Bulletin de la Société belge de Géologie Bulletin van de Belgische Vereniging voor Geologie	T. 93 V. 93	fasc. 1-2 deel 1-2	pp. 197-211 blz. 197-211	Bruxelles 1984 Brussel 1984

STRATIGRAPHIC CORRELATION OF FAMENNIAN OOLITIC IRONSTONES IN THE HAVELANGE (DINANT BASIN) AND VERVIERS BOREHOLES (VESDRE MASSIF) (UPPER DEVONIAN, BELGIUM)

by Roland DREESEN (*)

ABSTRACT. - The Lower Famennian (and Upper Frasnian) nodular shales of the Havelange and Verviers boreholes have been litho- and biostratigraphically correlated. Detailed study of the conodont faunas revealed the presence of paleontological condensations within the oolitic ironstones and proved their synchronism in both sections. Their proximal facies (Verviers) are characterized by an important concentration of heterogenous ferruginized allochems surmounting a hardground or basal erosional unconformity, whereas their distal facies (Havelange) display strongly dispersed ferruginous ooids or a red staining only.
Paleoecological interpretation of the conodont biofacies evolution demonstrates a probable deepening of the depositional environment of the upper Famenne Shales and a transition to more coastal conditions from the base of the Esneux micaceous sandstones. The lower Famenne Shales otherwise resulted from a slow sedimentation under relatively shallow shelf conditions. The Frasnian-Famennian boundary finally is situated near an important stratigraphical event, which has been responsible for the absence of the Lower *P. triangularis* zone in Belgium.

RESUME. - Une étude litho- et biostratigraphique a permis de corréler les sédiments essentiellement schisteux du Famennien inférieur (et du sommet du Frasnien) dans les sondages de Verviers et d'Havelange.
L'étude détaillée des faunes à conodontes a démontré la présence de condensations paléontologiques au sein des différentes couches à "oligiste oolithique" et le synchronisme de ces remarquables niveaux de repère dans les sondages étudiés. Leurs faciès proximaux (Verviers) sont caractérisés par une concentration assez importante d'allochèmes ferrugineux hétérogènes surmontant un hardground ou une disconformité érosive basale, tandis que leurs faciès plus distaux (Havelange) montrent la présence d'allochèmes ferrugineux fortement dispersés, ou seulement une pigmentation rouge.
L'analyse paléoécologique des différents biofaciès à conodontes démontre un approfondissement du milieu de dépôt dans la partie supérieure des Schistes de la Famenne et une transition vers des milieux plus côtiers dès la base de la Formation d'Esneux. La partie inférieure des Schistes de la Famenne par contre serait le résultat d'une sédimentation ralentie sur une plate-forme relativement peu profonde. La limite Frasnien-Famennien se situe non loin d'un événement stratigraphique important, responsable de l'absence de la Zone inférieure à *P. triangularis* en Belgique.

INTRODUCTION.

In 1972 a series of more than eighty 20 m-boreholes has been drilled for account of the Ministry of Public Works in the Vesdre river bed, in the centre of Verviers. These completely cored boreholes provided detailed information on the geological conditions of the shallow subsurface for a project of a viaduct over the Vesdre river (GRAULICH, 1972). All of the boreholes penetrated folded Famennian and Upper Frasnian strata which were frequently cut or displaced by longitudinal and transversal faults. In some of the boreholes oolitic ironstone

(*) Alexander von Humboldt Fellow,
Geologisches Institut der RWTH Aachen, Wüllnerstr. 2, D-5100 Aachen, West Germany.

levels have been encountered, the biostratigraphical identification of which helped to unravel the complex tectonics of the studied area.

Fresh material collected from these ironstones have been used by the aûthor for his study on the origin and paleogeographical significance of Famennian oolitic ironstones in the Vesdre and Dinant Synclinoria (DREESEN 1982). Figs. 1-3 represent location maps of the studied Verviers boreholes. Their Lambert coordinates are listed below :

VRG-30	x=255174	y=143478	z= + 157,94 m
VRG-28	255122	143481	157,36
VRD-31	255200	143495	157,99
VRD-30	255175	143495	157,74
VRD-28	255126	143501	157,85
VRD-27	255102	143506	157,60

The 400 m-borehole of Havelange (the so-called Petit Sondage d'Havelange) has been drilled by the Belg. Geol. Survey in August 1980, as a shallow stratigraphical test hole. Aim of this borehole was to determine the depth of the first casing within the adjacent deep Havelange borehole (the 6000 m Champ du Bois borehole). Lambert coordinates of the test hole are : x = 212622, y = 110358, z = + 289018 (see location maps on figs 1 + 4).

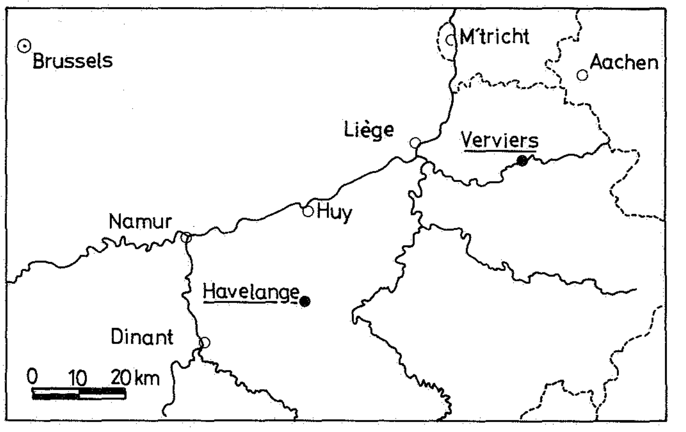


Fig. 1 - Location map of the Havelange and Verviers boreholes.

Target of this deep drilling project (which is still in progress) is to explore seismically located domal structures in the deep subcrop of the Famenne area, which could represent potential host rocks for gas. All but the first 85 m of the cores of the Havelange test borehole have been studies for this paper. That upper part consisted mainly of thin-bedded

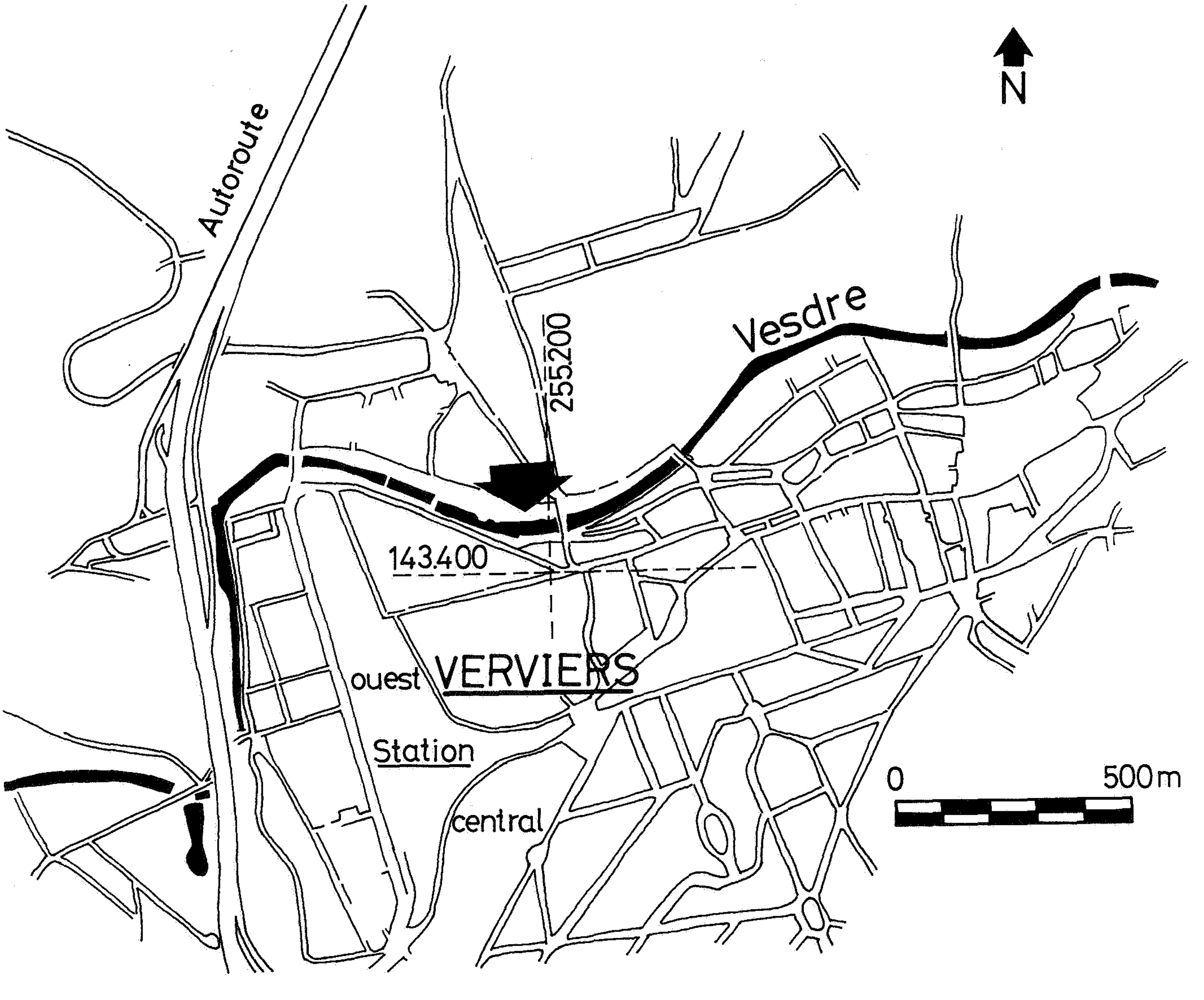


Fig. 2 - Street map of the central part of Verviers agglomeration. Arrows points to studied area and location of boreholes studied for this paper (see next fig. 3).

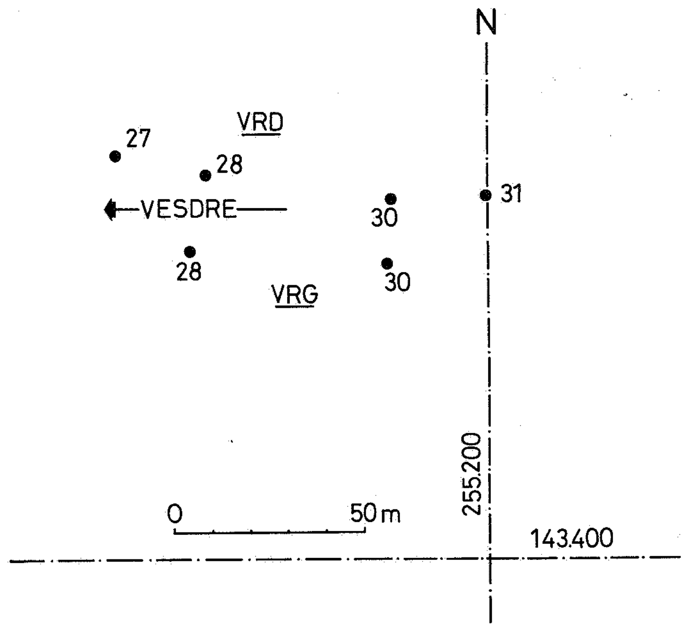


Fig. 3 - Detailed location map of the Verviers boreholes studied for this paper (VRG = Verviers Rive gauche = Verviers left bank, VRD = Verviers Rive droite = Verviers right bank).

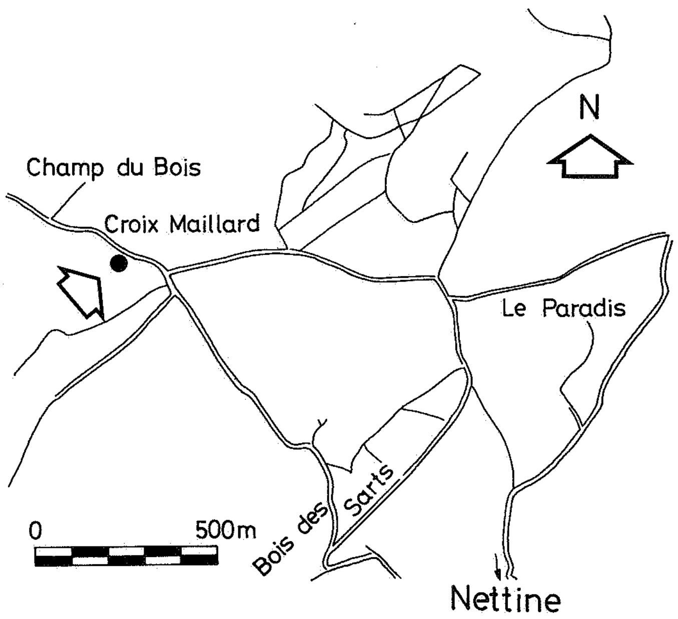


Fig. 4 - Location map of the Havelange borehole (Champs du Bois).

micaceous sandstones, almost devoided of limestones, which made it less interesting for biostratigraphic purposes (conodont dating).

The major part of the Havelange cores otherwise was composed of a continuous section of nodular shales with only minor sandy interruptions.

The apparently undisturbed aspect of this shaly sequence as well as the presence of dispersed ferruginous ooids within the carbonates, incited us to try out a long-distance correlation (55 km) with the Verviers boreholes.

BIOSTRATIGRAPHY.

An accurate dating of the sediments in both the Havelange and compiled Verviers boreholes has been realized on the basis of more than 180 positive conodont samples. Because of the relative scarcity of pelagic index conodonts (*Palmatolepis* species) in parts of the studied sections, both the standard conodont zonation for pelagic environments, and the recently proposed new alternate zonation for shallow marine environments have been used to date and correlate the conodont faunas (ZIEGLER, 1962; SANBERG & ZIEGLER, 1973; SANDBERG & DREESEN, 1984).

The Frasnian-Famennian boundary has been located in this way at a depth of 343,98 m within the Havelange borehole (see fig. 5).

The presence of this boundary in the Verviers boreholes is uncertain because of impoverished conodont faunas or insufficient weight of rock sample. GRAULICH (1972) nevertheless placed the Frasnian-Famennian boundary lithologically at the base of the lowest limestone bed in borehole VRD-27 (see fig. 6). A sudden outburst of Icriodids otherwise proved to be very useful in tracing this boundary in most of the studied sections of the Dinant and Vesdre basins (DUSAR, 1976; DREESEN & HOULLEBERGHS, 1980; BIRON *et al.*, 1983). Non-deposition and subsequent paleontological condensations further are obvious, not only at the Frasnian-Famennian transition but also at the *P. triangularis*-*P. crepida* and *P. crepida*-*P. rhomboidea* zonal boundaries. The latter condensations have also been associated with the presence of ferruginous ooid-bearing or red-stained sediments (DREESEN, 1981, 1982). This is also true in Havelange and Verviers : many of the conodont zonal boundaries above the Frasnian-Famennian transition are located within ferruginous ooid-bearing and/or red-stained shaly and calcareous sediments (see figs. 5 + 6).

The absence of some conodont zones such as the Lower *P. crepida* and Lower *P. rhomboidea* zones, reflects non-deposition preceding the storm-induced transport of the ferruginized allochems (DREESEN, 1982). The absence of the Lower *P. triangularis* zone otherwise is due to an important stratigraphical event occuring near the Frasnian-Famennian stages boundary : this event corresponds to either a non-deposition or an erosional phase both related to a probable eustatic sea-level fall. The latter erosion even affected the top of some uppermost Frasnian reefs, as documented recently by BIRON *et al.* (1983) from the marble quarry in Rance.

The distribution of significant platform conodonts in all of the studied boreholes is listed in tables 1 to 7.

When the zonal index conodont was lacking (because of biofacies restrictions) the first occurences of other important platform conodont species have been used to trace the zonal boundaries.

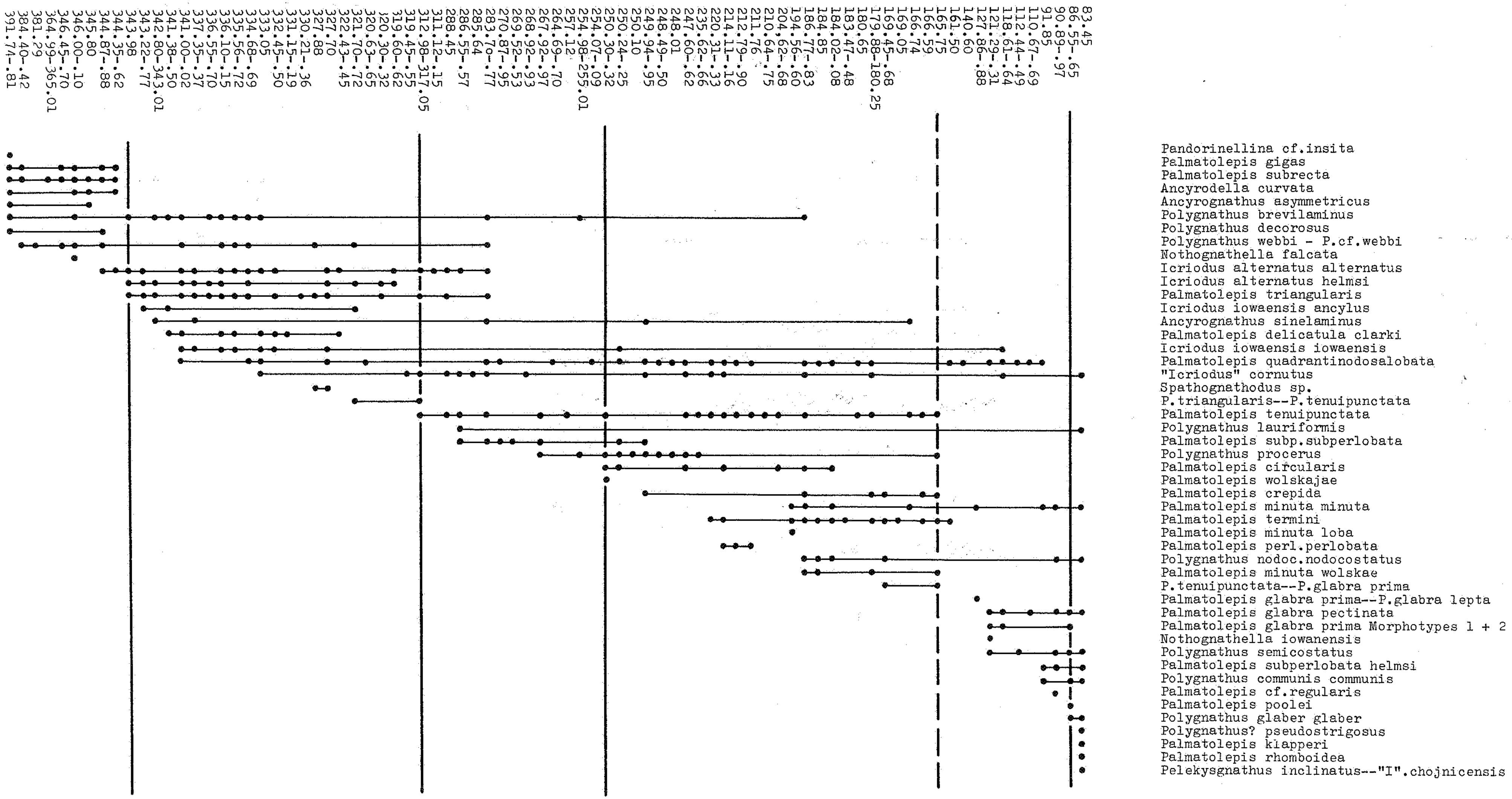


Table 1 - Distribution of conodonts in the Havelange borehole section.

Table 2 - Distribution of conodonts in the VRD-27 section.

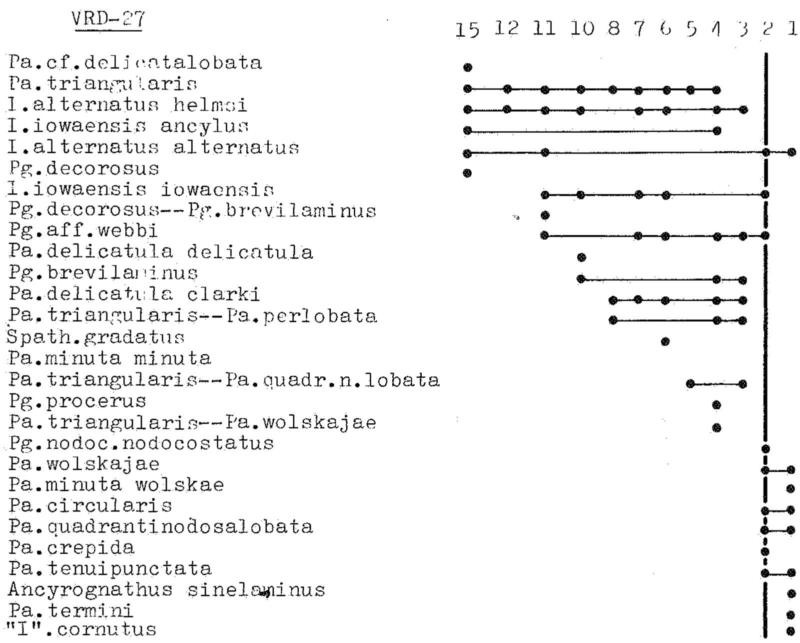


Table 3 - Distribution of conodonts in the VRD-28 section.

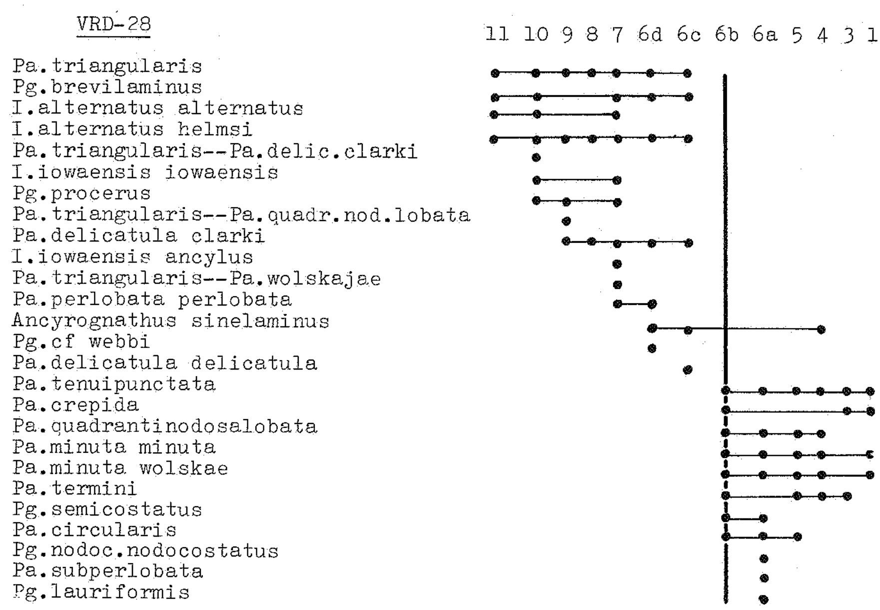


Table 4 - Distribution of conodonts in the VRG-28 section.

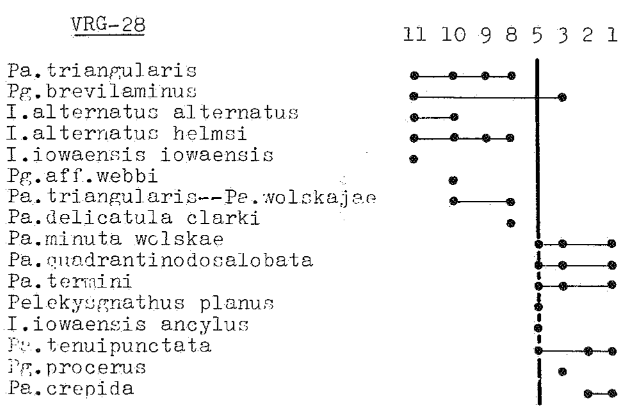


Table 5 - Distribution of conodonts in the VRD-30 section.

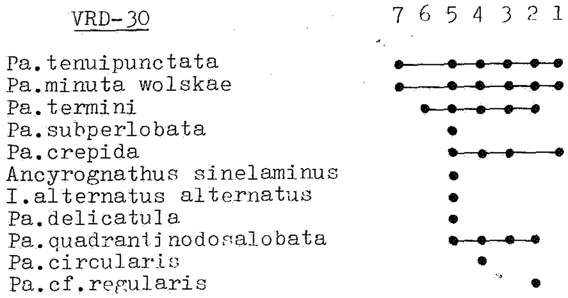


Table 6 - Distribution of conodonts in the VRD-31 section.

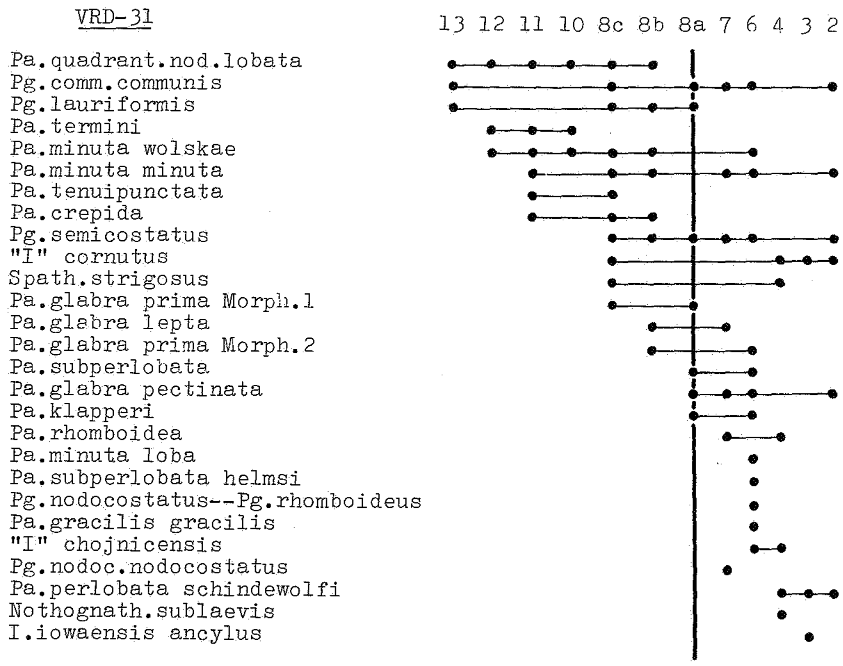
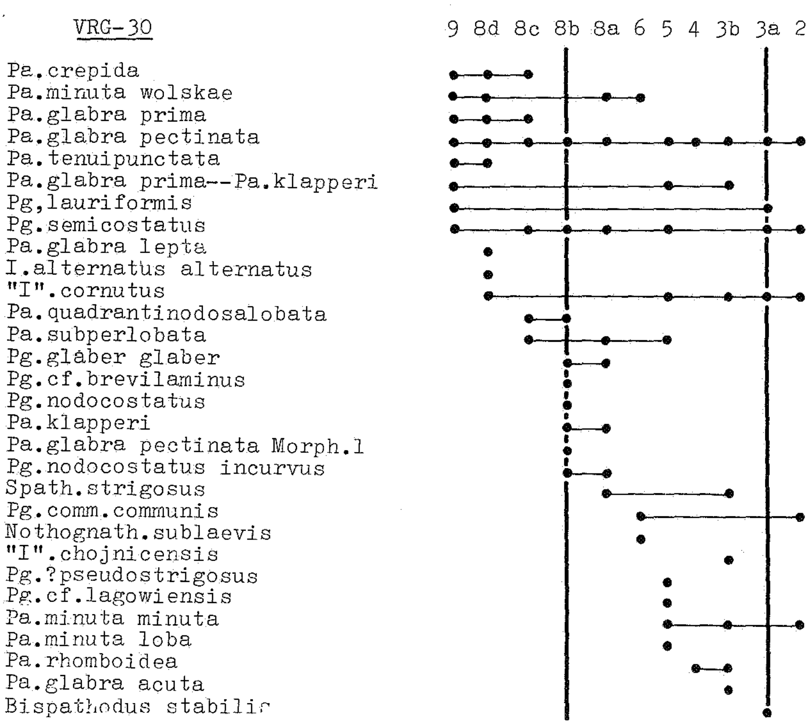


Table 7 - Distribution of conodonts in the VRG-30 section.



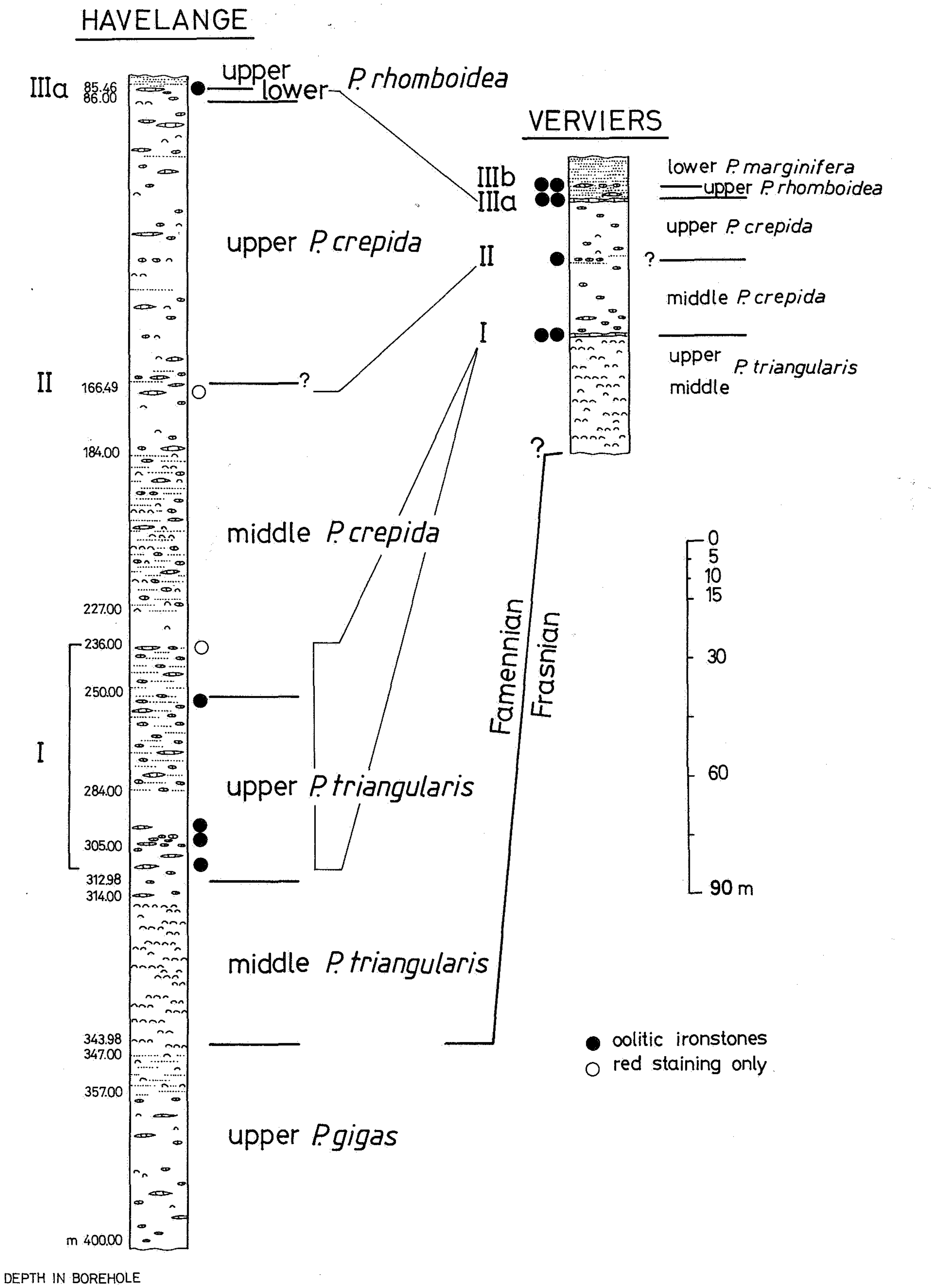


Fig. 5 - Stratigraphic correlation scheme of the Havelange and Verviers boreholes. Roman numerals I to IIIb refer to oolitic ironstone levels of DREESEN (1982).

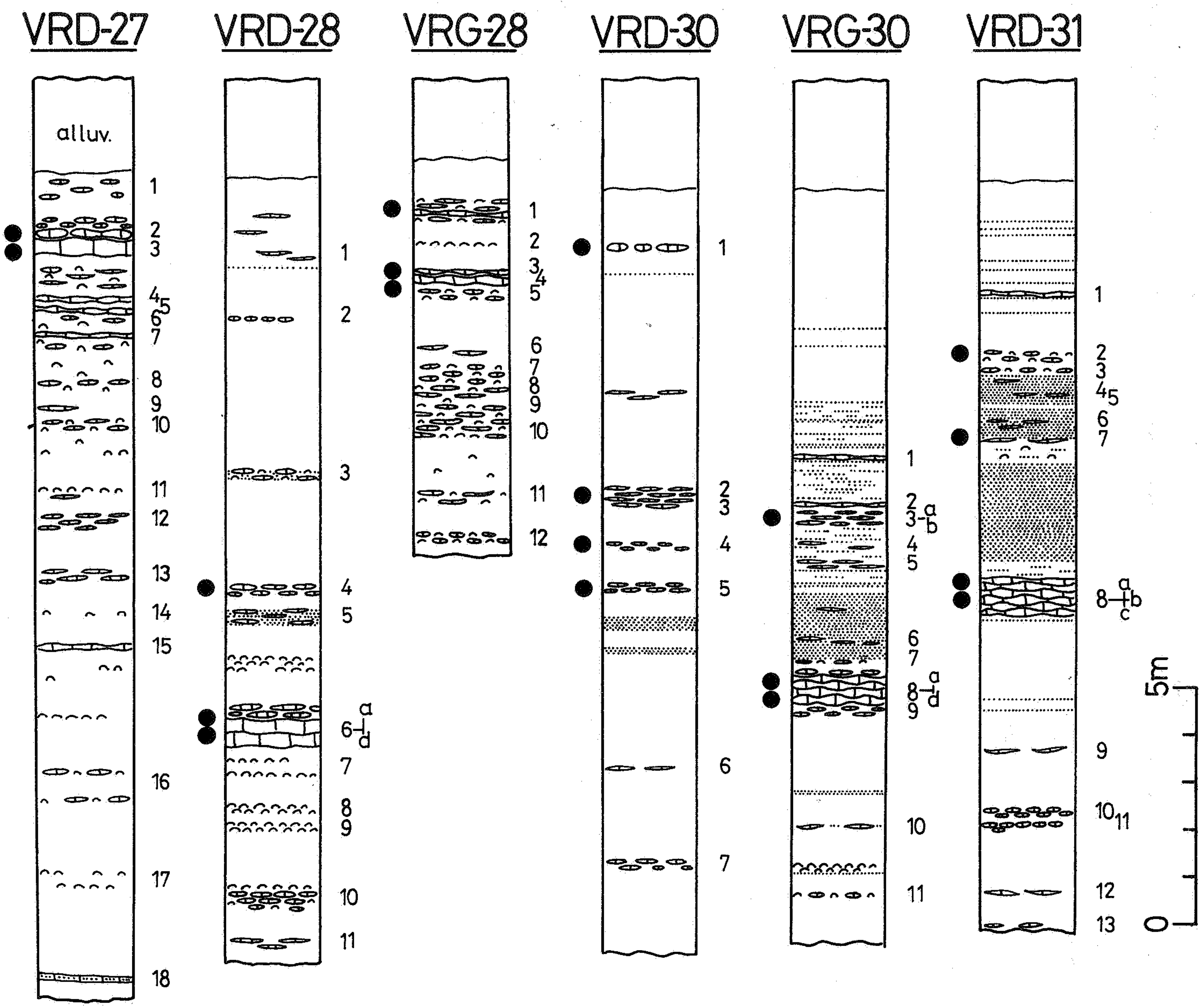


Fig. 6 - Single columnar sections of the studied Verviers boreholes and position of conodont samples (white = shales, dotted = micaceous sandstones, other symbols = limestones, black dots = oolitic ironstones).

The first occurences of *I. iowaensis ancylus*, *P. circularis*, *P. klapperi*, *"I". chojnicensis* and *Bisp. stabilis* are particularly useful in delimiting the base of the Middle *P. triangularis*, the Middle *P. crepida*, the Lower *P. rhomboidea*, the Upper *P. rhomboidea* and the Lower *P. marginifera* zones respectively.

LITHOSTRATIGRAPHY.

The studied section in the Havelange borehole (85,45 to 400,10 m) comprises the following lithological units (from top to bottom) :

- 93 m of greyish-green shales with dispersed nodular and lenticular crinoidal-brachiopodal wackestone, underlying thin-bedded micaceous, finely-laminated sandstones and sandy shales (thickness unknown).

A ferruginous ooid-bearing bioclastic (crinoidal) wackestone/packstone level occurs at their transition.

- 40 m of sandy shales with thin calcareous sandstone beds, nodular and lenticular bioclastic wackestones and dispersed brachiopods.
- 8 m of shales without limestone.
- 52 m of sandy shales with lenticular and nodular bioclastic wackestones and calcareous sand laminae.
- 14 m of shales with disperse lenticular and nodular wackestones.
- 40 m of sandy shales with numerous coquinas.
- 10 m of very sandy shales with strongly dispersed brachiopods.
- 41 m of greyish shales with small nodular and lenticular wackestones and dispersed brachiopods.

The lithological transition between Upper Frasnian and Lower Famennian nodular shales corresponds to the base of the sandy shales with numerous coquinas. It is interesting further to note that the uppermost Frasnian shales become very sandy towards the top.

The Lower Famennian nodular shales "Schistes de la Famenne") can be subdivided here into 3 lithological units : a lower shaly unit with an important concentration of coquinas, a middle shaly unit with frequent sandy intercalations and nodular-lenticular limestones, and an upper shaly unit with very dispersed limestones or brachiopod levels.

The thin micaceous sandstone beds or streaks are finely laminated and display often convoluted bedding, bioturbation and small-scale slumping. The coquina levels otherwise are essentially composed of Spiriferids, Athyrids, Productellids and some Rhynchonellids. The latter have been stored within the collections of the Belg. Geol. Survey for further study.

Relevant changes in colour of the shales have not been recorded, except near the Frasnian-Famennian transition where the shales grade from grey into olive-green. The dip ranges from subhorizontal to 40° with an average of 15°.

A slight to moderately strong red staining otherwise is conspicious in some lenticular limestone beds. Ferruginized allochems (coated bioclasts, crinoid ossicles, ostracods, superficial ooids) moreover occur within the dissolution residues of some acid-etched limestones. All of these red-stained and/or ferruginous ooid-bearing levels can be stratigraphically correlated with the well-developed oolitic ironstone levels of Verviers.

The different levels at Havelange are believed to represent the distal facies of oolitic ironstone levels I, II and IIIa, which are proximal tempestites (DREESEN, 1982).

The distal facies of level IIIa in Havelange consists of a crinoidal wacke-/packstone with pink-stained crinoid ossicles and disperse dark-green chloritized superficial ooids.

The red-stained lenticular bioclastic wackestone at 166,49 m could represent a distal equivalent of oolitic ironstone level II. Dispersed hematitic allochems finally (superficial ooids, coated bioclasts) have been observed within dissolution residues of acid-etched limestone samples between 236 m and 310 m. This nodular shale interval might represent the distal and time-equivalent facies of oolitic ironstone level I.

Single columnar sections as well as a compiled section of the Verviers boreholes are depicted on fig. 6 and 7.

In these boreholes the Lower Famennian nodular shales and basal Upper Famennian Esneux sandstones have been perforated only. The Lower Famennian shales can be lithologically subdivided here into a lower part (16 m) rich in Spiriferid-Anthyrid-Productellid coquinas, and an upper part (29 m) with strongly dispersed nodular limestones. Both units are separated by an important (80 cm) oolitic ironstone level (level I). Rhynchonellids are extremely rare.

The base of the Famennian has most probably not been reached, but must be quite close.

A concentration of thin ferruginous ooid-bearing lenticular crinoidal-brachiopodal wacke-/packstones occurs about half-way the upper part of the Famenne Shales, and corresponds to oolitic ironstone level II. A conspicious third oolitic ironstone level (IIIa) further marks the transition to the Upper Famennian micaceous sandstones of the Esneux Formation ("Psammites et schistes stratoïdes d'Esneux"). The latter comprise 10 m of brownish olive-green sandy shales and thin-bedded finely laminated micaceous sandstones, displaying bioturbation and convoluted bedding. Thin lenticular crinoidal wacke-/packstones are interstratified within the sandstones and sandy shales, and they are locally enriched with ferruginous ooids (oolitic ironstone level IIIb). Level IIIa proved to be an excellent stratigraphical marker bed, especially by its relative abundance in goniatites (*Cheiloceras*). For a detailed analysis of these ironstones the reader is referred to DREESEN (1982).

The main characteristic of the oolitic ironstone levels in the Verviers boreholes is the presence of algal-encrusted and mineralized hardgrounds (level I) or basal erosional unconformities (levels II-III), surmounted by graded-bedded ferruginized heterogenous allochems : Osagia-type oncoids, coated bioclasts, superficial ooids, etc... A sediment petrographical differentiation of the different ironstone levels is possible on the basis of the preponderance of particular allochems.

CONODONT BIOFACIES AND PALEOECOLOGY.

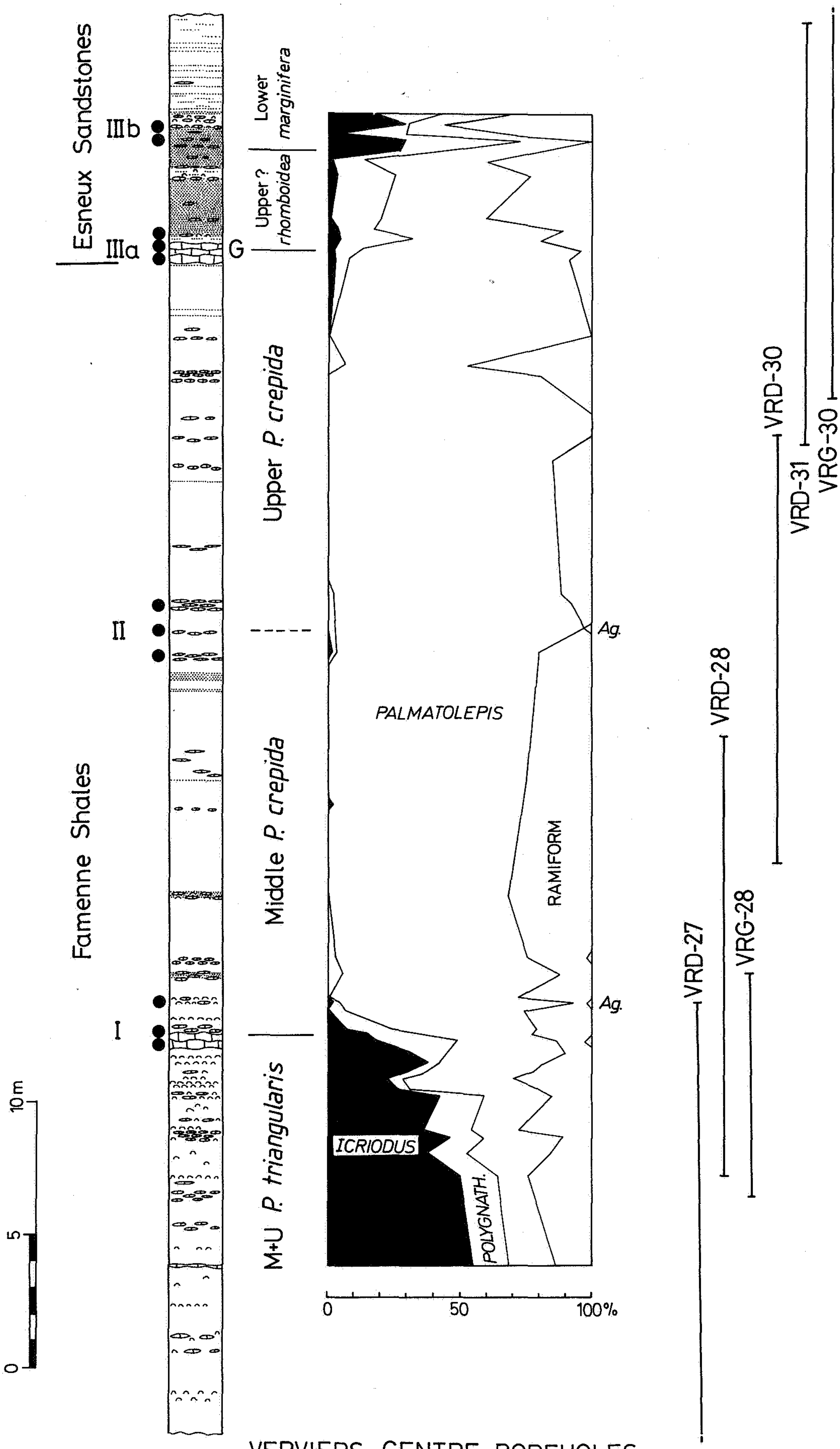
Conodont biofacies (associations of platform conodonts) are very helpful in interpreting the paleobathymetry and depositional environment of Upper Devonian conodont-bearing sedimentary rocks (SANDBERG, 1976, DREESEN & THOREZ, 1980, SANDBERG & DREESEN, 1984).

Conodonts are also accurate tools in tracking and calculating the relative time spans of stratigraphical events (SANDBERG & POOLE, 1977; SANDBERG *et al.*, 1983).

When interpreting the conodont biofacies evolution in the Havelange and Verviers boreholes, the following remarks are worth mentioning (fig. 7 and 8) :

1. The uppermost Frasnian nodular shales are characterized by a Polygnathid-Palmatolepid biofacies, which would indicate relatively shallow subtidal, inner-shelf environments. The presence of *Ancyrodella* and *Ancyrognathus* suggests possible influences from peri-reefal settings.

2. A very conspicuous outburst of *Icriodus* at the very base of the



VERVIERS-CENTRE BOREHOLES

Fig. 7 - Compiled columnar section and paleoecological analysis (conodont biofacies) of the conodont faunas in the Verviers boreholes. Right : location of the single columnar sections.

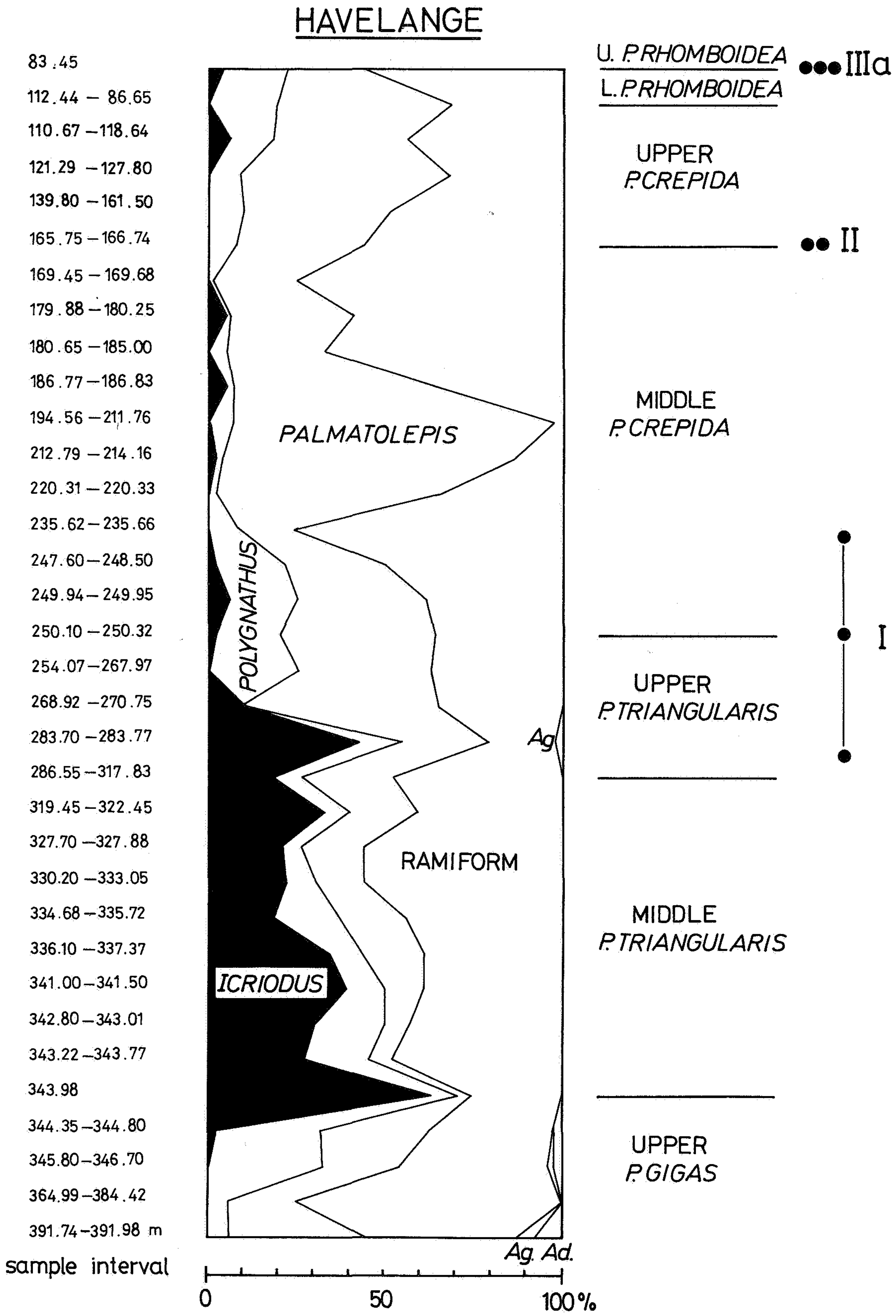


Fig. 8 - Paleoecological analysis of the conodont faunas in the Havelange borehole (Left : "sample interval" refers to grouped conodont samples within measured intervals, because of the insufficient amounts of conodont specimens per kilogram of rock sample in the cores).

Famennian stage (base of Middle *P. triangularis* Zone) is the mute evidence of an important stratigraphical event, which occured about 9 to 10 m. y. before the Devonian-Carboniferous boundary (DCB). The stratigraphical gap at the Frasnian-Famennian boundary amounts to 0.5-1 m. y..

3. Large amounts of euphotic *Icriodus* species with expanded basal cavities dominate the platform conodont populations throughout the Middle and Upper *P. triangularis* zones. This fact and an apparently reduced thickness with respect to the thickness of the shales in the next two *P. crepida-* zones, would suggest a slow or condensed sedimentation in a shallow shelf environment.

4. The more pelagic *Palmatolepis* species dominate the Middle and Upper *P. crepida*-zones, defining a Palmatolepid biofacies, wich would characterize the outer muddy shelf or a deeper subtidal offshore shelf environment (= the most fully marine episode during the Famennian).

5. Ferruginous ooids have been swept into more offshore settings after a non-deposition event which occured about 9 to 8 m. y. before the DCB (oolitic ironstone level I).

6. From the base of the *P. rhomboidea* zone on we observe an increase of shallower biofacies elements, defining a Polygnathid-Palmatolepid biofacies. This coincides with the start of the micaceous sand sedimentation (= sandy inner shelf).

7. oolitic ironstone level IIIa corresponds to an event which occured about 7.5 to 6.5 m. y. before DCB.

8. An apparent mixing of Polygnathid-Palmatolepid and Polygnathid-Icriodid conodont biofacies is obvious at the base of the Lower *P. marginifera* zone in Verviers, indicating a probable interference of sedimentological processes : conodonts from shallower marine settings (surroundings of shoals) have been transported into the sandy inner shelf during storm events. Therefore the sudden increase of nekto-benthic " *Icriodus* " species seems here to coincide with the presence of allochthonous ferruginized allochems (oolitic ironstone level IIIb).

9. A sudden and temporary increase of Icriodids and Polygnathids within a prevailing Palmatolepid biofacies coincides with oolitic ironstone level II, supporting the idea of transport of shallower biofacies elements into more offshore settings (Verviers boreholes).

10. An analogous but less pronounced influx of shallower conodont biofacies elements (here restricted to Polygnathids of the *semicostatus*-group) could also be present within the 236-268 m interval of the Havelange borehole. Within this interval dispersed ferruginized allochems occur, characterizing a distal facies of oolitic ironstone level I.

11. The conodont biofacies evolution in the Havelange borehole as a whole, reflects less the influence of sedimentological events such as tempestites, because of its more distal position (with respect to the source area of the ferruginized allochems).

CONCLUSIONS.

Differences in thicknes and in conodont biofacies within the Famenne Shales reflect important changes in their depositional environment. The lower part of the Famenne Shales, deposited during the Middle and Upper *P. triangularis* zones, represents slow sedimentation under relatively shallow marine conditions most probably.

The upper part of the Famenne Shales otherwise, deposited during the Middle and Upper *P. crepida* zones, represents a full-marine, offshore sedimentary sequence.

On the other hand, differences in thickness between the Havelange and Verviers sections, reflect differences in paleogeography (proximal-distal positions) and in subsidence rates (sedimentation velocities). Oolitic ironstones

Oolitic ironstones and associated red-stained sediments finally are excellent stratigraphic marker beds for correlating intrabasinal proximal and distal facies during the Lower and early Upper Famennian on the Ardennes shelf in Belgium.

ACKNOWLEDGEMENTS.

This paper was begun during a NFWO-supported stay at the Dept. Aardwetenschappen, Lab. Mikropaleontologie, K. U. Leuven, and it was completed while the author was an Alexander von Humboldt Fellow at the Geol. Inst. der RWTH Aachen. I am very grateful to these institutions for their support.
Ir. J. M. GRAULICH, Chief geologist - Director of the Belg. Geol. Survey, Brussels, most kindly released the cores of Havelange and Verviers for study and publication. Luc INGELBRECHTS, K. U. Leuven, helped with the core descriptions and conodont sample processing of the Havelange borehole. Parts of the manuscript have been discussed with Dr. M. DUSAR (Belg. Geol. Survey, Brussels) and Dr. C. A. SANDBERG (U. S. Geol. Survey, Denver). Dr. K. WOUTERS (Kon. Belg. Inst. Natuurwetensch., Brussels) finally, realized the scanning electron microphotographs.

They all owe my profound appreciation.

I am especially indebted to Prof. Dr. W. KASIG and to all my collegues of the Geol. Inst. Aachen, for their hospitality.

REFERENCES.

BIRON, J. P., COEN-AUBERT, M., DREESEN, R. DUCARME, B., GROESSENS, E. & TOURNEUR F. (1983) - Le Trou de Versailles ou Carrière à Roc de Rance. *Bull. Soc. belge Géol.*, 92, 4, pp. 317-336.

DREESEN, R. (1981) - Importance paléogéographique des niveaux d'oolithes ferrugineuses dans le Famennien (Dévonien supérieur) du Massif de la Vesdre (Belgique orientale). *C. R. Acad. Sci. Paris*, 292, série II, pp. 615-617.

DREESEN, R. (1982) - Storm-generated oolitic ironstones of the Famennian (Fa1b-Fa2a) in the Vesdre and Dinant Synclinoria (Upper Devonian, Belgium). *Ann. Soc. Géol. Belg.*, 105, pp. 105-129.

DREESEN, R. & HOULLEBERGHS, E. (1980) - Evolutionary trends of the Famennian Icriodids in the Dinant and Vesdre Basins. *Ann. Soc. géol. Belg.*, 103, pp. 111-141.

DREESEN, R. & THOREZ, J. (1980) - Sedimentary environments, conodont biofacies and paleoecology of the Belgian Famennian (Upper Devonian). An approach. *Ann. Soc. géol. Belg.*, 103, pp. 97-110.

DUSAR, M. (1976) - The Lower Famennian at the southeastern border of the Dinant Basin. *Ann. Soc. géol. Belg.*, 99, 2, pp. 565-570.

GRAULICH, J. M. (1972) - Agglomération verviétoise. Viaduc ouest-est. Canalisation de la Vesdre. Géologie des fondations. *Serv. Géologique de Belgique*, Rapport technique interne.

ZIEGLER, W. (1962) - Taxionomie und Phylogenie Oberdevonischer Conodonten und ihre stratigraphische Bedeutung. *Hess. L. amt Bodenforsch.*, 38, 166 p., 14 pls.

ZIEGLER, W. (Ed., 1975-1978) - Catalogue of conodonts, Vol. 1, 2, 3. *Stuttgart E. Schweitzerbart'sche Verlagsbuchhandlung.*

INGELBRECHTS, L. (1982) - Bijdrage tot de studie van de kleine boring van Havelange. *Unpublished B. Sc. thesis, K. U. Leuven*, 83 p.

SANDBERG, C. A. (1976) - Conodont biofacies of Late Devonian Polygnathus styriacus Zone in western United States, *in* C. R. Barnes, ed., Conodont Paleoecology. *Geol. Ass. Canada*, Spec. Paper 15, pp. 171-186.

SANDBERG, C. A. & ZIEGLER, W. (1973) - Refinement of standard Upper Devonian conodont zonation based on sections in Nevada and West Germany. *Geol. et Pal.*, 7, pp. 87-112.

SANDBERG, C.A. & POOLE, F.G. (1977) : Conodont biostratigraphy and depositional complexes of Upper Devonian cratonic-platform and continental-shelf rocks in the western United States, *in* MURPHY, M. A., BERRY, W. B. & SANDBERG, C. A., Eds., Western North America, Devonian. *California University, Riverside, Campus Museum Contributions*, 4, pp. 144-182.

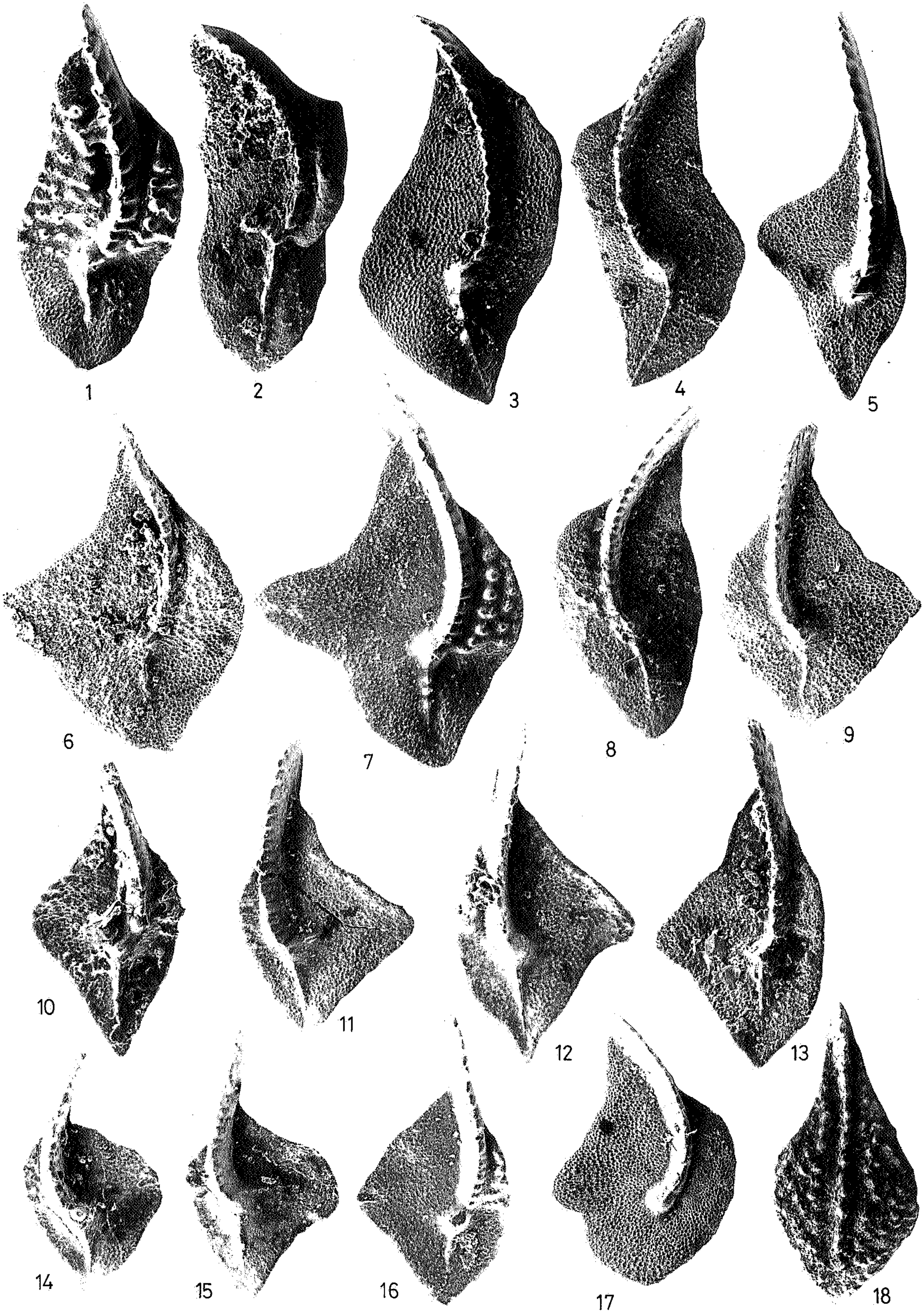
SANDBERG, C. A., GUTSCHICK, R. C., JOHNSON, R.C., POOLE, F. G. & SANDO, W. (1983) - Middle Devonian to Late Mississipian geologic history of the Overthrust belt region, western United States. *Rocky Mountain Association of Geologist, Geologic studies of the Cordilleran Thrust Belt*, 2, pp. 691-719.

SANDBERG, C. A. & DREESEN, R. (1984) - Late Devonian icriodontid biofacies models and alternate shallow-water conodont zonation *in* CLARKE, D. Ed. : Pander Society Symposium on conodont Biofacies and Provincialism (in press).

P L A T E I

Fig. 1	*Palmatolepis termini* SANNEMANN 1955, sample VRG-28-5.
Fig. 2	*Palmatolepis glabra pectinata*, ZIEGLER, 1962 Morphotype 1, SANDBERG & ZIEGLER, 1973, sample VRG-30-8b.
Fig. 3 and 4	*Palmatolepis* cf *P. regularis* COOPER 1931, samples VRD-30-2, VRG-30-8b.
Fig. 5	*Palmatolepis minuta wolskae* SCULCZEWSKI 1971, sample VRG-28-5.
Fig. 6 and 9	*Palmatolepis wolskajae* OVNATANOVA 1969, samples VRG-27-A, VRG-28-7.
Fig. 7	*Palmatolepis quadrantinodosalobata* SANNEMANN, 1955, sample VRD-28-5a.
Fig. 8	*Palmatolepis crepida* SANNEMAN 1955, smooth morphotype, sample VRD-30-5c.
Fig. 10, 11, 12, 13, 15	*Palmatolepis delicatula clarki* ZIEGLER 1962, different morphotypes, samples VRD-27-6 and VRD-27-7.
Fig. 14	*Palmatolepis delicatula delicatula* BRANSON & MEHL 1934, sample VRD-28-7.
Fig. 16	*Palmatolepis delicatula clarki* ZIEGLER 1962, sample VRD-28-7.
Fig. 17	*Palmatolepis circularis* SCULCZEWSKI 1971, sample VRD-28-5.
Fig. 18	"*Ancyrognathus*" *sinelaminus* (BRANSON & MEHL 1934), sample VRD-28-4.

All magnifications x80 except for fig. 14 : x40.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18