riescheid, where these taxa are absent in the samples attributed to the LL zone and appear slightly above the base of the LE zone (Higgs & Streel, 1984). A further difference between the samples from Oese, Apricke and Oberrödinghausen and those form the LL zone at Riescheid consists in the almost absence of miospores of the *Diducites* complex, which are "particularly abundant" in the LL biozonal assemblages of the Riescheid section (Higgs & Streel, 1984).

One might question why these assemblage had not been assigned to a higher zone. The discovery of *Hymenozonotriletes explanatus* or perhaps even *Verrucosisporites nitidus* would have solved the problem, because the base of these miospore zones is defined by the first appearance of its zonal index taxon. The presence of *H. explanatus* would have allowed an assignment to the LE zone, and the presence of *V. nitidus* to the LN zone. Otherwise, the assemblages of the LL, LE and LN zones are rather similar. The (incomplete) ammonoid evidence from the Hangenberg Shale at Oberrödinghausen indicates that the miospores assemblages from the Hangenberg Shale at Oese, Apricke and Oberrödinghausen should not be older than the LN zone.

Hangenberg Shale sequences in the Oese, Apricke and Oberrödinghausen sections were deposited during the maximum of the regression, in a somewhat isolated small basin in the immediate eastern area near the Seiler deltaic deposits (see fig. 8). The small basin was enclosed by the emergence of some shoals (like in Müssenberg) and therefore might have been separated from the longshore currents. In front of this small basin, onshore erosional processes might have reworked exceptionnally abundant LL- aged sediments seawards with reworked miospores largely outnumbering those produced by the contemporaneous flora. In light of these questions, several of these sections are being once more reinvestigated.

SYNTHESIS OF THE MIOSPORE ZONATION AND CORRELATION OF CONODONT, CEPHALOPOD AND MIOSPORE ZONATIONS

(after BLESS et al., 1993)

The following synthesis of the miospore zonation is based on papers by Higgs & Streel (1984) and Higgs *et al.* (1993).

- Miospore assemblages typical of the LL zone have only been recognized at Riescheid, where they occur between 12,5 and 15 m below the top of a succession of greenish silty shales. The lower boundary of this zone has not been established in Sauerland. The presence of a limestone nodule with conodonts of the "*costatus* zone" above the highest

miospore sample of the LL zone suggests that the top of this zone is situated below the top of the "*costatus* zone".

- Miospore assemblages of the LE zone have been found at Riescheid and Hasselbachtal. At Riescheid, they occur between 1 and 10 m below the top of the greenish silty shales (Higgs & Streel, 1984). At Hasselbachtal, a shale layer some 50 cm below the top of the Wocklum Limestone has yielded an LE biozonal assemblage, this is below the highest sample yielding a "middle *costatus* conodont assemblage", and well below the topmost occurrence of the cephalopods *W. sphaeroides* and *P. paradoxa* (cf. Becker *et al.*, 1984; Higgs & Streel, 1984).
- Miospore assemblages of the LN zone occur in six sections. It is emphasized once more that the index taxon *V. nitidus* has not been found in the samples from the (lower portion of the) Hangenberg Shale at Oese, Apricke and Oberrödinghausen (see discussion above). The observed base of typical LN assemblages is therefore strongly diachronous in Sauerland. The lowermost occurrence is in the lower HBS (bed 162) of the Stockum II-1988 trench (Higgs *et al.*, 1993). Miospore assemblages of the LN zone are known from some 4 m below the top of the Hangenberg Shale in the Hasselbachtal borehole (Higgs *et al.*, 1993), this is some 1-2 m above the top of the Wocklum Limestone. At Oese, typical LN assemblages only occur in the upper 2 m of the Hangenberg Sandstone, this is some 10-11 m above the top of the Wocklum Limestone. The only typical LN assemblage in the Apricke section occurs above a limestone bed that is tentatively equivalent to the "lower *Protognathodus* fauna".
- The top of the LN zone and the boundary with the overlying VI zone has been established 14 cm below limestone bed 84 (with the conodont *S. sulcata*) at Hasselbachtal (Becker *et al.*, 1984; Higgs & Streel, 1984). This is 2 cm below the first but questionable appearance of the cephalopod *A. acutum* (cf. Korn, 1993). The evidence at Seiler (miospores of the LN zone in between limestones of the "lower and upper *Protognathodus* faunas") and at Stockum (miospores of the VI zone below Bed c in the Stockum I trench, belonging to the "upper *Protognathodus* fauna"; cf. discussion in Higgs *et al.*, 1993 and in Clausen *et al.*, in press) proves that the LN zone ranges within the "lower *Protognathodus* fauna" and that the VI zone starts just below the base of the "upper *Protognathodus* fauna", probably in the topmost "lower *Protognathodus* fauna" range.
- Miospore assemblages of the VI zone have been described from two sections : Hasselbachtal and Stockum. Only the basal portion of this zone has been recognized : 18.5 cm at Hasselbachtal and 1.3 m at Stockum. In both cases this corresponds to shale layers just below and in between limestone lenses of the basal "upper *Protognathodus* fauna" or basal *sulcata* zone.
- The basal portion of the black Lower Alum Shale at Riescheid and Oberrödinghausen has yielded miospore assemblages of the HD zone.

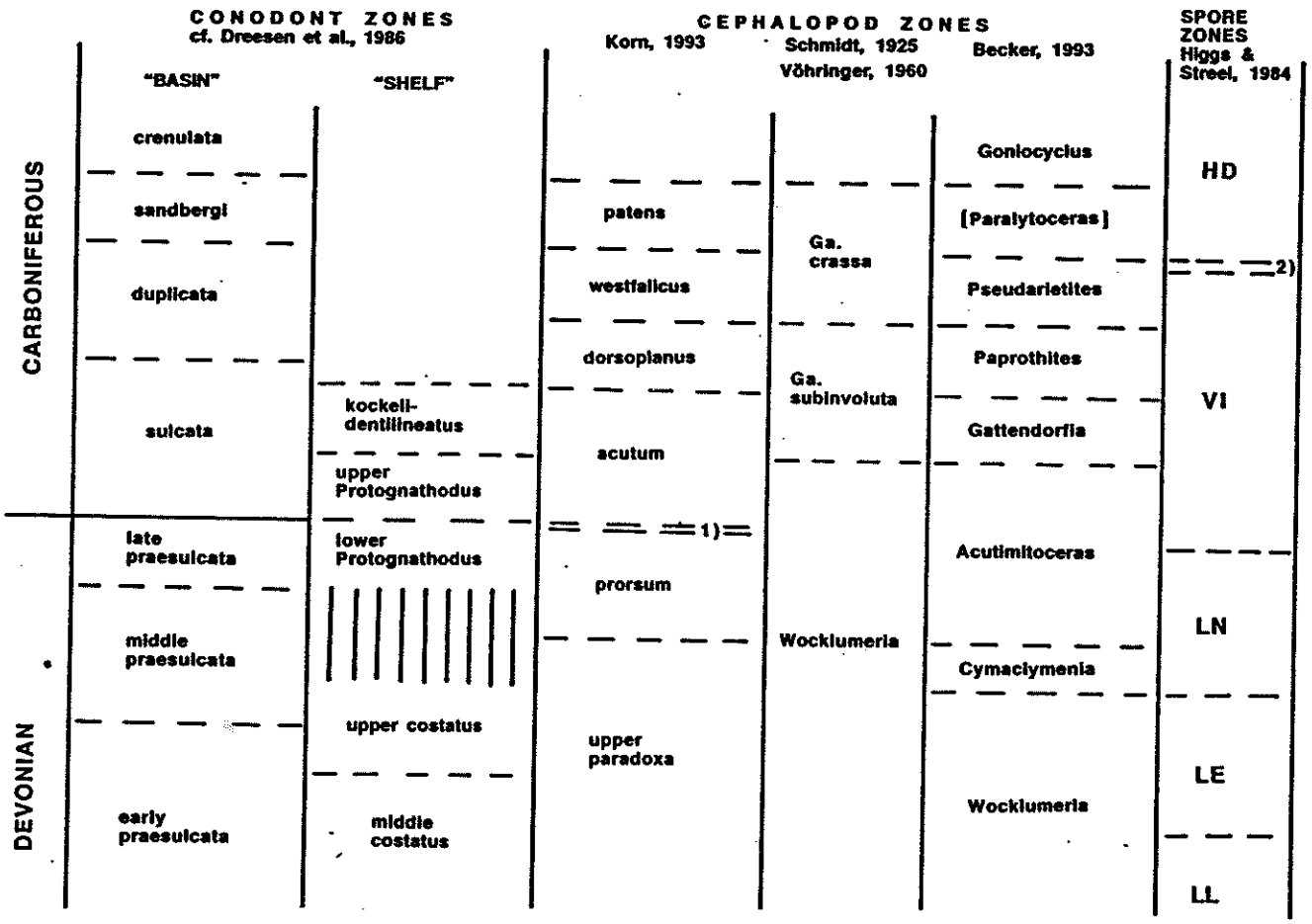

Fig. 11.- Correlation table of conodont, cephalopod and spore zonations inasfar as used in Sauerland (after Bless *et al.*, 1993)

1): The base of the *acutum* zone possibly matches the base of the "upper *Protognathodus* fauna" if we accept the find of *Acutimitoceras acutum* 2 cm above the LN/VI spore zones boundary in Hasselbachtal. This specimen occurs, however, some 15 cm below the first *Siphonodella sulcata* in that section. Therefore, it cannot be excluded that the base of the *acutum* zone s.l. is just below the *sulcata* and "upper *Protognathodus*" conodont zones. However, there is no evidence for *Gattendorfia* or other strictly Carboniferous goniatite genera at such an early level. The *Gattendorfia* genozone (Becker, 1993a = *acutum* base of former authors) postdates the "upper *Protognathodus*" level.

2): The HD Zone has been found with the conodont *duplicata* zone in the Namur Syncline in Belgium (Higgs *et al.*, 1992) and might even be older.