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SEDIMENTOLOGY AND BIOSTRATIGRAPHY OF THE VISEAN CARBONATES OF THE HEIBAART (DzH1) BOREHOLE (NORTHERN BELGIUM)[1]

by

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(4 figures, 1 table and 1 plate)

RESUME.- Quatre unités lithologiques peuvent être distinguées dans le Viséen du sondage de Heibaart (DzH1, Bassin de la Campine). La biostratigraphie situe la première unité dans le Molinacien supérieur (sous-zone Cf4δ), la seconde dans le Livien (zone Cf5), la troisième et la quatrième dans le Warnantien (respectivement sous-zones Cf6α-β et Cf6γ).

Les packstones et les grainstones bioclastiques du Molinacien supérieur ont été déposés dans un milieu peu profond et ouvert. La turbulence et la circulation de l'eau étaient assez élevées pour empêcher une accumulation significative de boue.

Au début du Livien, un approfondissement de la plate-forme dans la région de Heibaart est marqué par des sédiments se déposant sous la zone d'action des vagues, alors qu'au sommet du Livien, des calcaires lithoclastiques indiquent un milieu marqué par une influence importante des vagues ou des courants.

La partie inférieure du Warnantien inférieur (Cf6α-β) est constituée de dépôts formés à la base de la zone d'action des vagues ou plus bas. L'activité des courants ou des vagues est probablement à l'origine de la texture «grain supported» et des fragments remaniés.

Un changement du niveau de la surface marine dès la partie supérieure du Warnantien inférieur (Cf6γ) a causé un approfondissement du milieu de sédimentation. Un buildup crypto-algaire s'est développé dans la région de Heibaart. Sa partie inférieure est constituée de corps crypto-algaires non laminés (thrombolites) qui ne sont pas restreints à la zone intertidale. Cependant, dans sa partie supérieure («mound cap»), on note la présence de stromatolites caractéristiques de la zone subtidale peu profonde et de la zone intertidale. Cette séquence se termine par des sédiments de faible profondeur, résultat d'une baisse du niveau de la surface marine au sommet du Warnantien inférieur ou/et de la croissance du buildup.

ABSTRACT.- The Visean strata of the Heibaart borehole (DzH1, Campine-Brabant Basin, northern Belgium) can be divided into four lithological units. Biostratigraphical data indicate that the first unit was formed during the Late Moliniacian (foraminifer subzone Cf4δ), the second during the Livian (Cf5), the third and the fourth during the Early Warnantian (subzones Cf6α-β and Cf6γ respectively).

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The Upper Moliniacian bioclastic packstones and grainstones were deposited in a shallow open marine environment in which water turbulence and circulation rates were high enough to prevent a considerable accumulation of mud.

Due to a deepening of the sedimentation environment in the Heibaart area, the limestones of the Livian were deposited at depths below significant wave activity. In contrast, the lithoclastic limestones at the top of the Livian were formed in an environment with an important wave and/or current activity.

The lower part of the Lower Warnantian (Cf6α-β) strata represents deposits at or just below normal wave base. Current or wave activities are probably responsible for the grains-supported texture and the reworked fragments.

A rise of the sea-level at the base of the upper part of the Early Warnantian caused a deepening of the sedimentation environment. An algal-cryptalgal buildup developed in the Heibaart area. The lower part of the buildup consists of non-laminated cryptalgal bodies (thrombolites) which are not restricted to the intertidal zone. However, in the upper part laminated stromatolites occur which are characteristic for a very shallow subtidal and intertidal zone. This shallowing upward sequence resulted from a drop of the sea-level at the end of the Early Warnantian or/and from the growth of the buildup.

1.- INTRODUCTION

The Heibaart boreholes DzH1 to DzH6 (Distrigaz-Heibaart) were drilled in 1977 for Distrigaz to test the possible reservoir qualities of the uppermost karstic zone of the Dinantian carbonates for underground hydrocarbon storage (Bless *et al.*, 1981). The boreholes are situated 25 km NNE of Antwerp in northern Belgium (fig. 1). The uppermost 30 m of the Visean strata of the boreholes DzH 2, 3, 4, 5 and 6 have been studied by Bless *et al.* (1981). In the DzH1 borehole, the Dinantian has been reached at a depth of 1102 m and the drilling has been stopped at 1399 m.

In this study, the biostratigraphy and the sediment petrography of the Dinantian strata of the DzH1 borehole have been investigated. The facies and depositional environment of the different biostratigraphic units are discussed.

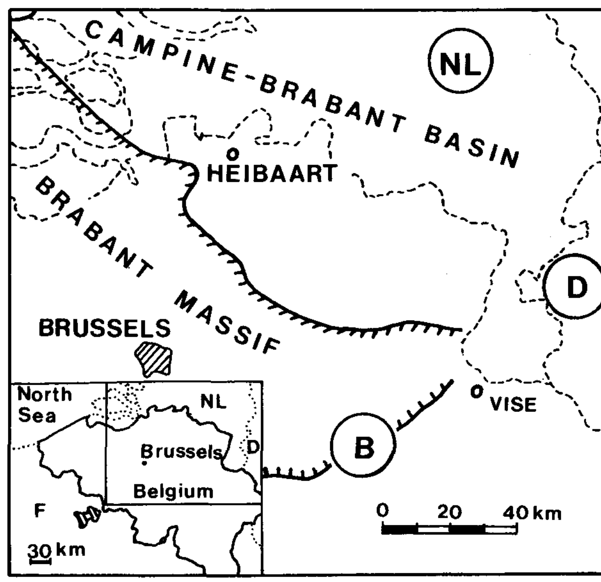

Figure 1.- Location of the Heibaart borehole (DzH1). The barbed lines mark the northern and southern border of the Dinantian strata.

2.- BIOSTRATIGRAPHY

2.1.- FORAMINIFERS, ALGAE AND PROBLEMATICA

Figure 2 shows the biostratigraphy of the Heibaart borehole DzH1, based on the occurrence of foraminifers, algae and problematica.

The carbonates between 1397 and 1326 m contain a typical Upper Moliniacian (Cf4δ) association with *Koninckopora* (double wall), primitive **Archaediscidae**, *Eoparastaffella, Florennella* and *Pseudolituotubella* (Conil & Naum, 1976). Other characteristic elements of the Moliniacian are *Baituganella, Endothyra tenuiseptata* **Lipina**, *Latiendothyranopsis* and *Urbanella.* At a depth of 1295 m there are no guides available. *Nodosarchaediscus (Nodosarchaediscus)* and primitive *Pojarkovella* cover the transition Moliniacian-Livian.

The appearance of a typical Livian (Cf5) association with *Omphalotis minima, Pojarkovella nibelis* and *Endothyranopsis* ex. gr. *crassas* occurs at a depth of 1286.10 m. The presence of *Pseudoammodiscus* and *Pseudolituotuba* are ecological. These species are frequent in the Moliniacian of the Franco-Belgian Basin. We also notice the occurrence of cf. *Ammarchaediscus* and of cf. *Koskinotextularia,* usually present in the

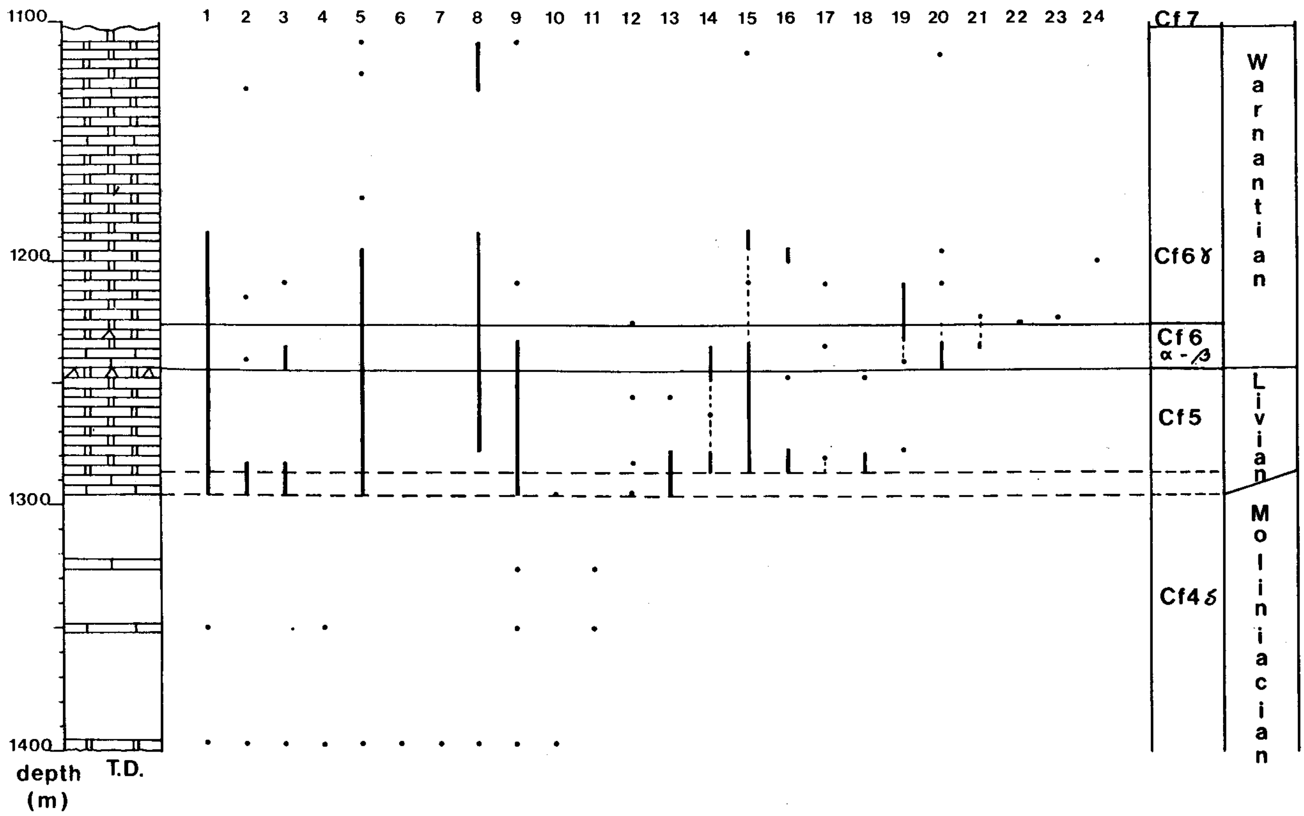

Figure 2.- Biostratigraphy of the Heibaart borehole based on the occurrence of foraminifers, algae and problematica. ——— and • presence of the fauna or flora; --- probable presence of the fauna or flora.

1. *Koninckopora* (double wall)
2. *Brunsia*
3. **Forschiinae**
4. *Pseudolituotubella*
5. **Archaediscidae**
6. *Archaediscus (Glomodiscus)*
7. *Ammarchaediscus (Rectodiscus)*
8. *Tetrataxis*
9. *Eostaffella*
10. *Eoparastaffella*
11. *Florennella*
12. *Plectogyranopsis*
13. *Mediocris*
14. *Pseudolituotuba gravata* **(Conil & Lys)**
15. **Palaeotextulariidae** (single wall)
16. *Omphalotis minima* **(Rauser & Reitlinger)**
17. *Endothyranopsis* ex. gr. *crassas* **(Brady)**
18. *Pojarkovella nibelis* **(Durkina)**
19. *Pseudoammodiscus*
20. **Palaeotextulariidae** (double wall)
21. *Fasciella*
22. *Cribrospira panderi* **(Moeller)**
23. *Howchinia*
24. *Vissariotaxis compressa* **(Brazhnikova)**

Legend lithological log see figure 4.

lower part of the Livian (Conil *et al.*, 1981). From 1262 to 1246.30 m the biota show no characteristics of an upper zone. The small «dainellides» with a fortified chomata have been observed from 1279.75 m to 1277.50 m. They are different from those identifying the Moliniacian. The presence of *Quasiumbella* (at 1246.30 m) in the Visean is rare and it has never been found after the Livian in the Franco-Belgian Basin.

An ecological change indicated by the decline in the frequency of *Omphalotis minima* and *Pojarkovella nibelis*, has been observed at 1243.50 m. The Warnantian (Cf6) is characterized by the appearance of **Palaeotextulariidae** with a double wall (from 1243.50 to 1108 m). The occurrence of *Fasciella* is ecological. This problematic organism is frequent in the Warnantian of Western Europe, but has already been found in the Moliniacian (Vieslet, 1983). An other ecological modification is indicated by the disappearance of *Pseudolituotuba* at 1232.50 m, after an extreme occurrence at 1234.10 m. We also notice the sporadic presence of *Nodosarchaediscus (Nodosarchaediscus)* and *Archaediscus (Nudarchaediscus)* at 1243.50 m, of *Koskinotextularia* at 1240.50 m and 1234.60 m, of *Archaediscus (Archaediscus)* stage *angulatus* and *Ammarchaediscus (Ammarchaediscus)* at 1232.50 m.

The appearance of *Cribrospira panderi* at 1224.50 m indicates the upper part of the Lower Warnantian (subzone Cf6γ). *Howchinia bradyana* also characterizes the subzone Cf6γ. However, the specimen at 1221.70 m is badly preserved and does not allow a precise identification. The primitive *Howchinia* occur already in the lower part of the Lower Warnantian (upper V3bα; M. Laloux, pers. comm.). A few foraminifers characteristic for the Warnantian have been determined: *Volvotextularia* and *Scalebrina* at 1221.70 m, *Nodosarchaediscus (Neoarchaediscus)* at 1208.50 m and *Endothyra spira* (**Conil & Lys**) at 1112.30 m. *Biseriella*, already present in the Moliniacian is frequent in the Warnantian and has been identified at 1221.40 m. The fauna and flora from 1177 to 1144 m is not characteristic and *Koninckopora* does not reappear anymore after 1187 m. A poor association occurs from 1128 to 1108 m. Only **Palaeotextularidae** with a double wall and the *Endothyra spira (***Conil & Lys**) at 1112.30 m are typical. We should mention the presence of *Renalcis* at 1112.77 m and 1112.30 m. This algae has already been found in the Campine-Brabant Basin, namely in the Turnhout borehole at 2271.50 m in the reworked sequence between the Moliniacian and the upper part of the Lower Warnantian. It also occurs in the subzone Cf6γ in the Franco-Belgian Basin (M. Laloux, pers. comm.).

The ubiquitous foraminifers *Earlandia* and calcispherids, *(Diplosphaerina* and *Pachysphaerina)* have not been figured. *Diplosphaerina barbata* (**Conil & Lys**) at 1112.90 m is only known at the transition Ivorian-Moliniacian in an environment around the Waulsortian reefs in the Franco-Belgian Basin. *Girvanella problematica* is rare in the Visean of Belgium. This species is present in the Heibaart borehole at 1123.05 m, 1121.70 m and 1112.30 m. *Kamaena* and the aoujgaliids are abundant from the base of the borehole until 1199.10 m.

2.2.- CORALS

The determined corals and their biostratigraphical interpretation are given in table 1. *Haplolasma* cf. *subibicinum* (1396 m) is one of the characteristic species of the RC4 coral zone (Poty, 1985) which matches the Cf4α-γ foraminifer subzones. Because *Haplolasma* cf. *subibicinum* is also known in the Upper Arundian strata (Cf4δ, RC5) in Great-Britain, it suggests a Moliniacian age (Cf4). *Lithostrotion araneum* (1261.50 m) is the type-species of the RC6 coral zone (= *L. araneum* interval zone), and it is also present in the lower part of the RC7α zone). It usually indicates a Livian age, but it can extend and be common until the Cf6β-lower γ subzones. The assemblage between 1187.60 and 1107.60 m is characteristic for the coral zones RC7β-RC8. The concurrent ranges of *Aulophyllum fungites* (1187.60 m), recorded for the first time in the

Table 1.- Corals present in the Heibaart borehole and their biostratigraphical interpretation.

depth(m)	corals	zones
1107.6	*Siphonodendron* aff. *pauciradiale*	uppermost RC7β — RC8
1117.1	*Syringopora* sp.	
1121.55	*Clisiophyllum* cf. *delicatum*	
1124.7	*Dibunophyllum bipartitum*	
1133.05	*Clisiophyllide*	
1136.15	*Siphonodendron pauciradiale*	
1142.1	*Pareynia* ? sp.	
1162.8	*Pareynia* ? sp.	
1163.45	cf. *Solenodendron furcatum*	
1163.7	*Solenodendron furcatum*	
1186.8	*Lithostrotion vorticale*	RC7β
1187.6	*Aulophyllum fungites*	
1192.3	*Clisiophyllide*	RC6 — RC7α
1199.2	*Axophyllum*	
1200.0	*Siphonodendron* cf. *martini*	
1211.7	*Cyathaxonia cornu*	
1211.8	*Heterophyllia ornata*	
1212.5	*Amplexus coralloides*	
1261.5	*Lithostrotion araneum*	
1349.8	*Palaeosmilia murchisoni*	
1396.0	*Haplolasma* cf. *subibicinum*	RC4-5

MOLINIACIAN	LIVIAN	WARNANTIAN				1
Cf4 (α, β, γ, δ)	Cf5	Cf6 (α, β, γ, δ)				2
RC4	RC5 (α, β, γ)	RC6	RC7 (α, β)	RC8		3
V1 (a, b)	V2a	V2b (α, β, γ-ε)	V3a	V3b (α, β, γ)	V3c (low, up)	4

Figure 3.- Correlation between the Visean stages (1), the foraminifer zonation (2), the rugosa coral zonation (3) and the previous Belgian system (4).

Campine Basin, and of *Lithostrotion vorticale* (1186.80 m) indicate the RC7β coral zone (upper Cf6γ). The occurrences of *Solenodendron furcatum* (1163.70 m) and of widely dissepimented **Axophyllidae** (1162.80 m) showing affinities with the genus *Pareynia* Semenoff-Tian-Chansky suggest an uppermost RC7β-RC8 age.

Figure 3 shows the correlation between the Visean stages, the foraminifer zonation, the rugosa coral zonation and the previous Belgian system. The foraminifer zubzones Cf4α, β, γ and the rugosa coral zone RC4 correspond with the Lower Moliniacian, the Cf4δ and the RC5α, β, lower γ with the Upper Moliniacian, the Cf5 with the Livian, the Cf6α, β, γ and the upper RC6, RC7α, β with the Lower Warnantian, and the Cf6δ and RC8 with the Upper Warnantian. The subdivision of the Warnantian is based on the stages in Great-Britain. The Asbian (6.5 million years) corresponds with the Lower Warnantian and the Brigantian (10 million years) with the Upper Warnantian (enclosure in Bless *et al.*, 1980). The presence of Upper Warnantian strata in the Heibaart borehole has not unequivocally been proved by the biota. In the following

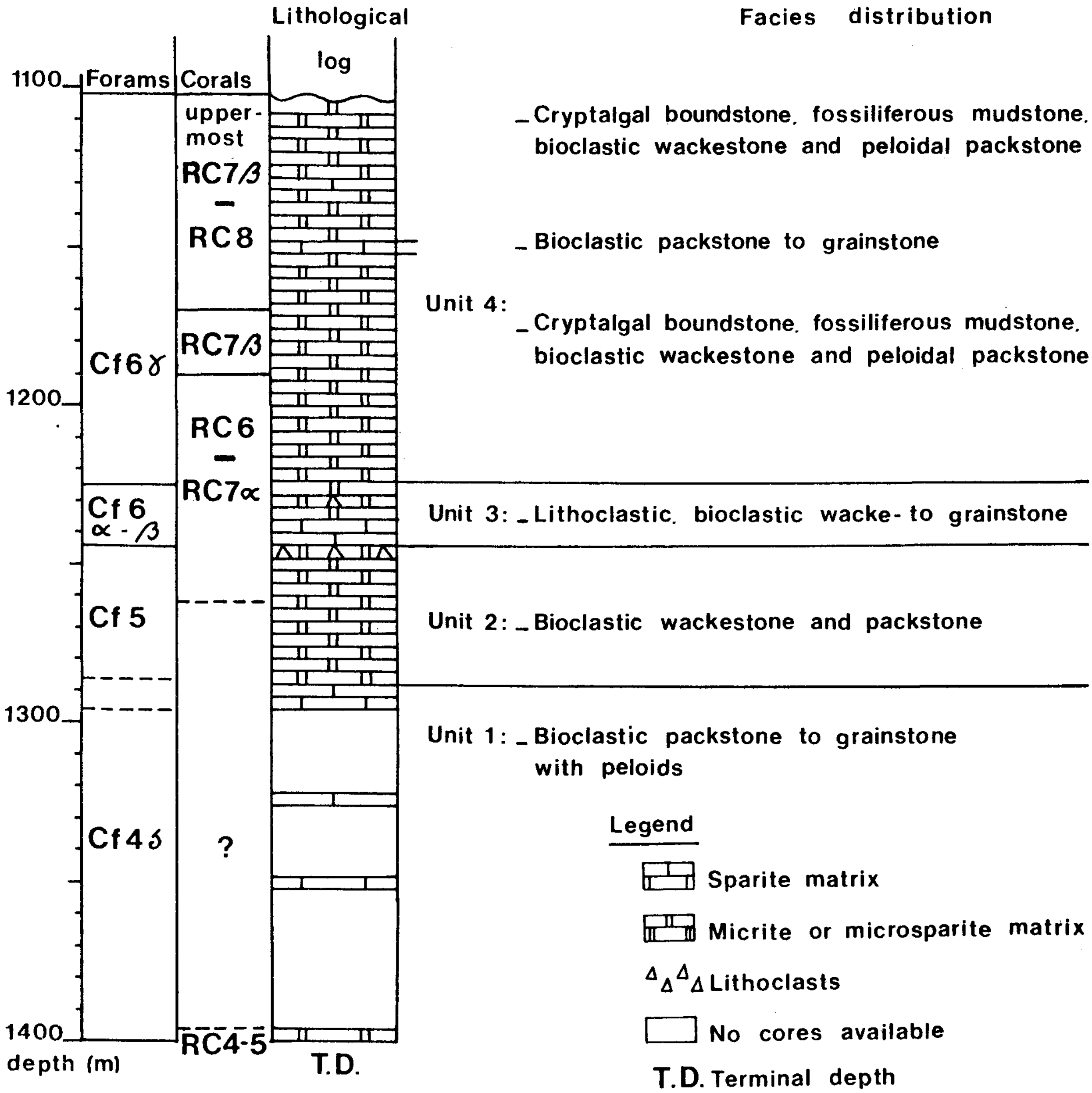

Figure 4.- Comparison between the biostratigraphy and the facies distribution.

paragraphs the top part of the Dinantian of the Heibaart borehole has been attributed to the upper part of the Lower Warnantian; however, a Late Warnantian age remains possible.

3.- FACIES DESCRIPTION

From a depth of 1352 m until 1102 m, four major lithological units occur in the DzH1 borehole (fig. 4). The upper unit can be subdivided into three minor lithological sequences. Biostratigraphical data indicate that the first unit was formed during the Late Moliniacian (Cf4δ), the second during the Livian (Cf5), the third during the lower part of the Early Warnantian (Cf6α-β) and the fourth during the upper part of the Early Warnantian (Cf6γ).

3.1.- UNIT 1 : UPPER MOLINIACIAN (Cf4δ)

The Upper Moliniacian strata from 1352 to 1288 m consist of bioclastic packstones and grainstones with large spherical and irregular peloids. The bioclasts are crinoids, brachiopods, algal tubes, echinoid spines, foraminifers, bryozoans, calcispheres, ostracods and a few gastropods and oncoids. Micritization of the bioclasts has produced micrite envelopes. It is possible that the large spherical and irregular peloids have an inorganic origin (Illing, 1954) or an organic, i.e. the result of a complete micritization of bioclasts and oolites (Purdy, 1963a; Bathurst, 1966, 1975). The occurrence of different stadia in the micritization of the bioclasts, however, points to an organic origin of the peloids. Several peloids are grouped into grapestones. Crinoids without micrite envelopes have syntaxial overgrowths. Authigenic quartz is preferentially formed in the micritic peloids or in the micrite of the packstones. Two cement generations can be observed in the grainstones : a first fibrous isopachous cement and a second blocky cement.

3.2.- UNIT 2 : LIVIAN (Cf5)

During Livian bioclastic wackestones and packstones were deposited in the Heibaart area. The bioclasts consist of foraminifers, crinoids, brachiopods, algal tubes and algal fragments, moravamminids, calcispheres, echinoid spines, corals, bryozoans and pelecypods. Crinoids and foraminifers can be micritized. Occasionally syntaxial overgrowths form the main component of the matrix. The micrite cement can be recrystallized into granular microsparite. At the top part of this sequence, 3 m of lithoclastic limestone is present. The lithoclasts have a Livian age (fig. 2). They are surrounded by radiaxial fibrous isopachous crystals (Pl. 1 : 1). Pelleted, dark lime mud filled up the remaining cavities.

3.3.- UNIT 3 : LOWER PART OF THE LOWER WARNANTIAN (Cf6α-β)

The lower part of the Lower Warnantian strata consists of lithoclastic, bioclastic wackestones, packstones and grainstones. The limestones contain crinoids, foraminifers, brachiopods, ostracods, bryozoans, algal tubes, algal fragments, pelecypods, corals, gastropods, trilobites, sponge spicules, calcispheres and brachiopod spines. The lithoclasts consist of fossiliferous mudstones. The bioclasts frequently possess a micrite envelope. The micritic matrix is recrystallized into granular microsparite crystals. Calcite veins are common at the base of this unit.

3.4.- UNIT 4 : UPPER PART OF THE LOWER WARNANTIAN (Cf6γ)

The upper part of the Lower Warnantian can be divided into three subunits. The first subunit (1222-1150 m) is characterized by cryptalgal boundstones, fossiliferous mudstones, bioclastic wackestones and peloidal packstones. Several structures are present : cryptalgal and algal structures are most common. A few meters thick limestone has been built up by a dark laminated globular framework (Pl. 1 : 2). Light-coloured lime mud filled up the remaining cavities between the globular framework. Parallel laminations in a mudstone with an irregular top (probably submarine erosion) also suggest an organic growth. The peloidal packstones (Pl. 1 : 3) consist of clotted peloidal masses and cryptalgal micrite . Two types of cavities filled by two major cement generations, i.e. fibrous to radiaxial fibrous cements and white mozaics (Pl. 1 : 4) have been distinguished. The first type occurs as irregular cavities between the algal and cryptalgal framework. The second type has a flat base and an irregular top and can be compared with stromatactis cavities (Pl. 1 : 5). They occur parallel to the bedding planes and also without a specific orientation in the limestones. Bioclasts consist of corals, crinoids, foraminifers, brachiopods, gastropods, ostracods, pelecypods, bryozoans, trilobites, moravamminids, goniatites and orthoceratids. Geopetal infillings in gastropods and brachiopods have an inclination of $\sim$ 6 degrees. However, the stratification and some stromatactoid cavities have an average dip of $\sim$ 34 degrees. This points to a depositional surface with a dip of $\sim$ 28 degrees. Many of the internal textures are obscured by an intensive recrystallization. Authigenic quartz is very abundant in the micrite. Subsurface karstification and stylolitisation occur in several horizons.

The second subunit (1150-1147 m) is characterized by an accumulation of crinoids and brachiopods.

The third subunit (1147-1102 m) is similar to the first and contains cryptalgal boundstones, fossiliferous mudstones, bioclastic wackestones and peloidal packstones. However, several cryptalgal textures at the top of this subunit are different from the first subunit. Cryptalgal laminites, spheroidal cryptalgal structures (oncolites) and hemispheroidal stromatolites are typical. The hemispheroidal stromatolites are formed by the doming up of cryptalgal laminites (Pl. 1 : 6). Lithoclasts occur very often in the cores from 1147 to 1144 m. The bioclasts consist of corals, crinoids, foraminifers, brachiopods, algal tubes, gastropods, ostracods, echinoid spines, bryozoa. Moravamminids, trilobites, goniatites and othoceratids are absent. The bedding planes have a dip of $\sim$ 10 degrees, corresponding with the geopetal infillings in fossils. This indicates that the slope recognized in the first subunit no longer existed during the third subunit. Small fenestrae and large irregular stromatactoid cavities are filled with fibrous and radiaxial fibrous cements and white mozaics. In some fenestrae the fibrous cements are absent.

4.- FACIES INTERPRETATION

The fauna of the Upper Moliniacian strata points to an open marine sedimentation environment. The peloids which are sometimes grouped into grapestones are characteristic for a shallow depositional environment, which is featured by a lack of appreciable current activity and by bottom stability (Purdy, 1963b; Winland & Matthews, 1974). The water turbulence and circulation rates however, were high enough to prevent a considerable accumulation of mud in this grapestone facies. The use of micritic envelopes in paleobathymetric studies have been questioned by Friedman *et al.* (1971). However, the bioclasts and the oolites of the Upper Moliniacian strata are so intensively micritized that a shallow water deposition environment is more probable than a deep water. A depth range between intertidal and 25 meter is considered as the presently active zone of micritization (Perkins & Halsey, 1971). The fauna, the grapestone and the intensively micritized bioclasts and oolites point to a shallow open marine sedimentation environment during Late Moliniacian times in the Heibaart area.

The Livian strata contain an open marine fauna. The muddy matrix of the wackestones suggests low energy conditions. The Livian sediments were deposited at depths below significant wave activity. The lithoclasts surrounded by a radiaxial fibrous cement at the top of this sequence are comparable with the Livian and Lower Warnantian breccias in the Visé area. The latter are interpreted as a sedimentary breccias formed in a high energy environment (Poty, 1982; Peeters, 1986).

The wackestones and packstones of the lower part of the Lower Warnantian with an open marine biota represent deposits at or just below normal wave base (Flügel, 1982). However, the reworked fragments (lithoclasts) probably point to an important current or wave activity.

Algal and cryptalgal structures, irregular and stromatactoid cavities filled with two major cement generations and important depositional dips are present in the upper part of the Lower Warnantian (subunit 1). Similar features have been recognized in a cryptalgal reef in the Warnantian of the Visé area (eastern extension of the Campine-Brabant Basin; Muchez & Peeters, 1986). Aitken (1967) and Tsien (1985) described similar clotted peloidal fabrics in the thrombolites of the southern Rocky Mountains and in the Belgian Devonian mud mounds respectively. An extensive development of «algal» buildups occurred in the Asbian and Brigantian (Warnantian) of Derbyshire and North Staffordshire, lateral extension of the Campine-Brabant Basin (Prentice, 1951; Ludford, 1951; Ramsbottom, 1969; Orme, 1970). On the basis of these comparisons we conclude that the subunit 1 represents a section through the core of an algal-cryptalgal buildup (sensu James & Macintyre, 1985). The absence of reworked fragments and of features related to wave activity points to sedimentation below wave base. This feature of the buildup at Heibaart excludes its classification as a reef sensu strictu (Braithwaite, 1973; Heckel, 1974; Tsien, 1984).

The large quantity of crinoids in subunit 2 points to an extensive development of this fauna in a calm water environment. However, the accumulation of crinoid fragments is the first indication of wave or current activity. The cryptalgal laminites and the hemispheroidal stromatolites at the top part of the Lower Warnantian are characteristic for an intertidal (Logan *et al.*, 1964, Pratt & James, 1982) or shallow subtidal environment (Monty, 1965). This interpretation is supported by the occurrence of fenestrae without marine fibrous cements. The fenestrae are formed in the intertidal zone (Shinn, 1968, 1983). The evolution of non-laminated cryptalgal boundstones to cryptalgal laminites at the top part of the Lower Warnantian can be explained by a drop of the sea-level at the end of this sub-stage (Paproth *et al.*, 1983) or/and by the growth of the buildup.

The transition from the Upper Moliniacian to the Livian is characterized by sediments indicating a transgressive trend. In the other boreholes of the Campine-Brabant Basin, the Livian strata are reduced. The general rise of the sea-level at the base of the upper part of the Early Warnantian (Muchez *et al.*, 1985) explains the evolution from a sedimentation environment at or just below wave action into a deeper setting. The reef growth and probably the regression at the end of the Early Warnantian caused the shallowing upward of the top part of the Lower Warnantian strata.

5.- CONCLUSION

The Visean strata of the DzH1 borehole can be divided into four lithological and biostratigraphical units. Sediment petrographical investigations indicate that:

- during the Late Moliniacian sedimentation took place in a shallow marine environment in which water turbulence and circulation rates were high enough to prevent a considerable mud accumulation;

- Livian carbonates were deposited at depths below significant wave activity;

- the lower part of the Lower Warnantian strata represents deposits at or just below normal wave base. Current or wave activity was responsible for the bioclastic accumulations and the reworked fragments;

- an algal-cryptalgal buildup developed during the upper part of the Early Warnantian.

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PLATE 1

1. DzH1 1247.5 m. Lithoclast (a) surrounded by radiaxial fibrous isopachous crystals (b). Pelleted, dark lime mud (c) filled up the remaining cavities. Scale bar is 360 μm.

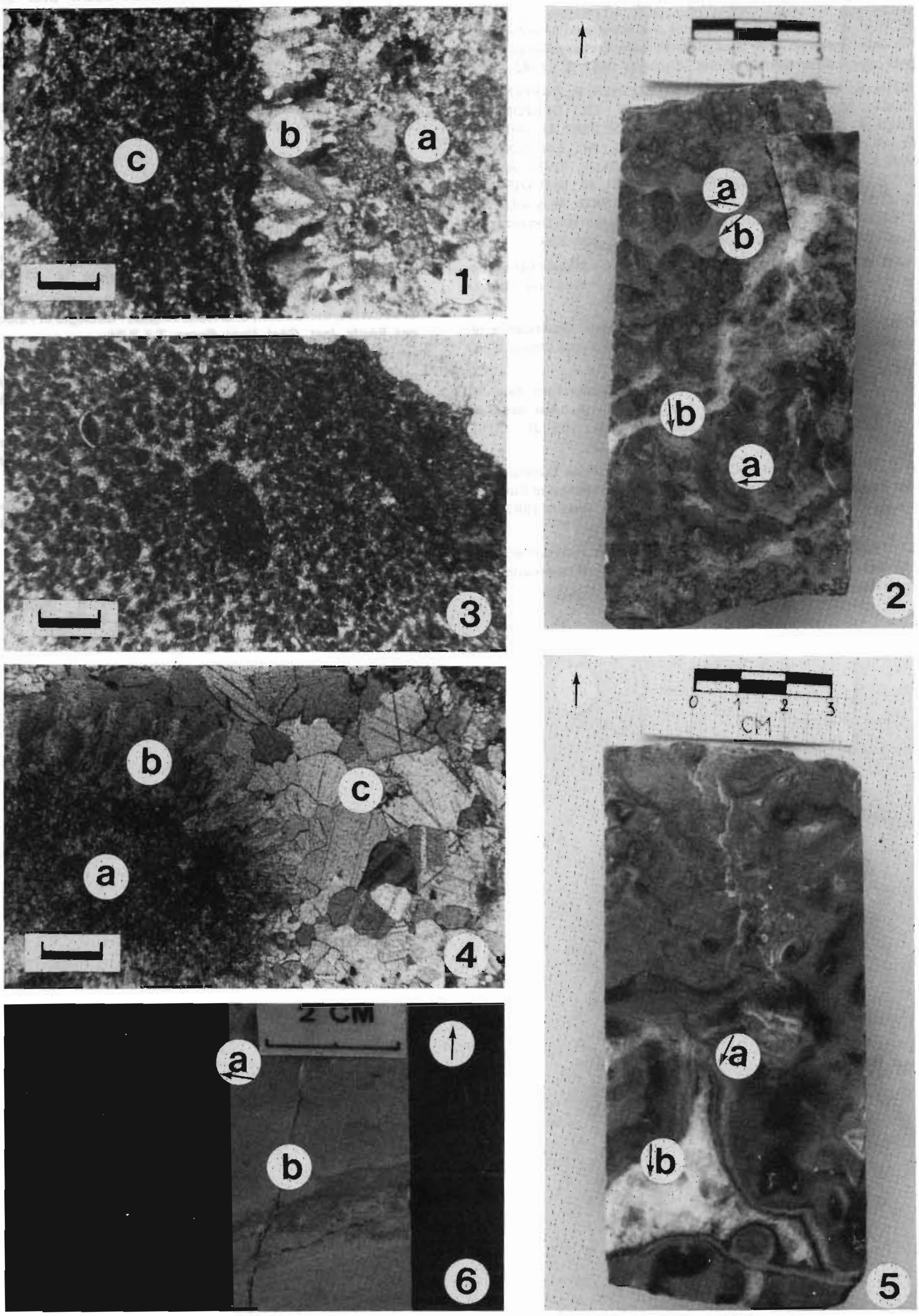
2. DzH1 1174.3 m. Light-coloured lime mud (a) between a darker laminated globular framework (b). The vertical arrow indicates the top of the sample.

3. DzH1 1221.4 m. Peloidal packstone. Scale bar is 360 μm.

4. DzH1 1177.4 m. Cryptalgal limestone (a) with cavities filled by two major cement generations, i.e. fibrous cements (b) and white mozaics (c). Scale bar is 360 μm.

5. DzH1 1164 m. Large stromatactoid cavity filled with fibrous cements (a) and white mozaic cement (b). The vertical arrow indicates the top of the sample.

6. DzH1 1127.7 m. Hemispheroidal stromatolites (a) formed by the doming up of cryptalgal laminites (b). The vertical arrow indicates the top of the sample.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