Annales de la Société Géologique de Belgique, T. 112 (fascicule 1) - 1989, pp. 47-56 Août 1989

NOTE ON THE LATE CRETACEOUS OF HOCKAI (HAUTES FAGNES, NE BELGIUM)[1]

by

Martin J.M. BLESS & P.J. (Sjeuf) FELDER[2]

(8 figures)

RESUME.- Les dépôts du Crétacé récent dans la tranchée du chemin de fer à Hockai (Hautes Fagnes, NE de la Belgique) consistent en un conglomérat basal d'âge Campanien ancien, surmonté par des sables glauconitiques et un limon résiduel avec du silex noir, caverneux d'âge Campanien récent, et ensuite un limon résiduel avec du silex gris d'âge Maastrichtien récent. Les dépôts du Maastrichtien ancien semblent absents. De plus, des études ultérieures devraient déterminer si, oui ou non, un équivalent lithostratigraphique de la Formation santonienne d'Aachen est présent dans cette section.

ABSTRACT.- The Late Cretaceous deposits in the railway cut at Hockai (Hautes Fagnes, NE Belgium) consist of an Early Campanian basal conglomerate, overlain by glauconitic sand and residual loam with black, cavernous flint of Late Campanian age, and a residual sandy loam with grey flint of Late Maastrichtian age. Early Maastrichtian deposits seem to be absent. Moreover, future study should determine whether of not a lithostratigraphic equivalent of the Santonian Aachen Formation occurs in this section.

1.- INTRODUCTION

The Late Cretaceous strata of the (now abandoned) railway cut at Hockai (Hautes Fagnes, NE Belgium) have been described already in the past century (e.g. Dewalque, 1886). The section is located some 6 km north of Malmedy and some 17km south of Eupen.

Dewalque (1886) recognized, in ascending order : Revinian phyllites with a cover of blackish clay; a 1 to 3 m thick conglomerate of poorly rounded quartzites upward passing into gravel mixed with coarse-grained clayey sand; and a silex or flint «conglomerate» (some flints with a black, translucent core possibly derived from the «craie blanche» or Senonian - our Upper Campanian Zeven Wegen Chalk of e.g. Halembaye -, but the bulk of the flints presumably derived from the «craie maastrichtienne» *fide* Dewalque, 1886, p. 35).
The distinction between «Senonian» and «Maastrichtian» flints was confirmed by the occurrence of echinoid, brachiopod and bivalve moulds in the flints (Dewalque, 1886, p. 36-37).

In recent years, W.M. Felder & H.J. Albers (1980) published a more detailed lithostratigraphic description of the same section. In contrast to Dewalque (1886), they attributed the whole interval of the quartzite conglomerate and the overlying flint «eluvium» to the Late Maastrichtian. According to them, the basal conglomerate should be correlated with the «Wahlwiller Horizon». The overlying flint eluvium was compared with the Lixhe («small flints») and Lanaye («large flints») members of the Gulpen Formation of South Limburg (SE Netherlands) and contiguous regions (e.g. Halembaye) of NE Belgium.

The remnants of the Late Cretaceous cover in the Hautes Fagnes area have been used as an argument for calculating the absolute rise of the Maastrichtian sea level by Hancock & Kauffman (1979). They suggested a sea level rise of 650 m

1. Manuscript received on the 1st April 1989.

2. Lab. Paléontologie, Université d'Etat à Liège, 7, place du Vingt-Août, B-4000 Liège, Belgium.

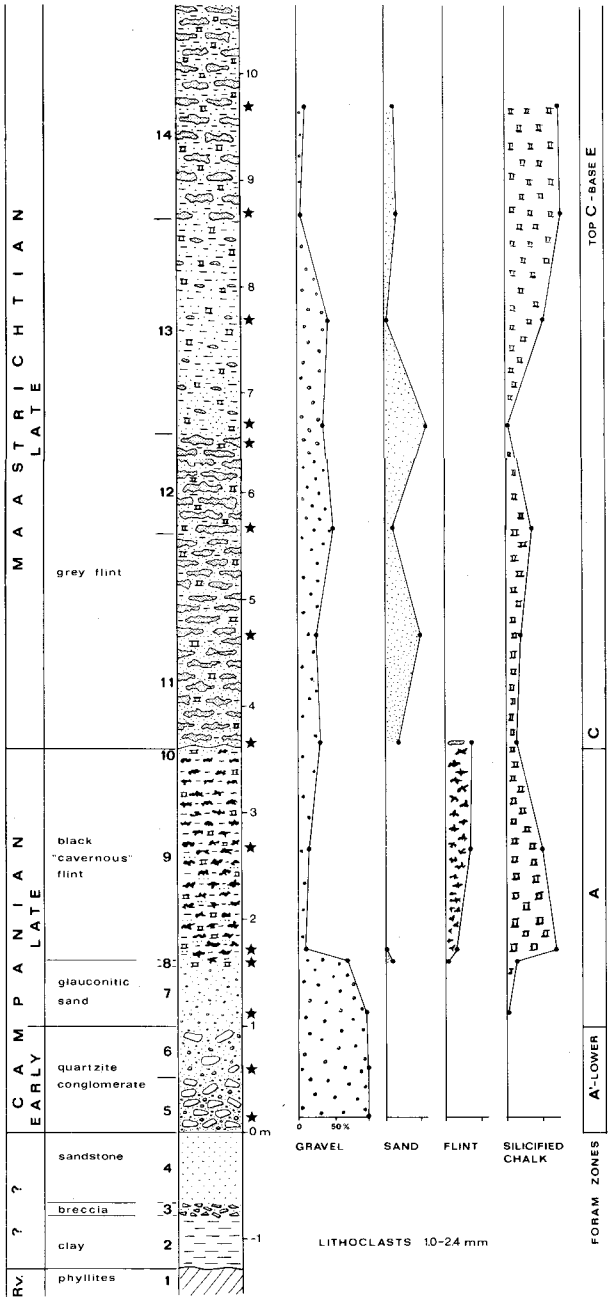


Figure 1.- Lithostratigraphy of Late Cretaceous strata in railway cut at Hockai (Hautes Fagnes, NE Belgium). Asterisks indicate position of samples. The composition of the lithoclast assemblage in the sieve fraction 1.0-2.4 mm roughly confirms the field observations, whereon the lithostratigraphic column is based. The fine-grained sand in this sieve fraction occurs in the form of small pellets with a clayey, siliceous or limonitic cement.

(compared to the actual one), presuming that this area has been a stable massif over a very long period. However, Robaszynski (1981) and Gullentops (1987) indicated that the Hautes Fagnes cannot be regarded as a stable massif. Therefore, they concluded that the Maastrichtian sea level had been much lower than advocated by Hancock & Kauffman (1979).

The present note is based on a re-examination of the section published y Felder & Albers (1980), who also presented a detailed location map.

2.- LITHOSTRATIGRAPHY

In ascending order, the following fourteen lithostratigraphic units have been distinguished (Figure 1; the base of the quartzite conglomerate is taken as a datum line : 0 m).

Unit 1.- Top of light bluish-grey Revinian phyllites.

Unit 2.- Dark-blue to black clay with some irregular sandy streaks, yielding abundant Revinian acritarchs (M. Vanguestaine, pers. comm.*); top white-coloured with reddish streaks; 50 cm.

Unit 3.- Red-stained breccia of quartz and phyllite fragments in clayey to sandy matrix; 10 cm.

Unit 4.- Yellowish-white to ochre fine- to medium-grained sand with silica cement, with reddish staining near the base; 60 cm.

Unit 5.- «Basal» conglomerate with up to 17 cm large, poorly rounded pebbles of quartzite and angular fragments of phyllite in limonitic, brown, silty sand; yielding abundant silicified bioclasts in 1.0-2.4 mm sieve fraction, as well as some arenaceous foraminifera; 50 cm.

Unit 6.- Poorly to fairly rounded pebbles of quartz and quartzite (up to 18 cm) in slightly limonitic, light-brown quartz sand of angular to poorly rounded quartz grains; 50 cm.

Unit 7.- Greenish-brown, glauconitic medium- to coarse-grained sand with abundant small quartz and quartzite pebbles, very rare flint fragments and residual pellets of silicified chalk; yielding abundant silicified microfossils; 50 cm.

Unit 8.- Dark-green, glauconitic sand with white streaks of residual silicified chalk, abundant small pebbles of quartz and quartzite, and some

* Note by M. Vanguestaine, Lab. Paléontologie, U.E.L.: According to previous experience in the Stavelot Massif, the Revinian acritarch species recognized in clay unit 2 may have been reworked from at least three different lithostratigraphic units (Rv3, Rv4 and Rv5; acritarch zones 4b, 5 and 6 of Vanguestaine 1974, 1978). However, this assemblage has been recognized *in situ* near the Rv4/Rv5 boundary in the Rocroi Massif (Meilliez & Vanguestaine, 1983; Vanguestaine, 1986). Thus, for the time being, the co-occurrence of *Timofeevia* aff. *lancarae, T. pentagonalis, Stelliferidium* spp., *Vulcanisphaera* cf. *turbata, Cristallinium randomense, Truncu-lumarium revinium, Polygonium* sp., *Stellechinatum* (?) sp. and *Acanthodiacrodium* cf. *ubui* cannot be used to distinguish between a clay reworked from different (local) sources and a residual soil on top of Rv4/Rv5 phyllites.

dark, «cavernous» flint (= «silex caverneuse» of Belgian authors; cf. Mourlon, 1879); yielding abundant silicified microfossils; 10 cm.

Unit 9.- «Cavernous» flints (up to 15 cm) with a black, translucent core and a white, silicified chalk cortex in matrix of sometimes slightly sandy loam with rare small pebbles of quartz and quartzite; yielding abundant silicified microfossils; 200 cm.

Unit 10.- Loamy sand with some flints and white, residual pellets of silicified chalk, presumably forming top of unit 9 (former hardground??).

Unit 11.- Light-grey flints (up to 25 cm) in loamy sand with silicified chalk pellets and small, well-rounded quartz pebbles; yielding abundant silicified microfossils near the base; 200 cm.

Unit 12.- Light-grey, sometimes very fossiliferous flints (up to 40 cm) in loamy sand with silicified chalk pellets and small, well-rounded quartz pebbles; about 100 cm.

Unit 13.- Few small flints (usually less than 10 cm) in brown, loamy sand with limonitic cement near the base, with upward increasing amount of silicified chalk fragments, and with well-rounded quartz pebbles; about 200 cm.

Unit 14.- Light-grey, frequently flat flints (up to 25 cm) with thick cortex of white, silicified chalk in brown, sandy loam with silicified chalk fragments and rare quartz pebbles; yielding abundant silicified microfossils near the base; about 200 cm.

Most likely, units 2 to 4 form the weathering product of the underlying Revinian rocks. But the presence of some smectite in the clay of unit 2 (J. Thorez, Lab. Géologie des Argiles, U.E.L., pers. comm.) suggests at least some local reworking during the Late Cretaceous. Future study should determine inhowfar units 2-4 might represent a lithostratigraphic equivalent of the Santonian Aachen Formation.

The sand and loam with flint and silicified chalk of units 9-14 form the residual deposit (flint eluvium) of the Late Cretaceous chalk. Note that flint constitutes only 10 % (in unit 13) to 50 % (in unit 9) of this eluvium. The remainder is fine gravel, sand, silt and clay as well as silicified chalk remnants. Although the silicified chalk remnants make up less than 5 % of the eluvium, they illustrate that the original deposit was a relatively pure chalk, and not e.g. a marl. This means that the sand, silt, clay percentage in the original sediment must have been low, and presumably comparable to that in other Late Cretaceous chalk deposits which occur to the north (e.g. Hombourg) or northwest (e.g. Halembaye) in NE Belgium.

3.- BIOSTRATIGRAPHY

Four different fossil groups have been observed: foraminifera, ostracodes, sponge spicules and bioclasts (1.0-2.4 mm sieve fraction). All the fossils have been silicified or were originally siliceous (sponge spicules).

3.1.- FORAMINIFERA

Six assemblages are distinguished (also compare figures 2, 3 and 5).

0.0 - 0.5 m.- Poor, monotonous fauna of agglutinated species, including *Trochammina* sp. and *Ataxophragmium crassum.* In the FRG, the latter rangers from the Late Santonian into the Early Campanian. In South Limburg and NE Belgium, this species is restricted to the Early Campanian (Hofker's 1957 foram zone A'-lower to A'-middle).

1.0 - 3.6 m.- Rich and diverse assemblage, including *Hedbergella* sp., *Bolivinoides decorata* (3-4 pustules on last chamber), *B. australis* (5 pustules on last chamber), *Neoflabellina leptodisca, Flabellina radiata, Globorotalites micheliniana, Lenticulina ordinaris, Saracenaria triangularis, Marssonella turris, Frondicularia* spp., *Marginulina* sp., *Dentalina* spp., *Nodosaria* spp., *Lagena aspera, Stensioina pommerana, Bolivina* sp., *Gyroidinoides nitida, Gavelinella clementiana, Cibicides* sp. This assemblage points to a Late Campanian age (Hofker's 1966 foram zone A; = Zeven Wegen Chalk or «craie blanche» of Halembaye).
Remarkable is the common presence of *Cymbalopora radiata* in the glauconitic sand (1.0-1.6 m). Schijfsma (1946) described this species from the «Upper Hervian» of South Limburg (now attributed to the Late Campanian; cf. Felder & Bless, 1989). However, Hofker (1957, 1966) considered this to be a Late Maastrichtian species, restricted to his foram zones J-K-L-M. Maybe, this is a useful facies fossil.

3.6 - 4.6 m.- Assemblage includes a.o. *Bolivinoides australis* (with 5-7 pustules on last chamber), *Gyroidinoides nitida, Flabellammina* sp., *Lenticulina* sp., *Lagena* sp., *Dentalina* spp., *Nodosaria* spp., *Cibicides* sp., *Praebulimina* sp. This association suggests a Late Maastrichtian age, presumably Hofker's (1966) foram zone C (= Vijlen Chalk or «craie grise» in Halembaye).

6.6 - 8.6 m. Small, non-distinctive assemblages with *Gyroidinoides* sp. and *Gavelinopsis* cf. *voltziana.*

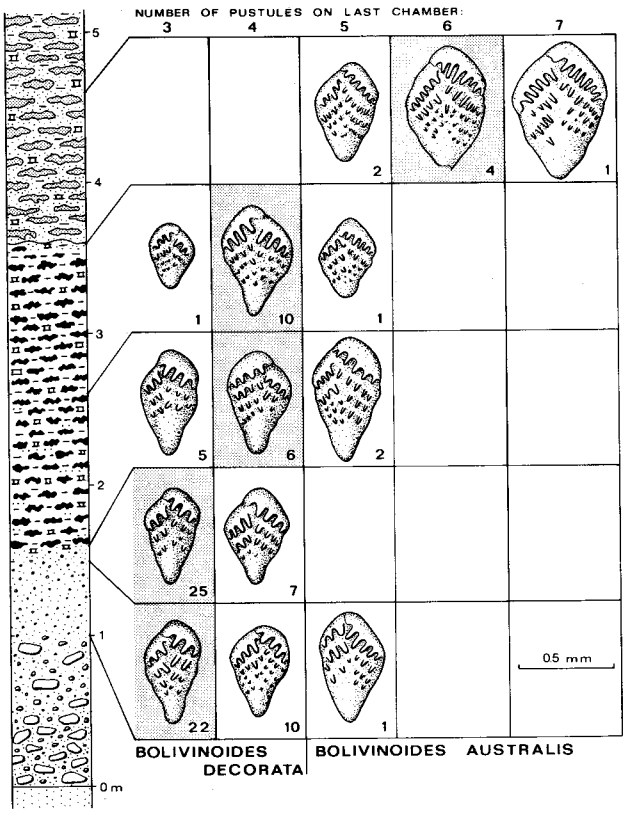


Figure 2.- Quantitative distribution of morphological variants of foraminifer species *Bolivinoides decorata* and *B. australis* in Late Cretaceous of Hockai (number of specimens indicated in lower right of each square). Specimens of *B. decorata* with three pustules on last chamber dominate in glauconitic sand with fine gravel between 1.0 and 1.6 m. Specimens of *B. decorata* with four pustules on last chamber dominate in interval with black «cavernous» flint between 1.6 and 3.6 m. Specimens of *B. australis* with six pustules on last chamber dominate in interval with grey flint between 3.6 and 4.6 m.

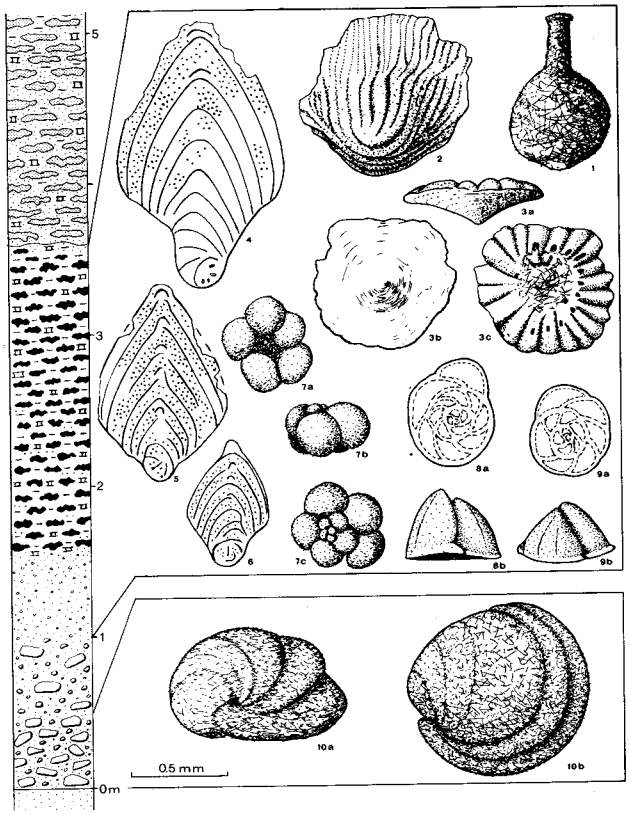


Figure 3.
Selected foraminifera from the Late Cretaceous of Hockai.
1-9: Late Campanian species from 1.0 to 3.6 m interval. 1. 1. *Lagena aspera,* 1.0-1.5 m. 2. *Flabellina radiata,* 2.6-3.6 m; 3. *Cymbalopora radiata,* 1.5-1.6 m; 4. *Neoflabellina leptodisca,* 1.6-2.6 m; 5. idem, 1.5-1.6 m; 6. idem, 1.0-1.5 m; 7. *Hedbergella* sp., 1.0-1.5 m; 8, 9. *Globorotalites micheliniana* (= *G. multisepta*), 1-0-1.5 m, respectively left- and right-coiled specimen. 10. Early Campanian species from 0.0 to 0.5 m interval, *Ataxophragmium crassum.*

8.6 - 9.6 m.- Diverse assemblage with a.o. *Bolivinoides australis, Eponides beisseli, Frondicularia ogivalis, Gyroidinoides* sp., *Gavelinopsis bembix, Lenticulina (Saracenaria) trilobata, Praebulimina* sp. *Lenticulina* sp., *Spiroplectammina* sp., *Nodosaria* sp., *Sigmomorphina* sp. (fig. 5). The mean number of pustules on last chamber of sixteen specimens of *B. australis* is 6.0. This suggests a Late Maastrichtian age, presumably the top of Hofker's (1966) foram zone C or the base of zone E (top «craie grise» or base of «craie tigrée» in Halembaye).

9.6 - 10.6 m.- Small, non-distinctive assemblage with *Gyroidinoides* sp.

3.2.- OSTRACODES

Five assemblages are distinguished (also compare figures 4 and 5).

1.0 - 3.6 m.- Rich and diverse assemblage with common to abundant occurrence of *Cytherella ovata* and *Bairdia* spp.; also including some twenty more species, most of these shown on figure 4 (4-5 to 4-22). The assemblage is characteristic of the Late Campanian chalk deposits in South Limburg and NE Belgium (cf. Deroo, 1966; Bless, 1988). Species characterizing the Late Campanian «Pre-Valkenburg» sandy marls or «Sandy Chalk of Benzenrade» (cf. Felder & Bless, 1989) in the area bordering the Rur Valley Block have not been observed. Therefore, this must be regarded as a typical «craie blanche»/ «craie glauconifère» assemblage as found in e.g. Halembaye.

3.6 - 4.6 m.- Poor, monotonous assemblage, dominated by *Cytherella ovata* and *Bairdia* sp. *Mosaeleberis* cf. *macrophthalma* and *Pterygocythereis serrulata* are restricted to the Late Maastrichtian in South Limburg and NE Belgium, where they become common in Hofker's foram zone F. This may be one of the earliest occurrences of these species (presumably in foram zone C; see above).

7.6 - 8.6 m.- Only *Cytherella ovata* was found.

8.6 - 9.6 m.- Monotonous assemblage dominated by *Cytherella ovata*. Rare specimens of *Bairdia* spp., *Cythereis zygopleura varia* and *Aversovalva v-scriptum* (fig. 5). Similar non-distinctive assemblage dominated by *Cytherella ovata* frequently occur in the Vijlen-Lixhe Chalk facies of e.g. Halembaye and Thermae.

9.6 - 10.6 m.- Only *Cytherella ovata* was found.

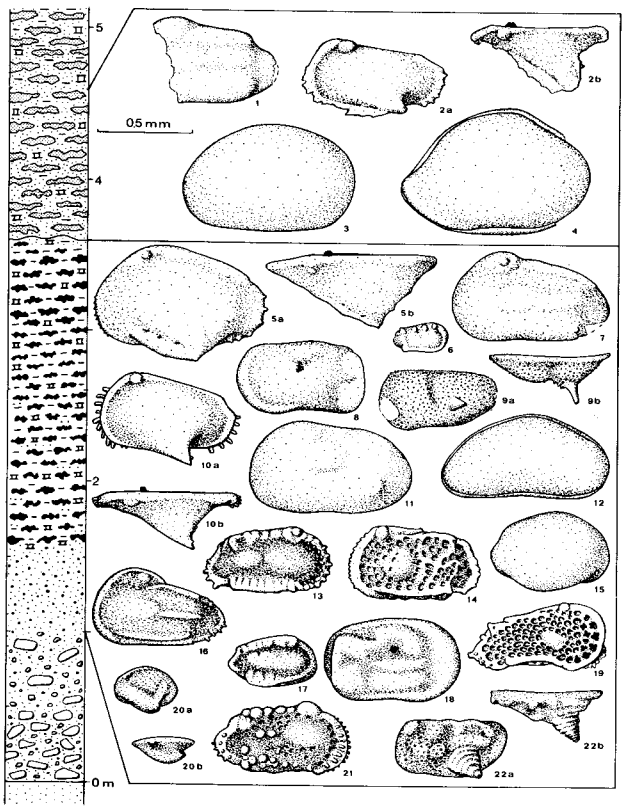


Figure 4.
Selected ostracodes from Late Cretaceous of Hockai.

1-4: Late Maastrichtian species from 3.6 to 4.6 m interval. 1. *Mosaeleberis* cf. *macrophthalma;* 2. *Pterygocythereis serrulata;* 3. *Cytherella ovata;* 4. *Bairdia* sp.

5-22: Late Campanian species from 1.0 to 3.6 m interval. 5. *Pterygocythre laticristata,* 2.6-3.6 m; 6. *Eucytherura dorsotuberculata,* 1.5-1.6 m; 7. *Mosaeleberis rutoti,* 2.6-3.6 m; 8. *Cytherelloidea levigata,* 2.6-3.6 m; 9. *Bythoceratina bonnemai,* 2.6-3.6 m; 10. *Pterygocythereis aserrulata,* 1.6-2.6 m; 11. *Mosaeleberis* sp., 1.6-2.6 m; 12. «*Bythocypris*» *limburgensis,* 1.6-2.6 m; 13. *Curfsina* cf. *alseni,* 1.5-1.6 m; 14. *Oertliella binkhorsti,* 1.5-1.6 m; 15. *Sphaeroleberis saccata* (= *Physocythere virginea*), 1.6-2.6 m; 16. *Phacorhabdotus semiplicatus,* 1.5-1.6 m; 17. *Schizocythere bonnemai,* 1.5-1.6 m; 18. *Cytherelloidea* cf. *obliquirugata,* 1.5-1.6 m; 19. *Trachyleberidea acutilobata,* 1.5-1.6 m; 20. *Aversovalva v-scriptum,* 1.0-1.5 m; 21. *Cythereis hallembayensis,* 1.5-1.6 m; 22. *Bythoceratina* sp., 1.0-1.5 m.

3.3.- SPONGES

Siliceous sponge spicules occur throughout the intervals 0.0 - 0.5 m and 1.0 - 4.6 m. But these abound particularly in the interval 1.0 - 2.6 m, where rich and diverse assemblages are found (cf. fig. 6). Between 1.0 and 1.6 m they make up about 25 % of the sieve fraction 0.25 - 1.0 mm! Some spicules show dissolution and/or secondary silicification features.

The most common spicule forms are large (up to 5 mm) oxeas and equally large, variably-shaped, long-shafted tetraxons (triaenes), as well as variably-shaped desmas (megaclones and rhizoclones), all presumably derived from lithistid sponges. Less common are isolated hexacts (triaxons) and calthrops (regular tetraxons), as well as up to 2 mm large fragments of rigid hexact skeletons, presumably derived from «hexactinellid» Hyalospongea (glass sponges).

Although sponge spicules have a limited stratigraphic value, their relative abundance and diversity may help to unravel the depositional environment. The relative abundance and diversity of lithistid sponge spicules in the 1.0 - 2.6 m interval at Hockai might point to a «littoral to upper neritic» environment (cf Lagneau-Herenger, 1959). Hyalosponges would prefer lower neritic to bathyal facies.

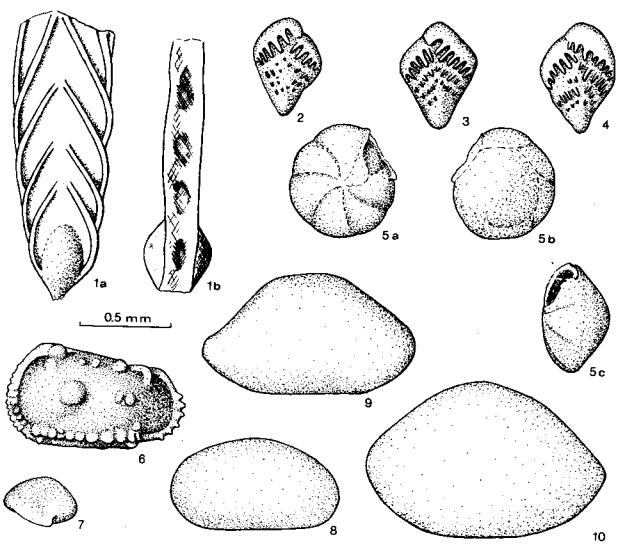
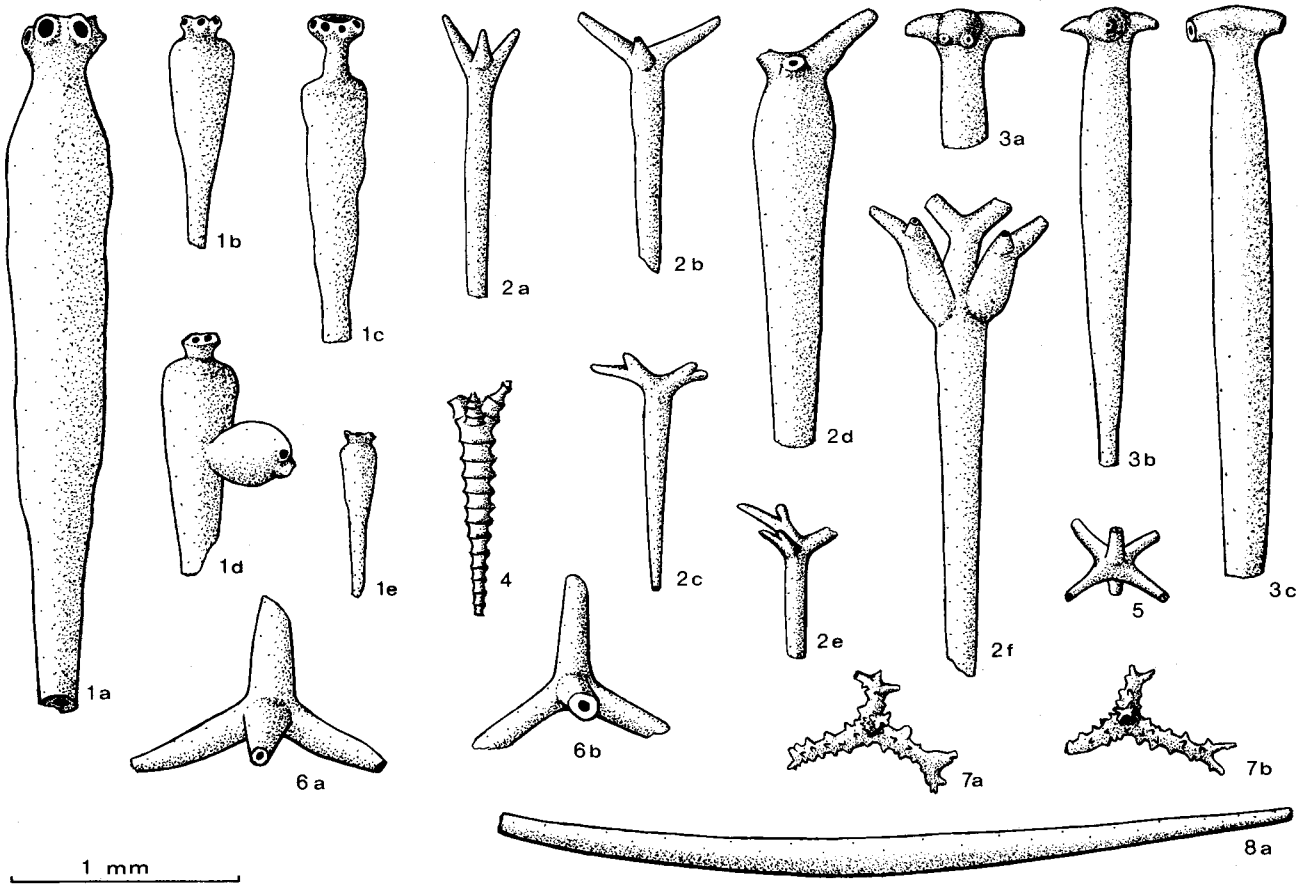
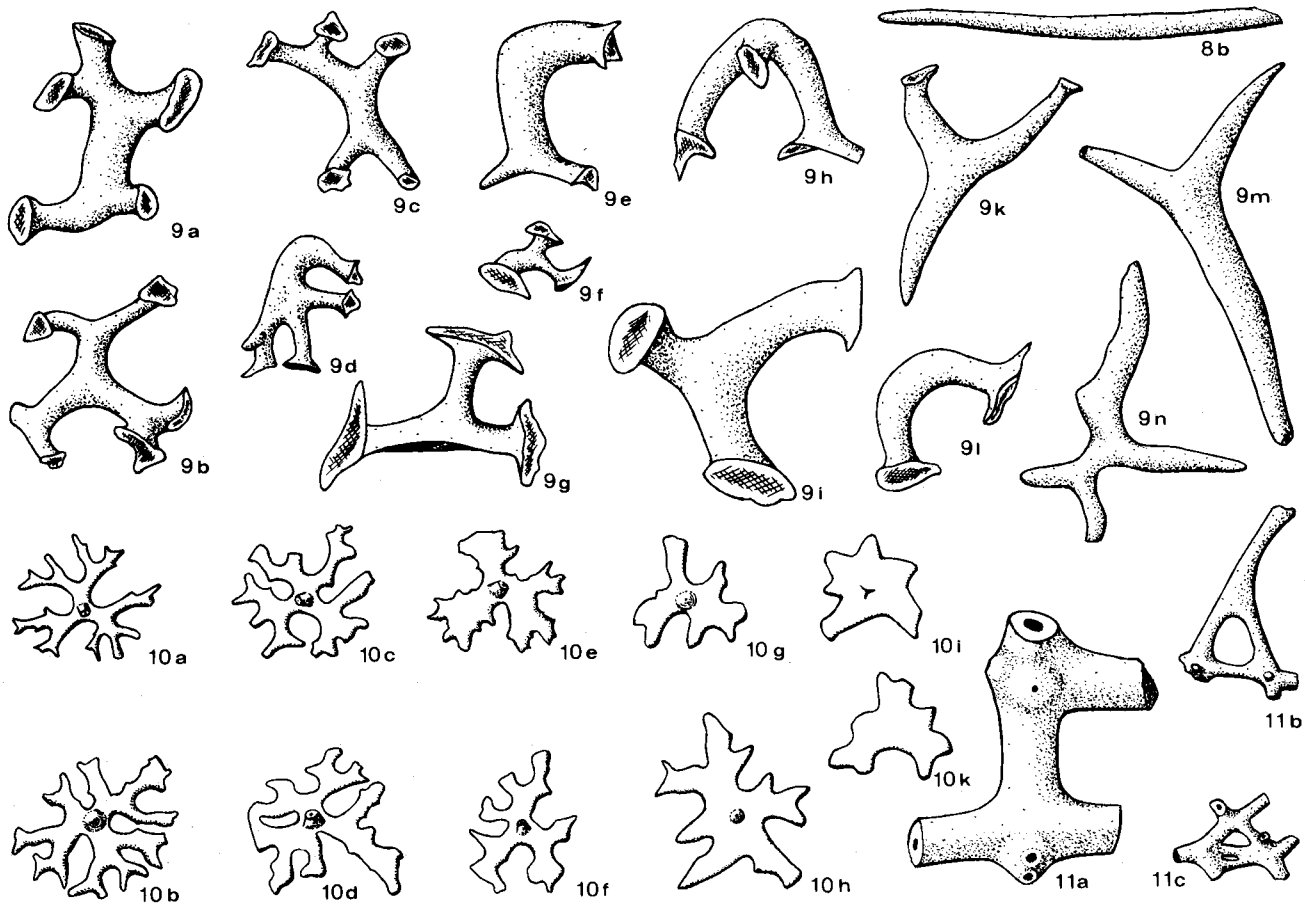


Figure 5.- Selected foraminifera (1-5) and ostracodes (6-10) from Late Maastrichtian (top foram zone C or base foram zone E) of Hockai, 8.6 to 9.6 m interval.

1: *Frondicularia ogivalis;* 2-4: *Bolivinoides australis* (in this sample, twelve specimens with 6 pustules on last chamber were found, two with 5 pustules, one with 7 and one with 8 pustules); 5: *Eponides beisseli;* 6: *Cythereis zygopleura varia;* 7: *Aversovalva v-scriptum;* 8: *Cytherella ovata;* 9-10: *Bairdia* spp.


1a
1b
1c
1d
1e
2a
2b
2c
2d
2e
2f
3a
3b
3c
4
5
6a
6b
7a
7b
8a
1 mm


8b
9a
9b
9c
9d
9e
9f
9g
9h
9i
9k
9l
9m
9n
10a
10b
10c
10d
10e
10f
10g
10h
10i
10k
11a
11b
11c

3.4.- BIOCLASTS

Only the bioclasts from the sieve fraction 1.0 - 2.4 mm are considered here, as well as the moulds in a flint from 6.6 m. All the bioclasts are silicified.

0.0 - 0.5 m.- A one kilogram sample has yielded about 800 bivalve fragments. This is a common feature for the Early Campanian (cf. Felder, 1988; Felder & Bless, 1989).

1.0 - 2.6 m.- Three samples have yielded assemblages with relatively abundant large agglutinated foraminifera (notably *Lituola nautiloidea*) and sponge fragments, along with some bivalve and echinoid clasts. Similar assemblages mark the lower portion of the Late Campanian deposits in NE Belgium (cf. Bless *et al.*, 1988).

2.6 - 3.6 m.- Small assemblage of bryozoans and bivalves (some of these with «Inoceramid-type» prismatic layer) characterizes upper portion of Late Campanian deposits, as well as Early Maastrichtian in NE Belgium and South Limburg (cf. Jagt *et al.*, 1987).

6.6 m.- Flint with 53 moulds (36 bivalves, 6 echinoderms, 9 bryozoans, 1 serpulid). Predominance of bivalves points to the interval of foram zones A-E.

7.6 - 9.6 m.- Small assemblages of predominantly bivalve clasts (and rare brachiopods, cirripeds and echinoid spines; the last two only in the 0.25 - 1.0mm sieve fraction) point to foram zones C-E (low number of bioclasts, dominance of bivalves; cf. Felder, 1988; Krings *et al.*, 1987).

4.- CONCLUSIONS

The Late Cretaceous succession at Hockai consists of :

- a maximum 1 m thick Early Campanian (foram zone A'-lower) conglomerate, upward passing into a coarse sand with coarse gravel (0.0 - 1.0 m).

- 2.6 m Late Campanian deposits (1.0 - 3.6 m; foram zone A), with at the base a 0.6 m thick glauconitic sand (equivalent of the «craie glauconifère» of Halembaye), overlain by a 2.0 m thick residual loam with black, cavernous flint (equivalent of the «craie blanche» in Halembaye). The thickness of the «craie blanche» is about 30 m in Halembaye, Hombourg or Diets-Heur (cf. fig. 7). Presuming a similar original thickness for the flint eluvium of unit 9 (1.6 - 3.6 m), and assuming that 50 % of this eluvium consists of flint, we may calculate the original flint content in the «craie blanche» at Hockai. This would have been in the order of about 3 %, whereas the sand, silt, clay content would have been also some 3 % (compare with the 2.5 % sand, silt and clay observed in samples from the «craie blanche» in Halembaye).

- 7 m Late Maastrichtian deposits (3.6 - 10.6 m), consisting of a residual sandy loam to loamy sand with varying amounts of grey flint (equivalent of the «craie grise» and perhaps base of «craie tigrée» in Halembaye; foram zones C to base of E). The thickness of foram zone C (= «craie grise» or Vijlen Chalk) varies from some 15 m in Halembaye to locally about 70 m in the SE of South-Limburg. Usually, the «craie grise» contains but a few, insignificant flint horizons. However, if we assume that e.g. units 11, 12 and 13 (total thickness 5 m) form the residual deposit of the «craie grise», and if we presume an original thickness of 40 m for the same (somewhere halfway between 15 m and 70 m), and if we furthermore accept that 25 % of the residual deposit consists of flint, then the original flint content in the «craie grise» would have been only 3 %, whereas the sand, silt, clay content would have been 9 % (compare with the 7 to 15 % sand, silt and clay observed in samples from the «craie grise» in Halembaye). This means that the relatively thich residual deposit representing foram zone C at Hockai may have been derived from a chalk similar to that of the «craie grise».

- Unit 14 is provisionally assigned to the base of foram zone E («craie tigrée» or Lixhe Chalk in Halembaye), although it might also represent the top of foram zone C. We have not detected (at least at this location) a residual deposit representing the younger foram zones F, J, K, L or M.

The succession of strata belonging to foram zones A', A, C and presumably E matches the succession observed in, e.g., Halembaye, Hom-

Figure 6.- Sponge spicules (megascleres) from Late Cretaceous of Hockai.
1-4: long-shafted tetraxons (triaenes). 1. carrot-shaped shaft (a, c: 1.0-1.5 m, b, d, e: 1.5-1.6 m). 2. protriaenes (a, b, d) and dichotriaenes (c, e, f) (b, c, e: 1.5-1.6 m, a, d, f: 1-6-2.6 m); 3. anchor-shaped anatriaenes (a, c: 1.5-1.6 m; b: 1.6-2.6 m); 4. protriaene with annular thickenings (1.6-2.6 m). 5: hexact (triaxon) (1.5-1.6 m). 6: smooth calthrops (tetraxons) (a: 1.0-1.5 m, b: 1.5-1.6 m). 7: lithistid verrucose calthrops (tetraclones) (1.5-1.6 m). 8: fusiform oxeas (b: 1.0-1.5 m, a: 1.5-1.6 m). 9: lithistid desmas (megaclones) (a, b: 1.0-1.5 m, c, d, e, g, i, k, l: 1.5-1.6 m; f, h, m, n: 1.6-2.6 m). 10: lithistid desmas (rhizoclones) (g: 1.0-1.5 m. a, c, d, f, i, k: 1.5-1.6 m; b, e, h: 1.6-2.6 m). 11: fused hexacts (triaxons) (b, c: 1.0-1.5 m; a: 1.6-2.6 m).

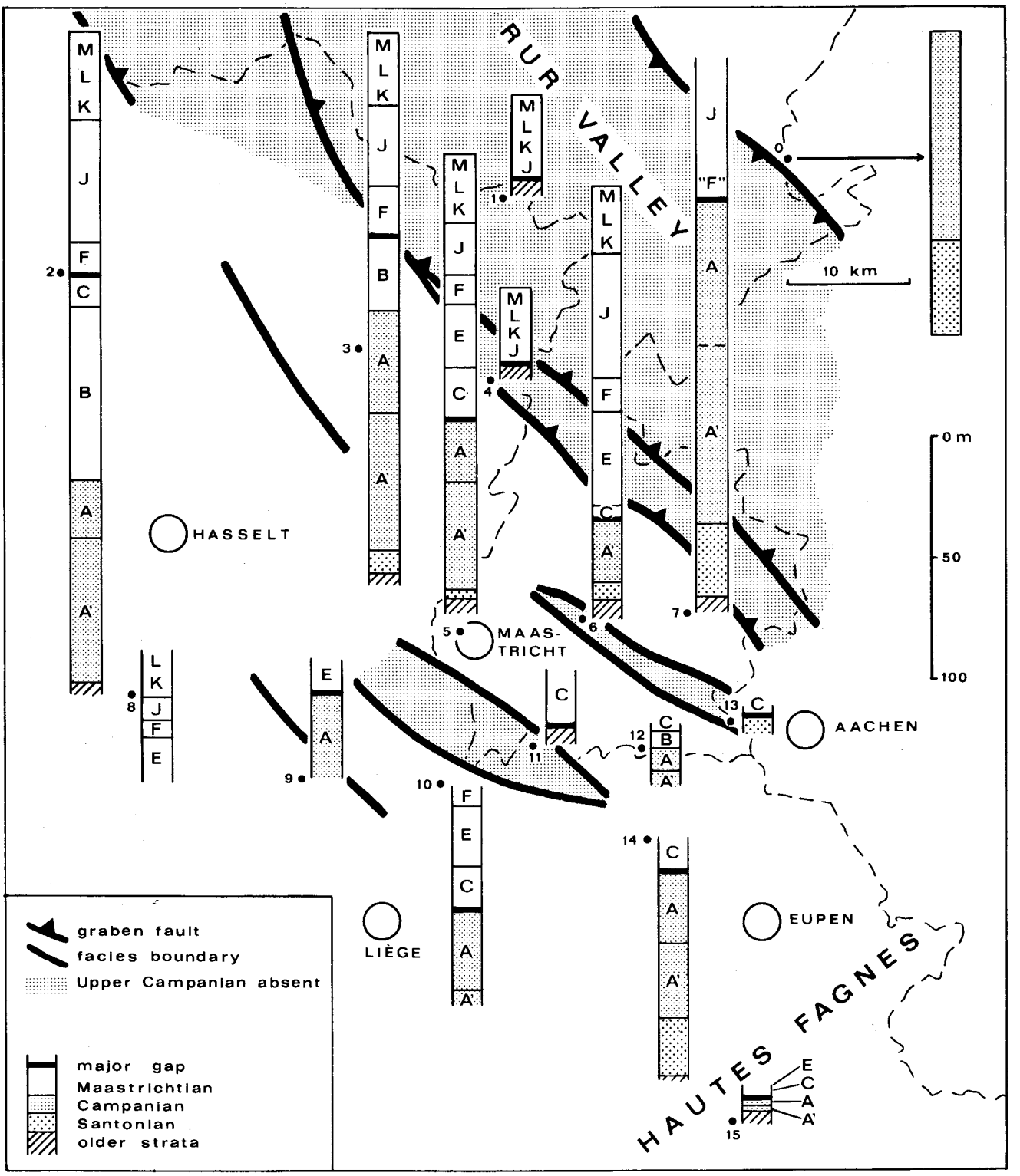


Figure 7.- Selected sections with Late Cretaceous strata in NE Belgium and SE Netherlands, showing variation in thickness and relative position of major sedimentary gap. Detailed age of Campanian and Maastrichtian strata is shown in terms of Hofker's (1957, 1966) foram zonation, also in those cases where (part of) section had been dated by other methods.

0. Maasniel (LXXIV); 1. Molenbeersel; 2. Oostham (KS 36); 3. Gruitrode (KS 172); 4. Dilsen (KS 2); 5. Kastanjelaan; 6. Thermae; 7. Kunrade area; 8. Hoepertingen; 9. Diets-Heur; 10. Halembaye; 11. Voeren-School; 12. Bovenste Bosch; 13. Lemiers; 14. Hombourg; 15. Hockai.

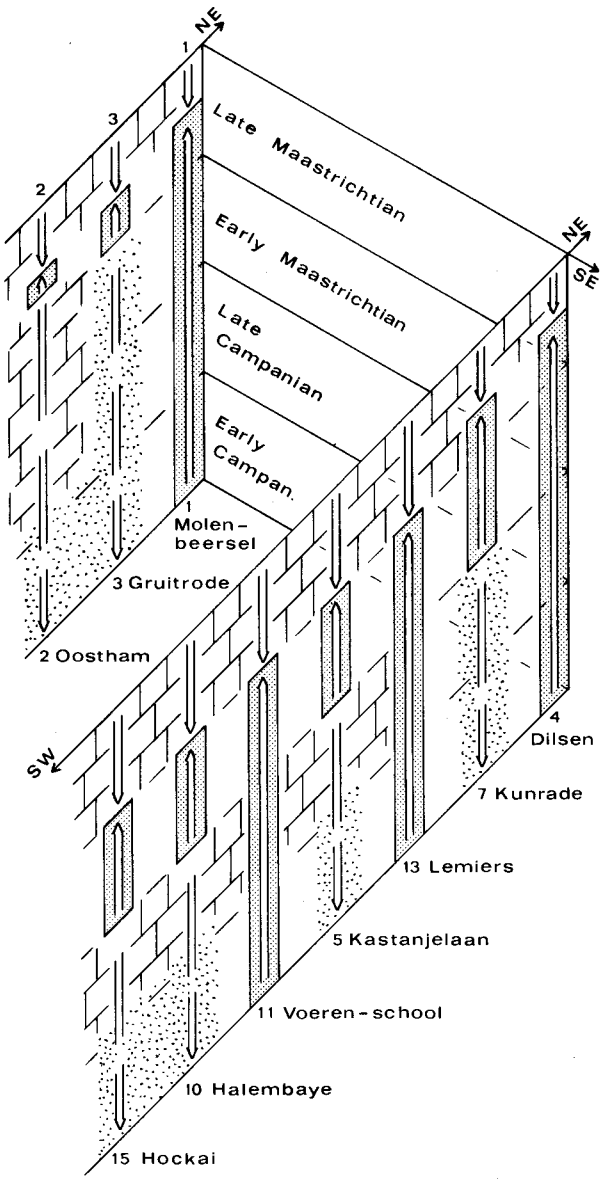


Figure 8.- Scheme showing relative tectonic movement of blocks in NE Belgium and South-Limburg during the Campanian and Maastrichtian. Relative upwarp (grey shading) is deduced from major sedimentary gaps (as compared with other sections). Sedimentary environment during downwarp is subdivided in dominantly chalk (brick symbol) and siliciclastic (sand, silt, clay or sandy marl; punctuated). Note similarity in relative movement and sedimentary facies between Hockai, Halembaye and Kastanjelaan on the one hand, and difference between these and sections to the NW (Campine area: Oostham and Gruitrode) on the other.

bourg or Kastanjelaan, wherein the Early Maastrichtian foram zone B is missing (cf. fig. 7). This suggests that the depositional history of the Hockai region during the Late Cretaceous is similar to that of Halembaye, Hombourg or Kastanjelaan. Therefore, the Hockai region must have been rather flat during that period, since it was drowned at about the same moment by the Early Campanian transgression as, for example, South-Limburg.

The Late Cretaceous foram assemblages (with frequent *Bolivinoides*) and ostracode faunas (with frequent *Cytherelloidea* and *Bythoceratina*) of Hockai closely resemble those of the «craie glauconifère/craie blanche» facies of Halembaye, Hombourg, Kastanjelaan and Diets-Heur, and differ from those of the sandy marls of the «Pre-Valkenburg» facies in Gruitrode or the Kunrade area. Thus, the Hockai region was at the same distance from the influx of siliciclastics as were Halembaye, Hombourg, Diets-Heur or Kastanjelaan. At the same time, abundance and diversity of lithistid sponge spicules in the Hockai section suggest that the depositional environment was relatively shallow. This is also indicated by the ostracode genus *Cytherelloidea* (cf. Bless, 1989).

The absence of Early Maastrichtian strata in the sections of Hockai, Halembaye, Diets-Heur, Hombourg and Kastanjelaan points to a short-lived phase of relative tectonic upwarp. This gap cannot be explained by an eustatic sea level fall (as for example the gap between Early and Late Campanian in this area), since the Early Maastrichtian is well-represented in the Campine (e.g. Gruitrode, Oostham; cf. fig. 7). This means, that the tectonic movements of the Hautes Fagnes were similar to those in South-Limburg and contiguous areas to the south in Belgium (e.g. Kastanjelaan and Halembaye; cf. fig. 8), and different from those in the Campine to the NW. This observation supports the hypothesis forwarded by Robaszynski (1981) and Gullentops (1987), and undermines the «stable massif» theory of Hancock & Kauffman (1979).

Finally, it is emphasized that the Late Cretaceous succession at Hockai is not necessarily representative of the whole Hautes Fagnes area. There are indications, that Campanian deposits are either missing or very condensed further to the east, e.g. at Beaulou (about 6 km to the ENE of Hockai).

BIBLIOGRAPHY

BLESS, M.J.M., 1988. Upper Campanian lithofacies and ostracode assemblages in South Limburg and NE Belgium. *In:* M. Streel & M.J.M. Bless (eds.), The Chalk district of the Euregio Meuse-Rhine: selected papers on Upper Cretaceous deposits, ISBN 90-70705-04-4: 57-67.

BLESS, M.J.M., 1989. Event-induced changes in Late Cretaceous to Early Paleocene ostracode assemblages of the SE Netherlands and NE Belgium. *Ann. Soc. géol. Belg.*, 112 (this volume).

BLESS, M.J.M., DJAIZ, R., FELDER, P.J., JAGT, J.W.M. & ROEBROEKS, W., 1988. «Session extraordinaire» of the two Belgian geological societies on the Late Cretaceous and Quaternary in the Liège-Maastricht-Heerlen area, 12-14 june 1987. *Bull. Soc. belge Géol.*, 96: 309-323.

DEROO, G., 1986. Cytheracea (Ostracodes) du Maastrichtien de Maastricht (Pays-Bas) et des régions voisines; résultats stratigraphiques et paléontologiques de leur étude. *Meded. Geol. Stichting*, Ser. C, V2-2: 197 p.

DEWALQUE, G., 1886. Session extraordinaire à Spa tenue les 30 et 31 août et 1er septembre 1885. *Ann. Soc. géol. Belg.*, 13 : 29-56.

FELDER, P.J., 1988. Lithologic and bioclastic aspects of the Maastrichtian type area between Maastricht (the Netherlands) and Halembaye (Belgum). *In:* M. Streel & M.J.M. Bless (eds.), The Chalk district of the Euregio Meuse-Rhine: selected papers on Upper Cretaceous deposits, ISBN 90-70705-04-4 : 41-55.

FELDER, P.J. & BLESS, M.J.M., 1989. Biostratigraphy and ecostratigraphy of Late Cretaceous deposits in the Kunrade area (South-Limburg, the Netherlands). *Ann. Soc. géol. Belg.*, 112 (this volume).

FELDER, W.M. & ALBERS, H.J., 1980. De lithostratigrafische plaats van het vuursteeneluvium in de spoorweginsnijding bij Hockai. *Grondboor en Hamer,* 1980 (6) : 201-206.

GULLENTOPS, F., 1987. The Maastrichtian sea level rise. *Ann. Soc. géol. Belg.*, 109 : 363-365.

HANCOCK, J.M. & KAUFFMAN, E.G., 1979. The great transgressions of the Late Cretaceous. *Jour. Geol. Soc. London,* 136 : 175-186.

HOFKER, J., 1957. Foraminifera of the Dutch Hervian. *Meded. Geol. Stichting,* NS 10 : 19-33.

HOFKER, J., 1966. Maastrichtian, Danian and Paleocene foraminifera. *Palaeontographica,* A 10 : 376 p.

JAGT, J.W.M., FELDER, P.J. & MEESSEN, J.P.M.Th., 1987. Het Boven-Campanien in Zuid-Limburg (Nederland) en Noord-Oost Belgie. *Natuurhist. Maandbl.*, 1987 (4) : 94-110.

KRINGS, S., BLESS, M.J.M., CONIL, R., FELDER, P.J. & MEESSEN, J.P.M.Th., 1987. Stratigraphic interpretation of the Thermae boreholes (Valkenburg a/d Geul, The Netherlands). *Ann. Soc. géol. Belg.*, 110 (1) : 9-38.

LAGNEAU-HERENGER, L., 1959. Les spongiaires siliceux du Crétacé supérieur français. *C.R. Congr. Soc. savantes Paris Départements, Dijon 1959; colloque sur le Crétacé supérieur français* : 399-413.

ROBASZYNSKI, F., 1981. Moderation of Cretaceous transgressions by block tectonics. An example from the north and north-west of the Paris Basin. *Cretaceous Research,* 1981 (2) : 197-213.

SCHIJFSMA, E., 1946. The foraminifera from the Hervian (Campanian) of southern Limburg. *Meded. Geol. Stichting,* Ser. C-V-7 : 174 p.