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Cretaceous lithostratigraphic units (Belgium)

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(1 figure)

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ABSTRACT. The Cretaceous formations of the Mons Basin, of the Méhaigne-Petite Gette Basin area and of the Liège-Limburg Basin area are described and discussed following recent literature.

Of the 22 Cretaceous formations of the Mons Basin 8 are of Early Cretaceous age and 14 of Late Cretaceous age. In the Méhaigne-Petit Gette Basin area no formations have been named, but the different levels found have been considered as members; their age varies from? Coniacian to Late Maastrichtian. In the Liège-Limburg Basin area four Cretaceous formations have been recognised, divided in very detailed members based on lithostratigraphical characteristics (flints) by Felder; these formations vary in age from? Coniacian to uppermost Maastrichtian.

KEY-WORDS: Cretaceous, lithostratigraphy, Belgium and Zuid- Limburg (The Netherlands).

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1. Introduction

As industrial raw material, as hydrogeologic reservoir or as barren measures to be pierced when drilling mine-shafts, the Cretaceous has frequently been studied since the mid 19th century. Descriptions of exposures or sections of wells and boreholes were compiled by J. Cornet (1923), enlarged by Leriche (1929), synthesised by Marlière (1954, 1957), formalised by Marlière and Robaszynski (1975), by W.M. Felder (1975) and by H.J. Albers *et al.* (1978).

The main subdivisions for the Cretaceous which have been in use in Belgium for a very long time, were transcribed into the legend of the Geological map at 1/40,000 by the Belgian Geological Council (1929). The cartography at 1/25,000 of the new geological map has made the need for an actualisation of this legend obvious. It is with that purpose that the names of the lithological units – formations, members, and beds – have been revised at the request of the National Belgian Geological Committee. The result of this revision is presented in the following texts and figure 1.

The texts indicate the major data on the units including a short description, their stratotype and age.

Figure 1 indicates the position of the lithological units in relation to the chronostratigraphic divisions in stages. The different columns are:

System, stages and substages: the chronostratigraphic units used follow the proposals or recommendations of the IUGS (Remane ed., 2000) or were discussed during the Second Symposium on Cretaceous Stage Boundaries in Brussels, September 1995 (Rawson *et al.*, 1996). Between the Jurassic and Cretaceous systems the sedimentary "enregistrement" is very slight or even absent or irregular. In continental facies the Jurassic-Cretaceous boundary cannot be placed accurately.

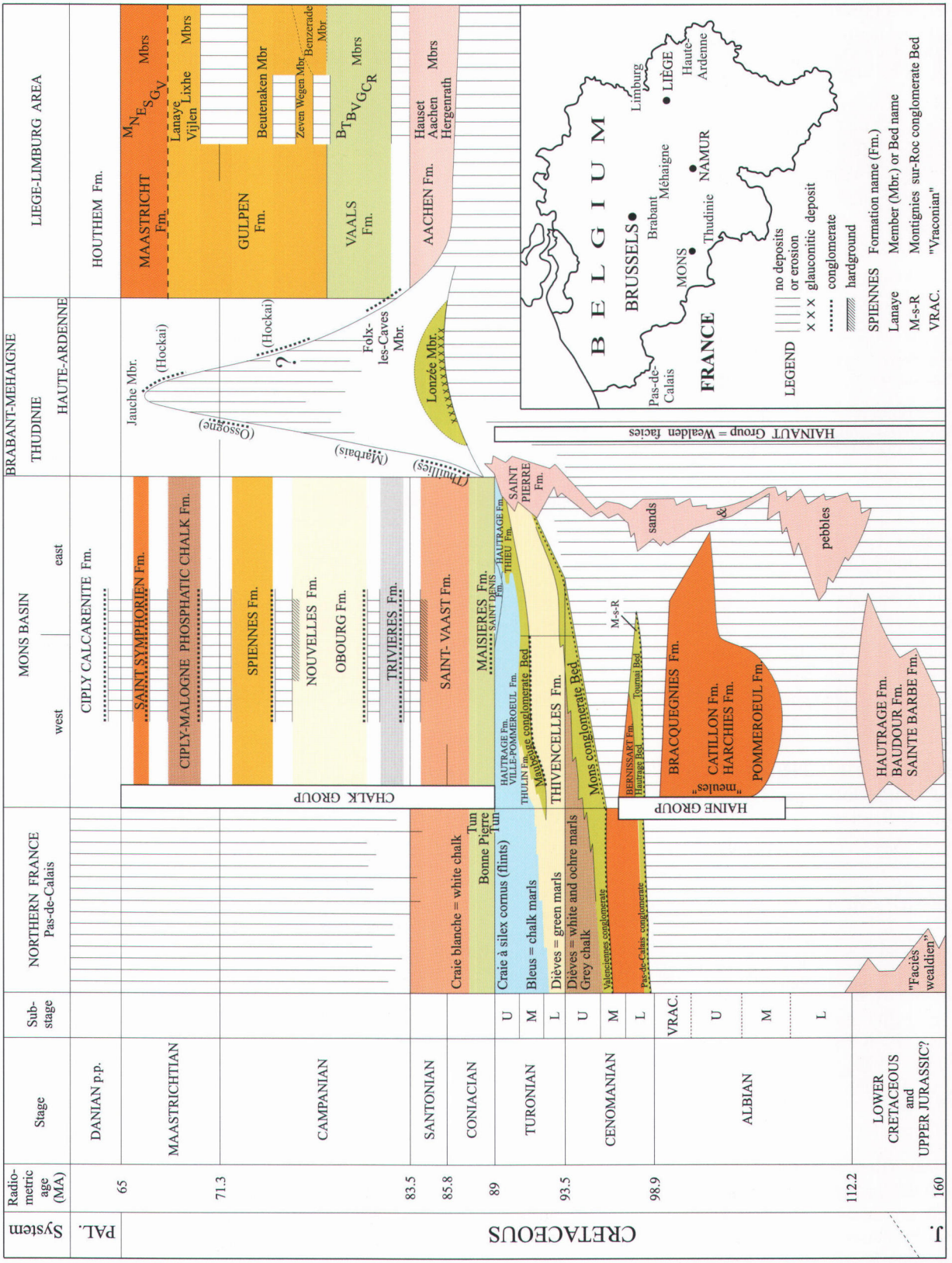

Figure 1. Stratigraphic distribution and age of the Cretaceous formations of Belgium

Radiometric age: the numbers corresponding to the column "Ages s/c" marked herein come from Hardenbol *et al.* (1998) and from Remane ed. (2000).

Regional columns: the Cretaceous facies differ substantially from region to region. Four columns indicate the succession of the lithological units specific for each region. From West to East the following regions have been taken into account:
– the Pas-de-Calais (France);
– the Mons Basin.
The Cretaceous of these two regions is very similar in the Cenomanian- Turonian interval.
– the high zones of eastern Brabant and northern Namur and the Haute-Ardenne;
– the Liège-Limburg Basin area.

Northern France: the terminology used in geological literature for the eastern part of the Pas-de-Calais has not been formalised and the lithological units correspond to the terms which are used since Gosselet and have been defined in the "Lexique Stratigraphique International" (Sornay coord., 1957) and in the "Synthèse géologique du Bassin de Paris" (Mégnien coord., 1980).

Mons Basin: many of the now formalised names were originally used by F.L. Cornet and Briart, by Rutot and Van den Broeck in the 19th century, or by Marlière (1936), or by Robaszynski (1975a-c). These papers contain the original descriptions of the lithological units, redefined and formalised herein.

Note: in some of the early map sheets of the "Carte géologique de la Wallonie" at 1/25,000 new formation and member names have been presented (e.g. Doremus, 1997, for map sheet Hertain-Tournai) when formalised names already existed for the same formations and members (Robaszynski, 1975a-c). These new names are considered herein as junior synonyms.

Brabant-Namur (Méhaigne – Petite Gette area), Thudinie, Haute-Ardenne: between Mons and Liège Cretaceous strata are rarely exposed. They have often only been visible by ground works, or temporary trenches or boreholes. They were generally deposited in shallow environments in arenaceous, coarse grained, often glauconitic, facies, sometimes decalcified by the proximity of the topographic surface (this does not apply to Upper Maastrichtian white chalks in Orp-Jauche deposited when the sea levels were very high). The "glauconie de Lonzée" near Gembloux (northern part of Namur) is present as a thin, arenaceous – glauconitic facies.
Similarly in Thudinie, between the Sambre and Meuse rivers, above a glauconitic facies occur partially decalcified coarse-grained chalks.
In the Haute-Ardenne from marly facies and residual flints macro- and microfaunas have been collected. For the Hockai outcrop, Bless & P.J. Felder (1989) studied the benthic Foraminifera *(Bolivinoides)* which suggest a Campanian-Maastrichtian age; based on macrofauna (bivalves, brachiopods, and echinoids) from several outcrops in the Hautes-Fagnes, Dhondt & Jagt (1997) suggested an early Late Maastrichtian age – thus showing that the maximum transgression took place at the same time on the Hautes-Fagnes and in the Orp-Jauche region.

Liège-Limburg area: The lithological units and their interpretation into formations and members were mainly formalised by W.H. Felder (1975), Albers *et al.* (1978) and Albers & W.H. Felder (1979).

2. Areas and formations

2.1. Hainaut basin

2.1.1. Hainaut Group - HAI

Authors: Robaszynski (1975) and herein.

Description: Clays, sands and conglomerates deposited irregularly, in lenticular "heaps" along and above each other, forming successions, which are complex and variable from one site to the next. They correspond to continental deposits in which neither carbonate rocks nor glauconite have ever been found.
The white, grey, black and occasionally red clays were used formerly to produce refractory tiles. For their kaolinite content they are still used today in the cement industry. They always contain high quantities of quartzose silt and, locally, lignified wood, often pyritized.
The sands and conglomerates are well represented at the top of the clay levels at Hautrage. They form an extensive torrential delta at Thieu (former St-Pierre quarry).
Several formations may be recognised, ignoring the order of deposition:

– Sainte-Barbe Clays Formation (SBA): grey, sandy, lignitic and highly fossiliferous clays, filling a sinkhole.
– Hautrage Clays Formation (HAU): silto-quartzose, grey, white, reddish, black clays with intercalations of sandy, silty and lignito-pyritic beds.
– Baudour Clays Formation (BAD): grey silty and variegated clays.
– Saint-Pierre Gravel Formation (SPR): coarse- and fine-grained white sands, gravel, eroded pebbles, conglomerates, silty beds, torrential and deltaic deposits with cross-bedded stratification.

Locally, only continental faunas and floras have been collected from fossiliferous deposits.

Stratotype: In the Haine River basin, and for each of the formations:
– Sainte-Barbe Fm.: in the former Ste-Barbe pit of Bernissart where the iguanodontid dinosaurs were discovered;
– Hautrage Fm.: in the Hautrage clay pits;
– Baudour Fm.: in the Baudour clay pits;
– St.-Pierre Fm.: in the former Château St.-Pierre quarry at Thieu and in the foundation pits of the sluices at the Strépy-Bracquegnies ships-lift.

Area: Three types of deposits:

– a circa 40 km long "band" on the northern slope of the Mons Basin, from Hautrage to Thieu: clays, sand and gravel;

– the sinkholes (on top of the Palaeozoic limestones, filled in by the Wealden facies), e.g. at Bernissart;

– dissolution pockets in the Palaeozoic limestone bedrock (in the Tournaisis, in Entre Sambre-et-Meuse, ...).

Thickness: Several tens of m; a 150 m deep borehole at Hautrage did not reach the base of the continental clays.

Age: Late Jurassic ("Purbeckian") to Early Cretaceous (Aptian) and possibly even extending into Early Cenomanian (white sands in the lift foundation pit at Strépy?) as based on floral and faunal content: flora: *Cycadites*, *Cedrus*, *Pinus*, ferns, conifers (*Elatides*, *Pityostrobus*), gymnosperm pollen grains (no angiosperms), pteridophyte spores;

fauna: especially at the famous Bernissart site where several hundreds of specimens were collected, among which: dinosaurs: *Iguanodon bernissartensis*, *I. mantelli*; crocodiles: *Bernissartia fagesi*, *Goniopholis simus*; turtles: *Chitracephalus dumoni*; numerous fishes: *Oligopleurus*, *Lepidotes*, *Amiopsis*, *Pholidophorus*...; also bivalve molluscs: *Unio*, *Cyrena* etc.

Remarks: – The "Groupe (continental) du Hainaut" was proposed by Robaszynski *in* Marlière & Robaszynski (1975, p. 4) to replace the "Groupe continental infra-crétacé" as suggested by the Mesozoic Commission who adapted the names to international standards. It equates with "Wealdien" or "faciès wealdiens" of authors.

– The name has been used with the rank of Formation by Doremus (1997).

– References: J. Cornet (1923); Conseil Géologique de Belgique (1929); Marlière (1946, 1954); Robaszynski (*in* Marlière & Robaszynski, 1975).

2.1.2. Haine Green Sandstone Group - HNE

Authors: Robaszynski, herein.

Description: Detritic facies, more or less conglomeratic and glauconitic, with a siliceous opaline cement or with a carbonate cement, occasionally sandy, or highly glauconitic, sometimes marly, with many sponges (body fossils, spicules, cement with chalcedony, "spongolites"...). In this group all the lithological units formerly described as "meules" are assembled, from bottom to top:

– Pommeroeul Fm.: conglomerates and sands;

– Harchies Fm.: mainly conglomerates;

– Catillon Fm.: marls and sands;

– Bracquegnies Fm.: glauconitic conglomerates;

– Bernissart Fm.: granular limestones

(details below).

Stratotype: The Harchies pit exposes most of the Group (Marlière, 1939).

Area: The western part of the Mons Basin. In the eastern part the Group is represented by facies with sands and glauconitic gravel with a chalcedony cement ("gaizes"). This Group is mainly known in abandoned mine shafts and boreholes.

Thickness: May reach 150 m in subsiding zones of the western Mons Basin (Harchies).

Age: The fossil assemblages indicate a Middle Albian to Early Cenomanian age.

Remarks: – the Bracquegnies, Catillon and Harchies fms were united in a "Groupe du Hainaut" by Marlière & Robaszynski (1975). This name was pre-occupied by a "Groupe du Hainaut" proposed by the same authors to denote Wealden facies. Here, the new term "Haine Group" has a wider meaning and includes the similar facies of the Pommeroeul Greensand Fm. and the Bernissart Calcirudites Fm. Thus the "Haine Group" is closer to the "meules" concept as previously used.

– References: Marlière (1936a, b, 1939, 1954); Marlière & Robaszynski (1975).

2.1.3. Pommeroeul Greensand Formation - POM

Authors: Marlière (1936b); Robaszynski (1975).

Description: Conglomerates of Palaeozoic rocks, coarse sands, fine sands and sandstones coloured by grass green ferruginous clays (a very characteristic shade of green). A few levels contain lignites, which are probably reworked from continental deposits (Wealden facies). The marine fauna is very poor.

Stratotype: Disused pits at Harchies (Marlière, 1939).

Area: This formation is found only in the deepest parts of the Mons Basin, in the subsiding zones of Harchies and Pommeroeul. It represents the oldest portion of the Cretaceous transgression in the Basin.

Thickness: 23 m in the Harchies pit.

Age: Middle Albian on the basis of *Actinoceramus concentricus*, *Hoplites* sp. near the top of the formation.

Remarks: This is the equivalent of the "Assise de Pommeroeul" of Marlière (1936a, b, 1939, 1957), raised to the rank of a Formation by Robaszynski (1975).

2.1.4. Harchies Formation - HAR

Authors: Marlière (1936b).

Description: Alternation of "spongolites", phosphatic conglomerates and glauconitic sands. Marine fauna is very poorly preserved.

Stratotype: Harchies pit (see Marlière, 1936b, 1939).

Area: Western part of the Mons Basin.

Thickness: 52 m in the Harchies pit.

Age: In the basal part of the Formation, *Actinoceramus concentricus* and *A. sulcatus* co-occur, which are characteristic of the base of the Late Albian.

2.1.5. Catillon Formation - CAT

Authors: Marlière (1936b).

Description: Glauconitic sands, more or less siliceous glauconites, marls with siliceous and phosphatic nodules, with numerous sponges. This formation is clearly less coarse-grained than the underlying Harchies Fm.

Stratotype: Pit n °1 at Harchies (between 122.75 m and 151.50 m); see Marlière (1936a, b, 1946).

Area: Eastern and western parts of the Mons Basin.

Thickness: 29 m in the Harchies pit.

Age: Late Albian on the basis of *"Trigonia" elisae* and by its stratigraphic position: overlying the Harchies Fm. (base of the Late Albian) and underlying the Bracquegnies Fm. (Vraconian).

2.1.6. Bracquegnies Formation - BRA

Authors: Marlière (1936b), Marlière (1957).

Description: Levels with sandy glauconitic marls, conglomerates, sandstones and sands, occasionally common sponge remains. Ammonite and bivalve faunas are rich and diverse at certain levels.

Stratotype: Harchies pit, see Marlière (1936a, b, 1939, 1957).

Area: In the most subsided parts of the Mons Basin: to the west at Harchies and Pommeroeul, to the east at Bracquegnies.

Thickness: 40 m in the Harchies pit.

Age: Latest Late Albian (Vraconian), *Stoliczkaia dispar* Zone: presence of *Hyphoplites subfalcatus, Callihoplites vraconensis, Leptohoplites* cf. *cantabrigiensis.* (ammonite faunas currently under revision).

2.1.7. Bernissart Calcirudites Formation - BRN

Authors: Marlière (1936b), Robaszynski (1975).

Description: Granular to gravelly, organo-detritic, grey to yellow at outcrop, only slightly glauconitic limestones, with flints and a chalcedony cement, with sandy and glauconitic marl beds. Towards the base the limestones are coarse, conglomeratic, glauconitic and ferruginous: this is the Hautrage Conglomerate Bed (Robaszynski, 1975c) or "Tourtia", as seen in local names such as "Tourtia de Tournai", "Tourtia de Montignies-sur-Roc"; "Tourtia du Pas-de-Calais" in northern France, "Tourtia" or "Sarrazin de Bellignies".

Stratotype: Pit n° 1 at Harchies, between 53.50 m and 82 m.

Area: From the western part of the Mons Basin to the north of France.

Thickness: 2 to 30 m and sometimes more in the most subsided parts of the basin.

Age: Early and Middle Cenomanian age on the basis of the ammonites *Mantelliceras mantelli* (Early Cenomanian), *Acanthoceras rhotomagense* (Middle Cenomanian) and *Schloenbachia varians* and the oyster *Amphidonte obliquatum.*

Remarks: – This is the "Assise de Bernissart" or "meule cénomanienne" of Marlière (1936a, b, 1939, 1957), raised to rank of formation by Robaszynski (1975).
– The term "Formation du Cornet" used by Doremus (1997) is a junior synonym of the Hautrage Conglomeratic Bed, which indicates the "Tourtia de Tournai" (Robaszynski, 1975).

2.1.8. Thivencelles Marls Formation - THV

Authors: Robaszynski (1975 a).

Description: Clayey, soft, "plastic" when wet, swelling when exposed, generally green when fresh, but yellow after alteration at outcrop: these are the "Dièves moyennes" of J. Cornet (1923). The lower part may be coloured differently: white, ochre, red ("Dièves blanches, rouges" from northern France or "Dièves inférieures" of J. Cornet, 1923).
The base of the Formation consists of a pebble conglomerate and a black and shiny gravel: this is more or less equivalent with the glauconitic Mons Conglomerate Bed "Lit du Conglomérat de Mons" (Robaszynski, 1975) or "Tourtia de Mons" *auct.* (cf. Marlière, 1957).

Stratotype: Saint-Aybert des Mines de Thivencelles Pit, between 266 and 218 m (see Robaszynski, 1975 b, p. 34).

Area: In the western part of the Mons Basin and in northern France.

Thickness: A few metres to 20 m.

Age: Latest Cenomanian for the Mons Conglomerate Bed in the western part and the white and red marls with *Actinocamax plenus, Rotalipora cushmani, Whiteinella archaeocretacea*; Early Turonian for the green marls containing *Mytiloides labiatus, M. hercynicus, Mammites nodosoides, Helvetoglobotruncana helvetica, Dicarinella hagni.*

Remarks: – The Mons Conglomerate Bed or "Tourtia" is diachronous: of Late Cenomanian age between Valenciennes and Mons, but of Early Turonian age east of Mons.
– References: J. Cornet (1923); Robaszynski (1971 a, b, 1975 a - c).
– The designation "Formation de Bruyelle" (Doremus, 1997) is a junior synonym of the Thivencelles Marls Formation.

2.1.9. Thulin Marls Formation - THU

Authors: Robaszynski (1975b).

Description: Chalky marls, yellowish white at outcrop, green when fresh; occasionally chalk banks of a few decimetres thickness contain a denser sediment. The marls occasionally contain a coarser, glauconitic,

diachronous level, with small black shiny pebbles, a few mm to a few cm in size: this is the Maubeuge Glauconite Member or "Tourtia de Maubeuge" (Robaszynski, 1971b, 1975 a, b).

Stratotype: Borehole Jardiné, at Thulin, between 156.5 and 140.5 m (see Robaszynski, 1975b, p. 35).

Area: Mons Basin and northern France.

Thickness: From a few m up to 20 m.

Age: Middle Turonian on the basis of *Terebratulina rigida*, *Coscinophragma irregularis*, *Helvetoglobotruncana helvetica*, *Marginotruncana marginata*...

2.1.10. Ville – Pommeroeul Chert Formation - VPO

Authors: Robaszynski (1975c).

Description: Light-coloured, chalky, siliceous limestone, rarely marly, with numerous, more or less completely silicified concretions. Towards the top there is a progressive transition into black cherts of the Hautrage Formation. Fauna is extremely rare.

Stratotype: Motorway cutting, at the bridge connecting Ville-Pommeroeul and Rond du Bois-de-Ville (see Robaszynski, 1975b, p. 35).

Area: Mons Basin. In the eastern part of the basin, the Formation also contains glauconite, and becomes a "glauconitite" with siliceous nodules of up to 10 cm in size; when altered they have a powdery aspect. Also known as the "Verts à têtes-de-chat" *auct.* (see J. Cornet, 1923) or the "Glauconitite de Thieu" (see Robaszynski, 1975c).

Thickness: 4 to 30 m.

Age: Late Turonian on the basis of *Micraster leskei,* recorded from Harchies.

Remarks: – This formation is also known as the "Fortes-Toises" *auct.* (J. Cornet, 1923).
– The designation "Formation de Merlin" (Doremus, 1997) is a junior synonym of the Ville-Pommeroeul Chert Formation.

2.1.11. Hautrage Flints Formation - HTR

Authors: Robaszynski (1975c).

Description: Chalky marls or coarse-grained chalks, slightly glauconitic, with numerous and voluminous irregular brown-black flints. These flints often contain numerous, small (mm size), white sponge spicules.

Stratotype: In the railway cutting at Hautrage (see Robaszynski, 1975, p. 36).

Area: Mons Basin. Towards the west in France the equivalent is the "Craie à cornus". Near the northern border of the Mons basin between Ghlin and Saint-Denis the Hautrage Formation is strongly silicified: see Saint-Denis Silicite Formation.

Thickness: 3 to 25 m near Saint-Vaast in the eastern part of the basin.

Age: Late Turonian on the basis of *Micraster leskei.*

Remarks: – These are the "Rabots" *auct.* (J. Cornet, 1923).
– The denomination "Formation d'Esplechin" (Doremus, 1997) is a junior synonym of the "Formation des Silex d'Hautrage" of Robaszynski (1975c).

2.1.12. Saint-Denis Silicite Formation - SDN

Authors: Robaszynski (1975b).

Description: Very hard rock, in banks of several decimetres thickness or totally silicified, of light grey colour, with conchoidal fracture; millstone grit used to this day the shaping of millstones. A few rare fossils with non-silicified shells.

Stratotype: Engelbienne Quarry at Saint-Denis (see Robaszynski, 1975b, p. 36).

Area: The Silicite is a lateral facies of the Hautrage Formation, only found between Ghlin and Saint-Denis, in the north of the Mons Basin.

Thickness: 2 to 7 m.

Age: Late Turonian on the basis of calcitic fossils: *Micraster leskei*, *Sternotaxis plana*, *Inoceramus carpathicus*, *I. mantelli.*

Remarks: – This is the "Meulière de Saint-Denis" of J. Cornet (1923).
– References: Brognon (1945 a, b).

2.1.13. Maisières Chalk Formation - MAI

Authors: F.L. Cornet & Briart (1874).

Description: Glauconitic, granular, calcarenitic green "chalk", with erosion surfaces and/or perforated hardgrounds at the base. Becomes more chalky towards the west and is the equivalent of lithological units known in France as "Verts", "Gris des mineurs" and "Bonne Pierre de Valenciennes" (where this chalk was worked in underground quarries as a building stone). Basal beds yield phosphate grains or pebbles. Fossil content: many bivalves.

Stratotype: Disused quarry "du Cimetière" at Maisières.

Area: Mons Basin, in France corresponding to the "Pierre the Lézennes" near Lille, "Craie grise du Cambrésis", and "Bonne Pierre de Valenciennes".

Thickness: 2 to 7 m, a very good marker level in boreholes.

Age: Coniacian on the basis of the planktonic foraminifers *Dicarinella* gr. *concavata* and *Globotruncana linneiana* (Moorkens, 1969; Godfriaux & Sigal, 1969); numerous oysters *Hyotissa semiplana* and *Gryphaeostrea canaliculata*, and the brachiopod *"Cretirhynchia" plicatilis*. The Late Turonian age given by J. Cornet (1923) was based on the presence of *"Neoptychites peramplus"*, but the specimen in the collections of the Faculté Polytechnique de Mons, is indeterminate according to F. Amédro.

2.1.14. Saint-Vaast Chalk Formation - SVA

Authors: F.L. Cornet & Briart (1870), and herein.

Description: White to greyish chalk, containing clay minerals but not marly, difficult to break. The lower part ("Craie de Saint-Vaast inférieure" *auct.*) contains sponges and grey to black flints but only in the eastern part of the Mons Basin. At the base, a thin conglomerate with phosphatised chalk pebbles, phosphatised and glauconitised sponges and glauconitic grains.

The upper part ("Craie de Saint-Vaast supérieure" *auct.)* is not flinty but chalky with pyritic spheroids. The top is sometimes marked by a hardground. Sponges are more abundant than other fossils.

Stratotype: The quarry at St. Vaast where the "Craie de Saint Vaast" was originally defined has been filled in. Still visible in the old quarry "des crayères" at Thieu.

Area: Mons Basin. The upper part seems to be transgressive over the lower part of the Saint -Vaast Fm. or the Maisières Fm. or Devonian bedrock.

Thickness: 15 to 25 m on the southern and northern margins of the Basin, about 50 m on the eastern margin near the village of Trivières.

Age: The lower part of the St.-Vaast Fm. is of Coniacian age on the basis of: *Micraster decipiens*, *Volviceramus involutus*, the foraminifer *Dicarinella* gr. *concavata*. It also contains numerous specimens of *Hyotissa semiplana*.

The upper part of the St.-Vaast Fm. is of Santonian age on the basis of: *Micraster coranguinum, Actinocamax verus*, *Gibbaster belgicus*, *Sphenoceramus digitatus*, and foraminifers: *Stensioeina exsculpta gracilis*, *Gavelinella clementiana*, *Bolivinoides strigillatus*...

Remarks: – At this moment (2000) there are no good outcrops exposing the Saint-Vaast Chalk Fm.
– Reference: Godfriaux & Sigal (1969).

2.1.15. Trivières Chalk Formation - TRI

Authors: Briart & F.L.Cornet (1880).

Description: A white to greyish marly chalk without flints. A conglomerate, from a few cm to one m thick, generally marks the base containing hardground fragments, phosphatised chalk nodules, phosphatised sponges and fossil fragments. The top is often a hardground (named "durillon" by the quarry workers). To the east of the Mons Basin several hardgrounds corresponding to large channels are distributed within this formation.
Fossils are not abundant except in the basal conglomerate.

Stratotype: No stratotype has been designated for the Trivières Fm. Depending on the activities at the cement quarries it is occasionally visible at Harmignies (C.C.C.) and Obourg (C.B.R.).

Area: Mons Basin, in quarries and boreholes.

Thickness: More than 10 m in the southern part of the Basin to 120 m in the northern part.

Age: Early-Late Campanian - cephalopods: *Gonioteuthis quadrata*, *Belemnitella* gr. *mucronata*, *Scaphites gibbus*; bivalves: *Oxytoma tenuicostata*, *Endocostea baltica;* echinoids: *Echinocorys* gr. *ovata*, *Micraster schroederi.*

Remarks: References: J. Cornet (1923), Leriche (1935), Marlière (1936a, b, 1957), Robaszynski & Christensen (1989), Robaszynski (1995), Christensen (1999).

2.1.16. Obourg Chalk Formation - OBG

Authors: F.L. Cornet & Briart (1870).

Description: A fine-grained white chalk, slightly greyer than the overlying Nouvelles Formation. In the northern part of the basin it contains a few dark black flints (used by Neolithic man for tool making, sometimes even exported towards the Meuse area). In the southern part of the basin chert nodules are absent or very small. A conglomerate layer may occur at the base of the formation containing phosphatised chalk pebbles, and numerous fossils, many of them reworked.

Stratotype: No stratotype has been designated for the Obourg Formation. The Formation outcrops depending on quarrying activities at the C.C.C. and C.B.R. quarries at Harmignies (section in the C.C.C. quarry studied in Robaszynski & Christensen, 1989).

Area: Mons Basin, in outcrops and quarries along the margins; also in boreholes.

Thickness: 15 to 25 m, more in boreholes.

Age: Early Late Campanian: cephalopods: *Belemnitella mucronata*, *Patagiosites stobaei*, *Glyptoxoceras retrorsum*, *Baculites aquilaensis*; brachiopods: *Carneithyris carnea*, *"Cretirhynchia" octoplicata;* echinoids: *Echinocorys* cf. *ovata*, *E. gibba*, *Micraster schroederi*, *M. stolleyi*; foraminifers: *Bolivinoides decoratus*, *Gavelinella monterelensis*, *Stensioeina pommerana*, *Globorotalites michelinianus* etc.

Remarks: References: see Spiennes Fm.

2.1.17. Nouvelles Chalk Formation - NOU

Authors: F.L. Cornet & Briart, 1870).

Description: A pure, massive, soft, very fine-grained white chalk, without flints, except for two to three bands of small flint nodules at the top. There is a gradual transition to the underlying Obourg Fm. At the southern margin of the basin, a prominent hardground may be present in the uppermost part of this formation.

Stratotype: No stratotype has been designated for the Nouvelles Formation. The Formation outcrops in quarries, especially at Harmignies (section in the C.C.C. quarry studied in Robaszynski & Christensen, 1989).

Area: Mons Basin, in outcrops along the margins and in boreholes.

Thickness: 20 to 25 m at the margin of the Mons basin, but about 75 m at Beaulieu in a subsidence area of this basin.

Age: Transition between the early and the late Late Campanian; cephalopods: *Belemnitella minor* I, *Bt. woodi*, *Trachyscaphites spiniger*; brachiopods: *Magas chitoniformis* (= *M. pumilus* auct.); echinoids: *Micraster schroederi*, *Echinocorys gibba*; foraminifers: first *Bolivinoides australis* (4 - 5 pustules); the majority of fossil taxa already found in the underlying Obourg Fm.

Remarks: References: see Spiennes Fm.

2.1.18. Spiennes Chalk Formation - SPI

Authors: F.L. Cornet & Briart (1870), Robaszynski & Christensen (1989).

Description: A white to whitish-grey, rather coarse-grained chalk, which becomes calcarenitic towards the top. It contains many large black to grey-brown cherts and some black chert bands, 10 to 60 cm thick (used by Neolithic man for tool making). At the base there occasionally is a thin layer of phosphatised chalk pebbles and inoceramid, echinoid and ostreid fragments and sponges; at the top sometimes a burrowed level.

Stratotype: No stratotype has been designated for the Spiennes Formation. Outcrops are occasionally available depending on activities in quarries. A good section exposing the Spiennes Fm. *pro parte* was studied by Robaszynski & Christensen (1989)

Area: Mons Basin, from Hautrage in the west to Havré in the east, in outcrops and boreholes.

Thickness: 20 to 25 m on the margin of the Mons Basin (e.g. at Harmignies) to 50 m in the centre of this basin in its most subsided zones.

Age: Late Late Campanian: fossil content: cephalopods: *Belemnitella minor* I Jeletzky, *Bt. minor* II Christensen; echinoids: *Cardiaster granulosus*, *Echinocorys belgica*; benthic foraminifers: *Bolivinoides australis* (4 to 6 pustules), *Globorotalites hiltermanni*, *Gavelinella voltziana involutiformis*, *Eponides beisseli*...

Remarks: References: F.L. Cornet & Briart (1874); J. Cornet (1923); Leriche (1935); Marlière (1936a, b, 1957); Robaszynski & Christensen (1989); Kennedy (1993); Robaszynski (1995); Christensen (1999).

2.1.19. Ciply-Malogne Phosphatic Chalk Formation - CIP

Authors: F.L. Cornet & Briart (1866), and herein.

Description: Cohesive or crumbly calcarenite, invariably intensely bioturbated, consisting of phosphate granules within a chalky matrix. The granules are brown at the surface, but grey in the sediment.

The average P_2O_5 is around 8%. Bands with rounded black or brown flints with phosphate grains are sometimes intercalated between the calcarenites. Fossils are extremely common.

At the margins of the phosphatic basin, the base of this formation is marked by a conglomeratic level with chalk gravel, sponges, fragments of baculitid ammonites, all of them phosphatised whereas in the central part of the basin there is a continuous transition between this unit and the underlying Spiennes Chalk Formation.

The top of the Formation is almost always marked by a conspicuous hardground, often complex in structure, 0.4 to 1.4 m thick. This hardground was the "roof" of the underground quarries of the La Malogne Plateau where the phosphatic chalk was worked at the end of the 19th century.

Stratotype: No stratotype has been designated for the Ciply-Malogne Formation. At present the only good outcrops are in the underground quarries of the Malogne below the village of Cuesmes.

Area: Mons Basin, south of Mons at Ciply and Saint-Symphorien; north of the Mons Basin in the subsurface of Baudour.

Thickness: One to a few metres on the margin of the Ciply and Baudour basins, up to 76 m in the centre of the Ciply Basin. In the underground quarries of the Malogne the Ciply-Malogne Formation had a thickness of 10 to 12 m.

Age: Early Maastrichtian; cephalopods: *Belemnella obtusa*, *Belemnitella pulchra*, *Bt. minor* II, *Pachydiscus* cf. *neubergicus*, *Hoploscaphites constrictus*, *Baculites knorrianus*, *Ba. baculus* etc.; brachiopods: *Trigonosemus palissyi*; foraminifers: *Neoflabellina praereticulata*, *Gavelinella bembix*, *Osangularia navarroana* etc.

Remarks: – This is the "Craie grise" of F.L. Cornet & Briart (1866) and the "Craie brune" of F.L. Cornet & Briart (1874).

– References: J. Cornet (1923); Marlière (1957); Poels & Robaszynski (1988); Robaszynski & Poels (1988); Robaszynski & Christensen (1989); Kennedy (1993); Christensen (1999).

2.1.20. Saint-Symphorien Calcarenite Formation - SSY

Authors: Rutot & Van den Broeck (1885a) and herein.

Description: Crumbly, porous, poorly cemented, grey when fresh, yellow to brownish at the altered surface, often bioturbated, calcarenites or calcirudites. Locally the calcarenites may contain grey, green or brown phosphatised granules and pebbles. Similarly, one or more flint bands may be intercalated within the Calcarenite (or "Tuffeau").

Numerous fossils are present, either complete, or in fragments or forming the bioclastic base of the rock: scaphopods, echinoid spines, oysters and other bivalves, belemnite guards, brachiopods.

The base of this formation is often clearly distinguished by the presence of an indurated and phosphatised chalk pebble conglomerate: the top is generally a hardground of 10 to 40 cm thickness, but known in places to reach a thickness of 140 cm, burrowed, with bivalve and gastropod internal moulds and small pyrite crystals.

Stratotype: No stratotype has been designated for the St-Symphorien Fm.; it outcrops in abandoned quarries at St-Symphorien and in parts of the Vandamme (formerly André) quarry at Ciply.

Area: Mons Basin, in the disused quarries of St - Symphorien and Ciply and in boreholes. Towards the west it reaches Hornu.

Thickness: From one to a few metres, sometimes absent between the underlying Ciply Phosphatic Chalk Formation and the overlying Ciply Calcarenite (of Cainozoic age). Reaches about 10 m in boreholes near Ciply.

Age: Late Maastrichtian on the basis of belemnites (Jeletzky, 1951). The presence of numerous *Thecidea papillata* and *Trigonosemus pectiniformis* are good regional markers.

Remarks: References: Rutot & Van den Broeck (1885 a, b), Marlière (1957).

2.2. Liège-Limburg basin area

2.2.1. Aachen Formation - AAC

Authors: Dumont (1849), W.M. Felder (1975).

Description: A complex unit, in the type area primarily sands with intercalations of clayey and silty sands and sandy and silty clays in the lower part. The Aachen Formation rests on eroded Palaeozoic carbonate and psammitic/pelitic rocks, and comprises three members:

Hergenrath Member (thickness 10-35m): alternation of light to dark grey, sandy and silty clays with silty and clayey, light grey fine to coarse-grained sands, with subordinate fine-grained gravel, silts, minor red clays and ferruginous horizons. Locally, with large quantities of wood debris, marcasite and pyrite concretions. Root horizons are common, and in part they are associated with lignite deposits, especially in the upper part.

Aachen and Hauset members (thickness up to about 40 m): well-sorted, yellow-white to clean white, limonite-stained fine sands, locally with irregular gravelly sandstone beds and concretions, with small- and large-scale cross-bedding. Flaser cross-bedding occurs commonly; bioturbation of varying intensity. In the lower part, locally lenticular bodies of silty clays.

Stratotypes:

Hergenrath Member: Schampelheide quarry at Kelmis (La Calamine), Liège (co-ordinates 302.750/201.250).

Aachen Member: Käskorb Quarry (outcrop 62D-74 of W. M. Felder) at Kelmis (La Calamine), Liège (co-ordinates 304.000/199.750).

Hauset Member: Flög Quarry at Hauset, Liège (co-ordinates 203.470/303.360).

Area: Type area is the wooded area south of Aachen (Aachener Wald), on German/Belgian border

Thickness: Varying from less than one m to 60 m.

Age: Middle Santonian to earliest? Campanian on associations of spores, pollen and dinoflagellates (Batten *et al.*, 1987, 1988; Streel *et al.*, 1994). Unfortunately, marine fossil associations, e.g. coleoid and ammonoid cephalopods and inoceramid bivalves, are unknown from this unit.

Remarks: – Formerly described as "grès blanc" (Dumont, 1832), "Aachénien" (Dumont, 1849), "Sables d'Aix-la-Chapelle" *auctorum*, "Assise d'Aix-la-Chapelle" (Purves, 1883; Rutot, 1892; Stockmans, 1946), "Akens Sand" (Netherlands Geological Survey, 1957).

– Recent references: W.M. Felder (1975), Albers *et al.* (1978), Albers & W.M. Felder (1979), Batten *et al.* (1987, 1988), Streel *et al.* (1994), Jagt (1999), Meyere (2000).

2.2.2. Vaals Formation - VAA

Authors: Netherlands Geological Survey (1957), W.M. Felder (1975).

Description: In the type area, the unit comprises six members with a total thickness of about 150 m, to which W.M. Felder & Bosch (2000) added a seventh, the Benzenrade Member.

– Raren Member (thickness between 12 and 18 m): predominantly laminated, yellow to greyish-green, glauconitic fine-grained sands, in channel fills. In places lenticular sandstone bodies occur with rich faunas, interfingering in westerly direction with silty fine-grained sands and sandy silts.

– Cottessen Member (thickness up to 10 m): cyclic alternation of yellow to greyish-green, glauconitic laminated channel fills, and light grey-brown, fine-grained sandy silts to silty fine-grained sands. Occurring locally are fossil-rich sandstone banks; towards the west, a facies change similar to that in the Raren Member occurs. The top corresponds to a fossiliferous, dark grey-green glauconitic horizon.

– Gemmenich Member (thickness about 10-12 m): similar to Cottessen Member.

– Vaalsbroek Member (thickness 4-6 m): cyclic alternation of yellow to greenish-grey, glauconitic, laminated fine-grained sands without silt, and glauconitic, silty, fine sands with extensive bioturbation.

– Beusdal Member (thickness between 14 and 25 m); cyclic alternation of poorly indurated, yellow to greyish-green, glauconitic laminated fine sands without silt and glauconitic, silty, fine-grained sands with extensive bioturbation.

– Terstraten Member (thickness up to about 15 m): greyish-green, silty fine-grained sandy silts with glauconite. Base characterised by poorly indurated, light grey, fine-grained sandy silt with fossil hash, in particular the bivalve *Cucullaea subglabra.*

– Benzenrade Member: see W.M. Felder & Bosch (2000)

Stratotypes:

– Raren Member: road cutting along Sandbergweg, Aachen-Vaalserquartier, Germany (co-ordinates 308.700/200.600).

– Cottessen Member: road cutting along Holle Weg at Cottessen (Limburg, The Netherlands) (co-ordinates 308.200/194.540).

– Gemmenich Member: road cutting between Terstraten and grenspaal 7, Bleiberg (Plombières), Liège (co-ordinates 196.120/307.300).

– Vaalsbroek Member: road cutting at Mechelen – Overgeul (Limburg, The Netherlands) (co-ordinates 311.820/192.200).

– Beusdaal Member: road cutting between Sippenaeken and Teuven, Liège (co-ordinates 306.830/192.240).

– Terstraten Member: road cutting east of Terstraten on the Belgian-Dutch border, near grenspaal 6) (co-ordinates 307.420/196.420).

– Benzenrade Member.

Area: Type area in direct vicinity of the Vaalserberg, southeast of Vaals (Limburg, The Netherlands)

Thickness: Total thickness up to about 150 m.

Age: Early Early Campanian to early Late Campanian by ammonoid and coleoid cephalopods: *Belemnitella praecursor, Bt. m. mucronata, Gonioteuthis granulataquadrata, G. q. quadrata, Scaphites hippocrepis* II-III, *Trachyscaphites spiniger, Pachydiscus duelmensis, P. launayi, Eupachydiscus levyi, Hoplitoplacenticeras marroti, H.* cf. *coesfeldiense, Glyptoxoceras vaalsiense,* and *Baculites vaalsensis.*

Remarks: – Formerly described as "Smectite de Herve" (Dumont, 1832), "Système hervien" (Dumont, 1850) "Assise de Herve" [Rutot (1894), Leriche (1929), Marlière (1954)], "Vaalser Groenzand" or Hervian (Netherlands Geological Survey, 1957).

– Recent references: Albers (1976), Albers & Felder (1979), Jagt (1989), Kennedy & Jagt (1995, 1998), Jagt (1999).

2.2.3. Gulpen Formation - GUL

Authors: Netherlands Geological Survey (1957), W.M. Felder (1975).

Description: Five members are distinguished as follows from the base to the top:

Zeven Wegen Member (thickness up to about 30 m): white to light grey, fine-grained chalks with basal layer of glauconitic zones, towards the west with randomly distributed black, fine-grained flints with glassy fracture.

Beutenaken Member (thickness up to about 10 m): light greyish to whitish yellow, glauconitic fine-grained clayey and calcareous marls, with glauconite concentration in lowermost metre.

Vijlen Member (thickness generally between 15 and 25 m, but locally up to about 100 m): yellowish grey, glauconitic fine-grained chalks, with basal glauconite-rich portion, subdivided into seven intervals by P. J. Felder & Bless (1994), each with distinctive fossil assemblages.

Lixhe Member: (total thickness of Lixhe 1-3members up to 25 m) white, fine-grained chalks with irregular dark blue-grey to black flint nodules. West of the River Maas (Meuse) threefold subdivision possible on flint type and abundance.

Lanaye Member (thickness *c.* 20 m) white, fine-grained chalks with irregular light to dark blue-grey flint nodules; west of River Maas with 23 flint bands, east of river bedding the Lixhe Member is absent and only randomly distributed flint nodules occur.

Stratotypes:

– Zeven Wegen Member: road cutting along tourist road Vaals-Epen, near Zeven Wegen (Vijlenerbosch), Limburg, The Netherlands (co-ordinates 308.550/194.940)

– Beutenaken Member: disused Habets quarry, Beutenaken, Limburg, The Netherlands (co-ordinates 309.270/188.250).

– Vijlen Member: road cutting between Mamelis and Bocholtzerheide, on the Dutch-German boundary (co-ordinates 312.330/196.450).

– Lixhe 1-3 members: disused Dierkx quarry, Lixhe; Liège (co-ordinates 308.400/174.500).

– Lanaye Member: western portion of Albert Canal outcrop, north of bridge at Lanaye, Liège (co-ordinates 311.000/176.150).

Area: In southern Limburg, confined to area south of Benzenrade and Schin op Geul faults; well developed in Haccourt-Eben Emael area (Liège).

Thickness: Up to about 175 m.

Age: Earliest Late Campanian to early Late Maastrichtian by: coleoid and ammonoid cephalopods: *Scaphites gibbus, Trachyscaphites spiniger, Acanthoscaphites (A.) tridens, A. (Euroscaphites) varians blaszkiewiczi, Pachydiscus neubergicus, Belemnella (B.) inflata, Bn. (Pachybelemnella) obtusa, Bn. (P.) sumensis, Bn. (P.) cimbrica, Belemnitella pulchra, Bt. junior, Bt. minor* II, *Bt. najdini,* and *Bt. woodi.*

Foraminifera: *Bolivinoides delicatulus regularis, B. australis, B. d. draco, B. draco miliaris, Neoflabellina permutata.*

Remarks: – Formerly described as "Gulpens Krijt" (Netherlands Geological Survey, 1957), "Craie grise" *auctorum,* "Craie blanche" *auctorum,* "Craie tigrée" *auctorum,* "Tijgerkrijt" *auctorum.*

– Recent references: P. J. Felder & Bless (1994), P.J. Felder (1996, 1997), Keutgen & Jagt (1999), Keutgen (1996, 1997), Jagt (1999), Jagt *et al.* (1999).

2.2.4. Maastricht Formation - MAA

Authors: Dumont (1849), W.M. Felder (1975).

Description: Six members are distinguished, as follows from the base to the top:

– Valkenburg Member (thickness between about 2.5 and 45 m): poorly indurated, white-yellowish to yellowish grey, fine-to coarse-grained "chalk" with greyish brown flint nodules of varying size in the west. In the east, sequence changes into alternation of poorly and more intensely indurated chalk beds, part of so-called "Kunrade limestone". Flints, where occurring, are crumbly, light grey nodules. Base with coarse-grained, phosphatic/glauconitic and pyritic bioclastic sand.

– Gronsveld Member (thickness between 4.5 and about 10 m): poorly indurated, white- yellowish to yellowish grey, fine to coarse-grained "chalk". In its lower portion, small, light to dark greyish brown flint nodules of varying size and shape, in its higher portion arranged in more or less regular beds of nodules. Towards the east the higher portion is missing, where the "chalk" changes

into cyclic alternation of more or less indurated chalk beds, part of the so-called "Kunrade limestone".

– Schiepersberg Member (thickness 5 to 6 m): poorly indurated, white yellowish, fine- to coarse-grained, homogeneous "chalk" with numerous regular beds and randomly distributed, light-grey to bluish-grey flint nodules. Homogeneous "chalk" changes towards the east into alternation of chalk beds of varying induration, part of the so-called "Kunrade limestone".

– Emael Member (thickness between about 5 and 7.5 m): poorly indurated white-yellowish and yellowish-brown, fine- to coarse-grained, homogeneous "chalk", in its lower portion with numerous light grey flint nodules; typical are large, regular flat and pipe-shaped flint bodies. In the east, this homogeneous "chalk" changes into alternation of more or less indurated chalk beds, which form the highest part of the so-called "Kunrade limestone".

– Nekum Member (thickness between about 7 and 15 m): poorly indurated, white yellowish, coarse-grained, homogeneous "chalk", in its lower part with few randomly distributed greyish brown flint nodules. Locally with coarse-grained fossil hash lenses and beds.

– Meerssen Member (thickness between about 15 and 20 m): poorly indurated white yellowish, coarse- to very coarse-grained "chalk" with clearly developed hardgrounds and fossil hash layers and omission surfaces.

Stratotypes:

– Valkenburg Member: disused quarry east of Valkenburg aan de Geul, Limburg, The Netherlands (co-ordinates 318.520/186.770).

– Gronsveld Member: quarries Wijngaardsberg and Varkensgat at Riesenberg, east of Gronsveld, Limburg, The Netherlands (co-ordinates 314.050/180.150).

– Schiepersberg Member: disused Schiepersberg quarry, Cadier en Keer, Limburg, The Netherlands (co-ordinates 315.880/182.680).

– Emael Member: Marnebel quarry, Emael, Bassenge, Liège (co-ordinates 310.850/175.050).

– Nekum Member: disused de Tombe Quarry, St Pietersberg, Maastricht, Limburg, The Netherlands (co-ordinates 315.130/175.350).

– Meerssen Member: Ankerpoort-Curfs quarry, Geulhem, Limburg, The Netherlands (co-ordinates 320.120/182.100).

Area: With the exception of the area south of the line St Geertruid-Gulpen-Vaals and north of the Heerlerheide fault, where the formation is absent due to erosion, the unit occurs throughout southern Limburg and contiguous areas of Belgian Limburg and Liège.

Thickness: Between about 45 and 90 m.

Age: Early Late to latest Maastrichtian by: coleoid and ammonoid cephalopods: *Belemnitella junior, Belemnella (Neobelemnella) kazimiroviensis, Baculites vertebralis, Pachydiscus gollevillensis, P. jacquoti, Sphenodiscus binckhorsti, Menuites terminus, M. fresvillensis* and *Hoploscaphites constrictus.*

Inoceramid bivalve: *Tenuipteria argentea.*

Microfauna/flora: *Thalassiphora pelagica, Palynodinium grallator.*

Remarks: – Formerly known as "Calcaire de Maestricht" *auctorum,* "Maastrichtien" (*sensu* Dumont, 1849), "Maastrichts Krijt (Tufkrijt)" (Netherlands Geological Survey, 1957).

– Recent references: W.M. Felder (1975), Zijlstra (1994), Vonhof & Smit (1996), Schiøler *et al.*, 1997, Machalski & Jagt (1998), Jagt (1999).

2.3. Méhaigne + Petite Gette area

2.3.1. Lonzée Member - LON

Authors: Dumont (1878) and herein.

Description: From bottom to top:

– basal grey to green clay-silt, overlying Silurian bedrock, with many moulds of bivalves and gastropods;

– grey-green glauconitic clay-silt, with planar bedding; no macrofossils;

– blue clay with numerous bivalves, belemnites, shark teeth, teleosts, mosasaurs (thickness: up to 60 cm);

– fine grey sand with large blocks of glauconitic sandstone with many bivalves, belemnites, microfauna etc. (thickness: 145 cm);

– glauconitic, dark green-blue clays, with many bivalves, belemnites, shark teeth, fish vertebrae (thickness: 20 cm);

– indurated calcarenite and sand (thickness 15 cm);

– yellowish green or brown, glauconitic, very sandy clay, with numerous silicified shell fragments (thickness: 30 cm).

Stratotype: No stratotype fixed; at present there are no outcrops in the succession.

Area: Known occurrence of this member is restricted to the area around Lonzée near Gembloux (Namur)

Thickness: About 3 m (unpublished section drawn by M. Glibert in 1936).

Age:? Coniacian – Santonian -? basal Campanian:

Cephalopods: *Actinocamax verus, Gonioteuthis westfalica westfalica, G. westfalicagranulata, G. granulata,? G. granulataquadrata.* Inoceramids: *Inoceramus (Heroceramus)* cf. *hercules, I. (Volviceramus)* cf. *koeneni*

Remarks: – Formerly considered as belonging to the Mons Basin: Marlière (1954, 1957), following data in Leriche (1929), considered the Glauconie de Lonzée as being the littoral extension of the Craie the Saint-Vaast (Saint – Vaast Chalk Formation, see above, p. 127).

In their study of the bivalves Malchus *et al.* (1994, 1996) demonstrated that the Lonzée fauna is strongly related to the Vaals-Aachen fauna (Liège-Limburg Basin) and not at all to the faunas from the Mons – Paris Basin. Thus, Malchus *et al.* confirmed the view originally expressed by Rutot (1894). The belemnites at Lonzée indicate a Santonian age (Christensen, 1994), but the inoceramids are partially of Coniacian age (Malchus e*t al.*, 1994).

– References: Christensen (1994), Dumont (1878), Leriche (1929), Malchus *et al.* (1994, 1996), Marlière (1954, 1957), Rutot (1894).

2.3.2. Folx-les-Caves Member - FOX

Authors: Rutot & Van den Broeck (1888).

Description: From bottom to top, the Cretaceous strata at Folx-les-Caves comprise:
– arenaceous facies of the white chalk ("craie arénacée");
– conglomerate, with pebble bed; pebbles consist of petrified calcarenites but also of older strata;
– calcarenites with *Thecidea papillata* and *Bourgueticrinus ellipticus* ("tufeau jaune" of Rutot & Van den Broeck, 1888)
– unconformably overlain by "Tuffeau de Lincent" of Palaeocene age.
The "Folx-les-Caves Formation" is restricted to the "craie arénacée" in the section above.

Stratotype: Entrance to the underground quarry "Folx-les-Caves" at Jauche (Orp-Jauche, eastern Brabant) (not in the territory of Folx-les-Caves as shown by Groessens, 1998).

Area: Valley of the Petite Gette, eastern Brabant

Thickness: 3 to 6 m *fide* Bless *et al.*, 1991

Age: The belemnite *Gonioteuthis quadrata* indicates an Early Campanian age for the "craie arénacée" (= Tuffeau de Folx-les-Caves).
The coccolith assemblage CC 22 (*Lithastrinus grilli, Aspidolithus parcus, Rheinhardtites anthophorus, Eiffelithus eximius, Uniplanarius sissinghii)* mentioned by Mulder & Mai (1999) from one sample of the "Tuffeau jaune" (not "jaunâtre" as stated by these authors) is probably based on reworked material.
Fossils (such as very numerous specimens of the brachiopod *Thecidea papillata*) in the collections of the IRSNB/KBIN, confirmed by the publications of Rutot & Van den Broeck (1888), from the same "tuffeau jaune", indicate an undoubted Late Maastrichtian age for this younger tuffeau, thus confirming the existence of a a hiatus between the Early Campanian "Tuffeau de Folx-les-Caves" and the overlying "Tuffeau de Jauche" (see below).

Remarks: Previously also known as "Tuffeau de Folx-les-Caves" Rutot & Van den Broeck (1888); historical review by Groessens (1998). Recently studied by Bless *et al.* (1991), Kennedy (1987), Mulder & Mai (1999).

2.3.3. Jauche Member - JAU

Authors: Rutot & Van den Broeck (1888).

Description: From bottom to top the Cretaceous strata at Orp-Jauche comprise:
– sands and sandy marls at the base of the white chalks;
– calcarenitic or sandy facies of the white chalk;
– very fine-grained white chalk with black flints;
– coarse-grained chalk with bed with rolled pebbles and nodules at the base;
– calcarenites with *Thecidea papillata,* flints and a pebble bed at the base;
– unconformably overlain by Palaeocene sands and marls with flint pebbles at the base.

Stratotype: at old quarry at Orp-le-Grand (Orp-Jauche, east Brabant).

Thickness: 0.20 m to 2 m.

Age: The Late Maastrichtian brachiopod *Thecidea papillata* occurs in great numbers in the Jauche Member.

Remarks: Previously known as "Tuffeau d'Orp-le-Grand" in Thielens (1871-1872), Rutot & Van den Broeck (1887-1888), Leriche (1929), Marlière (1957). The denomination "Orp-le-Grand" was used previously by Thielens (1871-1872) for two levels in the section – one of Maastrichtian age and one of Palaeocene age. Vincent (1873) used "Sables heersiens d'Orp-le-Grand" for this Palaeocene formation, generally today called "Sables d'Orp". Thus, it was necessary to introduce a new name for the Cretaceous lithostratigraphic unit, and since today Orp and Jauche belong to the same administrative unit, it was decided to name it Jauche Member.

3. References

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