

Cambrian-Ordovician-Silurian lithostratigraphic units (Belgium)

Jacques VERNIERS¹, Alain HERBOSCH², Michel VANGUESTAINE³,
Fernand GEUKENS⁴, Bernard DELCAMBRE⁵, Jean-Louis PINGOT⁵,
Isabelle BELANGER⁵, Michel HENNEBERT⁶, Timothy DEBACKER¹,
Manuel SINTUBIN⁷ & Walter DE VOS⁸

(6 figures)

1. Ghent University, Department Geology & Pedology, Research Unit Palaeontology, Krijgslaan 281, B-9000 Ghent, Belgium.
2. Université Libre de Bruxelles, Département des Sciences de la Terre et de l'Environnement, 50 Avenue F. Roosevelt, CP160/02, B-1050 Brussels, Belgium.
3. Université de Liège, Laboratoire de Paléobotanique, Paléopalynologie & Micropaléontologie, Allée du Six Août, Bât. B18, Sart Tilman, B-4000 Liège, Belgium.
4. Katholieke Universiteit Leuven, Afdeling Historische Geologie, Redingenstraat 16, B-3000 Leuven, Belgium.
5. Université Catholique de Louvain, Unité de Géologie, Place L. Pasteur 3, B-1348 Louvain-la-Neuve, Belgium.
6. Faculté Polytechnique de Mons, Institut Jules Cornet (Géologie), Rue de Houdain, 9, B-7000 Mons, Belgium.
7. Katholieke Universiteit Leuven, Afdeling Historische Geologie, Laboratorium voor Structurele geologie en tektoniek, Redingenstraat 16, B-3000 Leuven, Belgium.
8. Geological Survey of Belgium, Jennerstraat 13, B-1000 Brussels, Belgium.

ABSTRACT. The National Subcommittee on the Stratigraphy of the Lower Palaeozoic of Belgium has evaluated the previous and present definitions of the Cambrian, Ordovician and Silurian lithostratigraphical units (groups, formations and members) and presents in this paper the results of this evaluation. Some of these units described in published or unpublished documents are considered to be junior synonyms of previously described units. Other units were given a higher or lower ranking. Units that are too thin or too thick were abandoned. The Subcommittee reached agreement on the validity and usefulness of all the units that are described below.

For each of them, a lithological and sedimentological description is given, the area of distribution and possible facies changes, the thickness of the unit, the arguments for the age determination, some remarks about the history of the definitions, and the names of units considered to be junior synonyms. In the Brabant Massif 32 formations are (re) defined and described, in the Condrosz inlier 18 formations, in the Stavelot Massif 3 groups, 8 formations and 8 members, with an additional formation with an unspecified Mid Ordovician-earliest Devonian age, in the Rocroi Massif 3 groups, 7 formations and 2 members, in the Givonne Inlier 4 formations and in the Serpont Inlier 2 formations. The formations are shown in chronostratigraphical tables with a colour encoding the dominant lithology or sedimentology.

KEYWORDS: Cambrian, Ordovician, Silurian, Belgium, lithostratigraphy.

REFERENCE TO THIS VOLUME. Verniers, J., Herbosch, A., Vanguestaine, M., Geukens, F., Delcambre, B., Pingot, J.-L., Belanger, I., Hennebert, M., Debacker, T., Sintubin, M. & De Vos, W., 2001. Cambrian-Ordovician-Silurian lithostratigraphic units (Belgium). In Bultynck & Dejonghe, eds., Guide to a revised lithostratigraphic scale of Belgium, *Geologica Belgica*, Brussels, 4/1-2, 5-38.

1. Introduction

The Lower Palaeozoic formations in Belgium crop out in six areas: the Brabant Massif in the north and north-west, the Condroz inlier, also called the "Bande condru-sienne" or "Bande de Sambre-et-Meuse" (Sambre-et-Meuse Strip) in the centre of the country, and four inliers in the Ardennes, which traditionally are called "Massifs" in the regional literature: the two larger Stavelot and Rocroi inliers and the two smaller Givonne and Serpont inliers (Figs. 1 and 2). Four of these massifs extend into the surrounding countries: the Brabant Massif into the Netherlands and France, the Stavelot Massif into Germany where it is called (Stavelot-) Venn Massif, the Rocroi Massif and the Givonne inlier into France. All the massifs or inliers are unconformably covered by Devonian rocks. The unconformity has been called Caledonian in the literature and results from orogenic deformations caused by the Avalonia-Baltica-Laurentia collisions during the Late Ordovician to Early Devonian times.

The Brabant Massif contains a thick siliciclastic often turbiditic and rather complete Lower Palaeozoic sequence, from the lowest Cambrian to the uppermost

Silurian. Its prolongation below the Devonian cover can be traced by boreholes and geophysical data to the north under the Campine Basin until the Roermond Graben, in the south at least under the northern half of the Namur Synclinorium and to the west under the North Sea into the concealed Caledonides of East-Anglia. The entire fold belt is called the Anglo-Brabant fold belt (Pharaoh *et al.*, 1993).

The Condroz Inlier is composed of at least four tectonic wedges carried along the Midi Overthrust in the Variscan deformation front: a northern part at Ombret, a major central part and two smaller southern parts, the Oxhe Inlier in the east and the Puagne area in the south-west. It contains only Ordovician and Silurian siliciclastic sediments of a deeper shelf facies, generally not turbiditic, except at Ombret.

The four Ardennes inliers are similar in composition: they contain a thick siliciclastic, often turbiditic sequence from the lowest Cambrian to the top of the Middle Ordovician. They are all situated in the Variscan Ardennes Allochton, previously also called Dinant Nappe, thrust from the south and south-east about ten to one hundred kilometres into their present position.

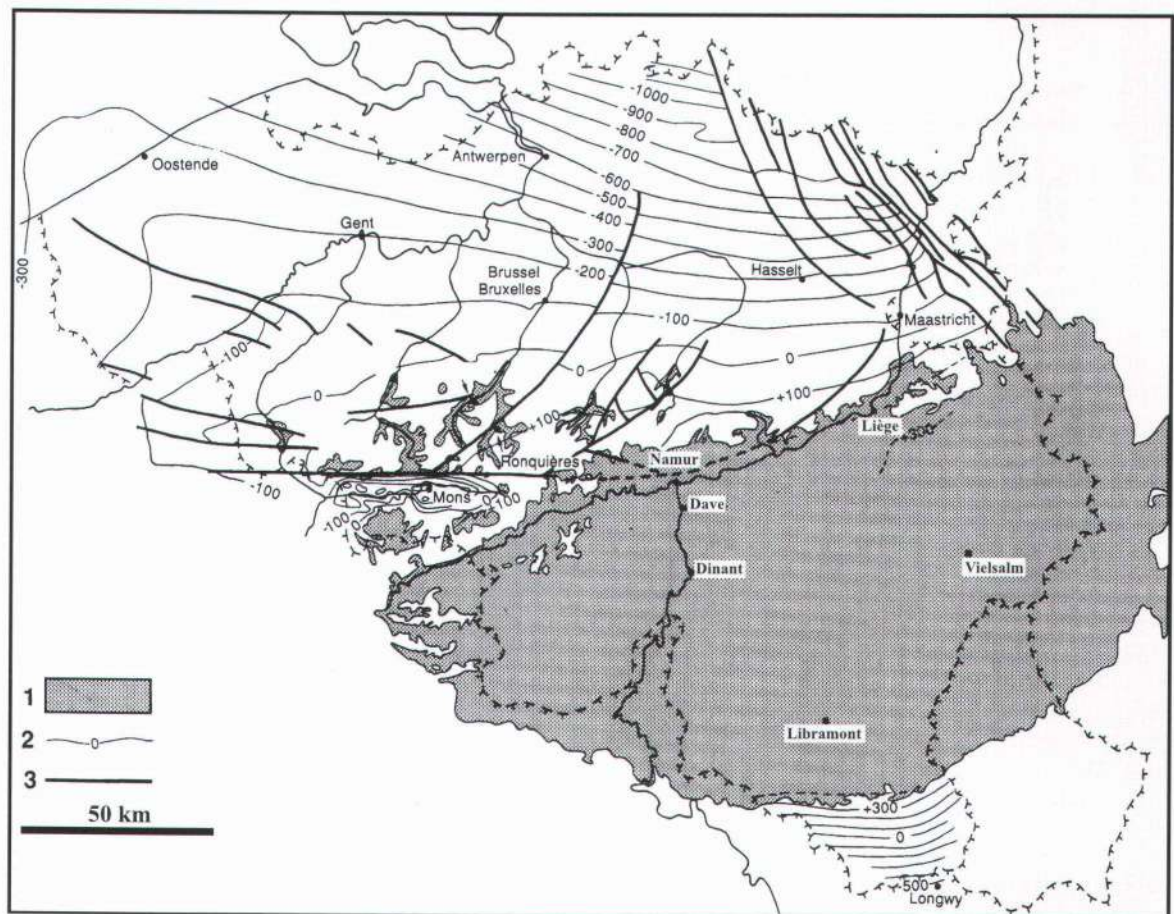


Figure 1. Top of Palaeozoic basement in Belgium. 1: outcrop area of Palaeozoic rocks; 2: isobath of the top of Palaeozoic basement under Mesozoic or Cenozoic cover; 3: faults (after Legrand, 1968 and Marechal, 1992).

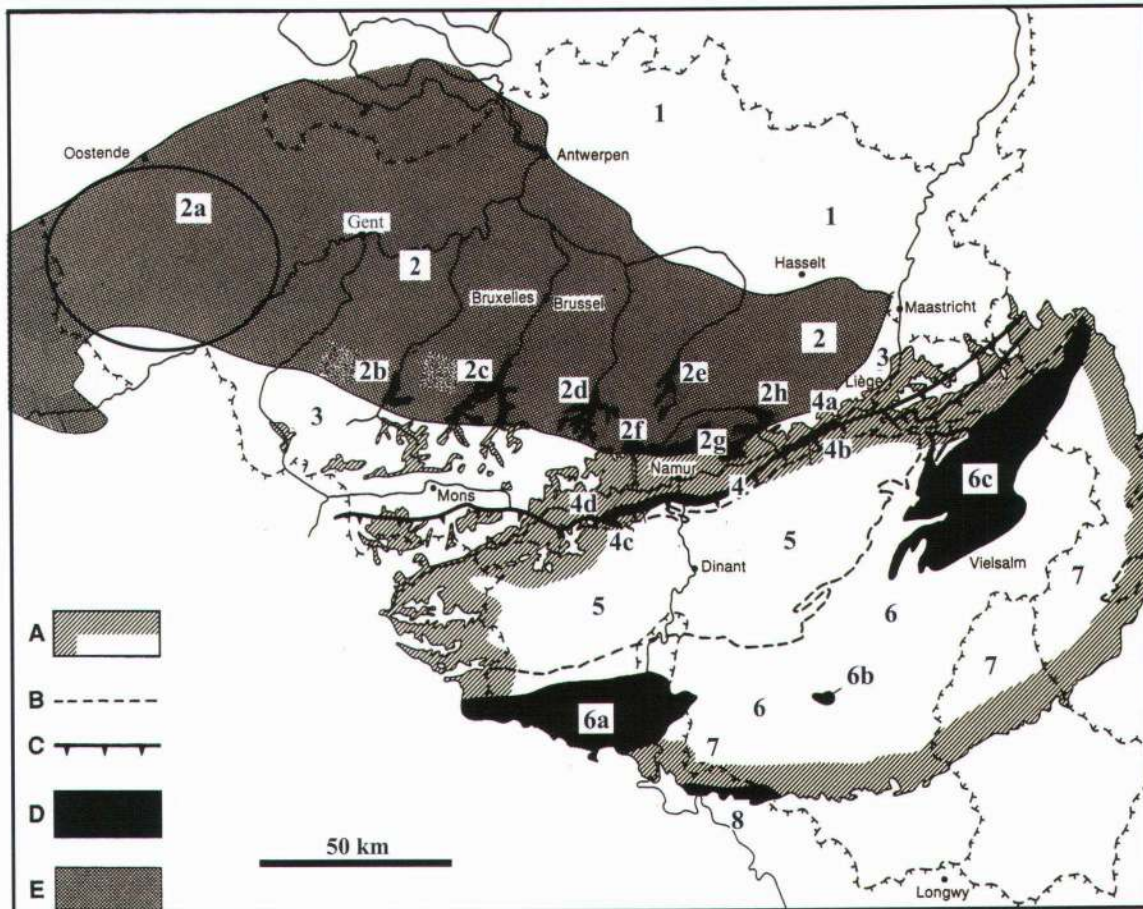


Figure 2. Large structural units in the Palaeozoic basement in Belgium. A: outcrop area of Palaeozoic rocks; B: Variscan Midi thrust fault and northern limit of the Variscan deformation front; C: Lower Palaeozoic outcrop area; D: Lower Palaeozoic Brabant Massif under Mesozoic/Cenozoic cover. 1: Campine Basin; 2: Brabant Massif with 2a: Western Flanders borehole area; 2b: Dendre valley; 2c: Senne basin, 2d: Dyle basin; 2e: Gette valley; 2f: Orneau valley; 2g: Landenne area; 2h: Mehaigne area; 3: Synclinorium of Namur; 4: Condroz inlier, with 4a: Ombret area; 4b: Fond d'Oxhe window; 4c: Puagne area, 4d: western end: Acoz area; 5: Synclinorium of Dinant; 6: Anticlinorium of the Ardennes with 6a: Rocroi inlier; 6b: Serpont inlier; 6c: Stavelot (-Venn) inlier; 7: Synclinorium of Neufchâteau or of the Eifel; 8: Givonne inlier. Units 2, 4, 6 and 8 contain Lower Palaeozoic rocks, the units 1, 3, 5 and 7 Devonian and Carboniferous rocks. The units 5, 6 7 and 8 are part of the Allocthon of the Ardennes. (after Marechal, 1992)

The Stratigraphic Subcommittee on the Lower Palaeozoic of Belgium has evaluated the descriptions of formations in the older and younger literature, the descriptions of units in publications in press or under study. It has put several units into synonymy with earlier described units, it abandoned units which are too large or too thin and it agreed on the following formations described below and located in the chronostratigraphy in figure 3 (details in Figs 4, 5 and 6). Syntheses on the Brabant Massif can be found in Legrand (1968) and De Vos *et al.* (1993), on its Ordovician in Servais *et al.* (1993), on its Silurian in Verniers and Van Grootel (1991), on the Stavelot Massif in Geukens (1986, 1999), on the Rocroi Massif in Beugnies (1963) and on the dating with acritarchs of the Ardennes Massifs in Vanguestaine (1992).

The boundaries of the Silurian system and its stages and substages have been accepted by the International

Commission on stratigraphy (see Holland & Bassett, 1989). For the definition of the chronostratigraphical boundaries of the Cambrian and Ordovician systems work is still in progress. For the Ordovician System the global chronostratigraphical version by Webby (1998) is used, next to the traditionally better known British chronostratigraphy as redefined by Fortey *et al.* (1995). The geological time scale of Gradstein and Ogg (1996) is used for the Cambrian series and stages and for the absolute time scale. No new abbreviations were attributed to unnamed members.

It should be mentioned that Precambrian rocks have never been proven in Belgium, except for some xenoliths in Ordovician intrusive rocks in the Brabant Massif dated with Proterozoic ages obtained by isotopic studies (André, 1991). The Jodoigne Fm and the bases of the mostly Lower Cambrian Blanmont and Tubize Fms and the Deville Group could range into the uppermost



Figure 3. Chronostratigraphical position of the Lower Palaeozoic lithostratigraphic units of Belgium. The genesis of the sediments is not studied in the Givonne and the Serpont area and only the lithology is shown. The succession of the two units in the Serpont area is debated (Beugnies, 1960 and Geukens & Richter, 1962). The latter authors consider the succession to be inverted from what is shown in the column. The fat rectangle in the Series column of the chronostratigraphy shows under 1 the British Ordovician chronostratigraphy revised by Fortey et al. 1995 and under 2 the position of the Llanvirn and Llandeilo stages, before the latter was abolished in 1995. Abbreviations: Prec.: Precambrian; Moridu.: Moridunian; Whitla.: Whitlandian; Fenn.: Fennian; Abereid.: Abereiddian; Aurel.: Aurelucian; Bur.: Burrellian; Chen.: Cheneyan; Stref.: Streffordian; Dev.: Devonian.

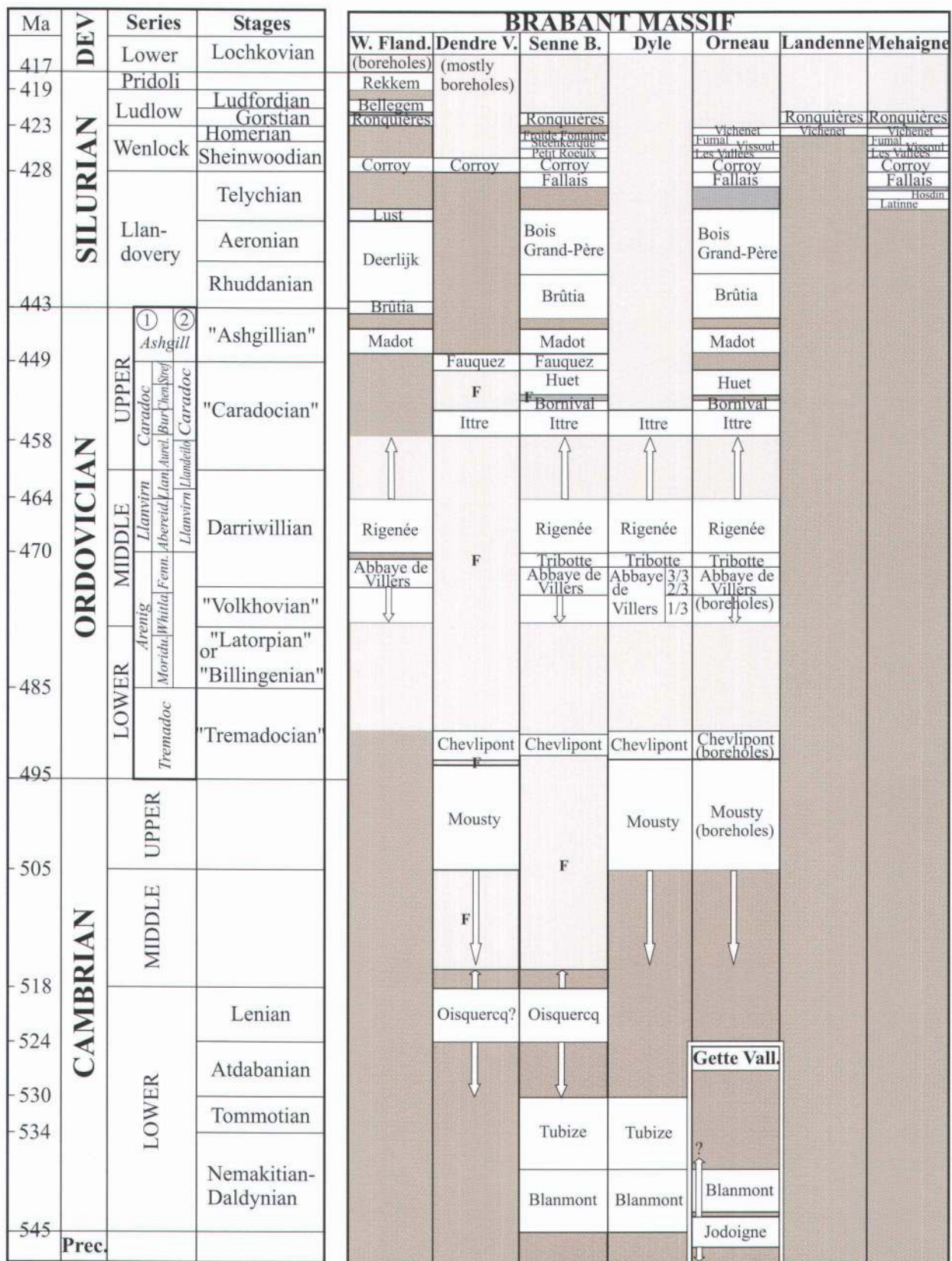


Figure 4. Chronostratigraphical position of the Lower Palaeozoic lithostratigraphic units in the Brabant Massif (detail of fig. 3).

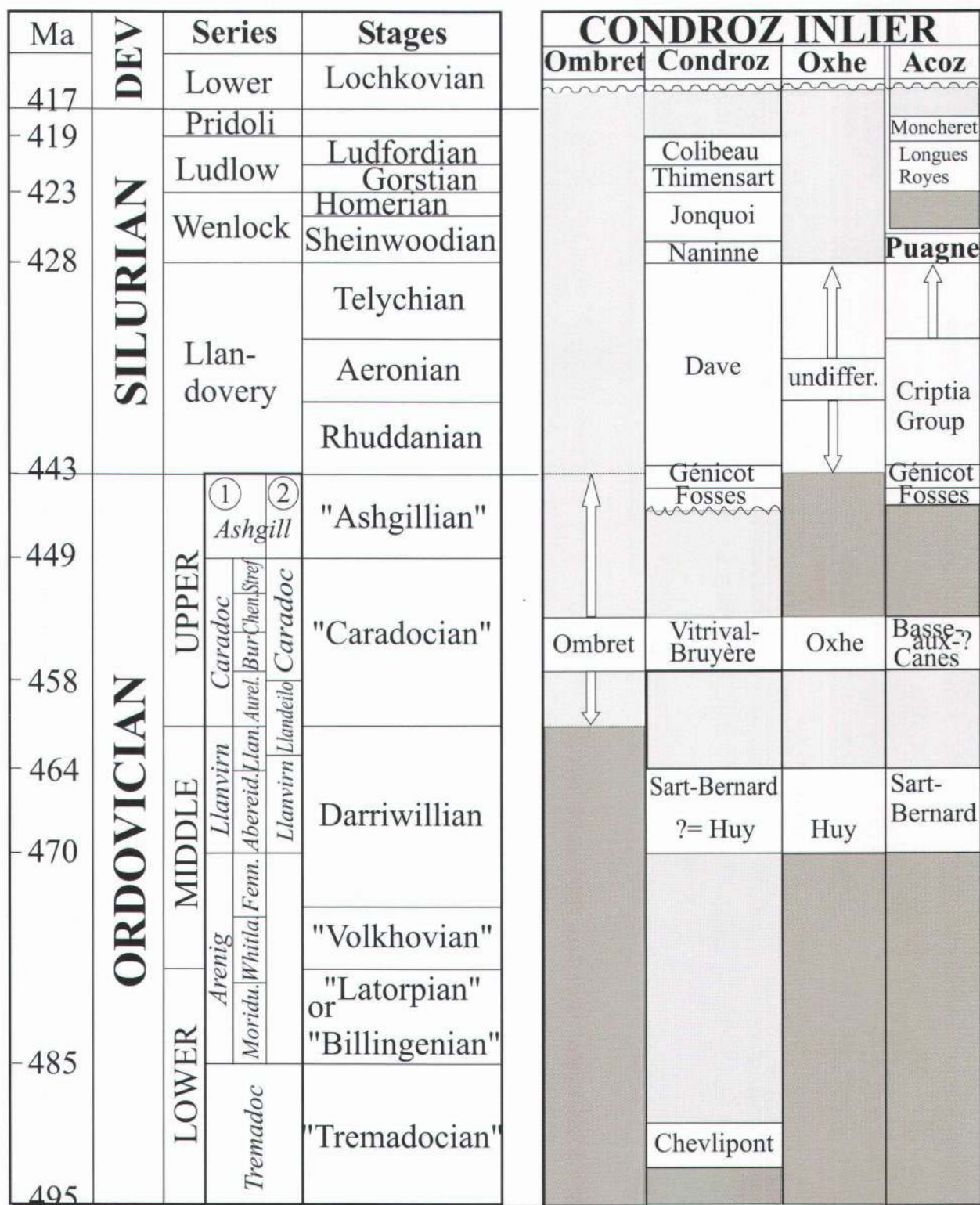


Figure 5. Chronostratigraphical position of the Lower Palaeozoic lithostratigraphic units in the Condroz inlier (detail of fig. 3).

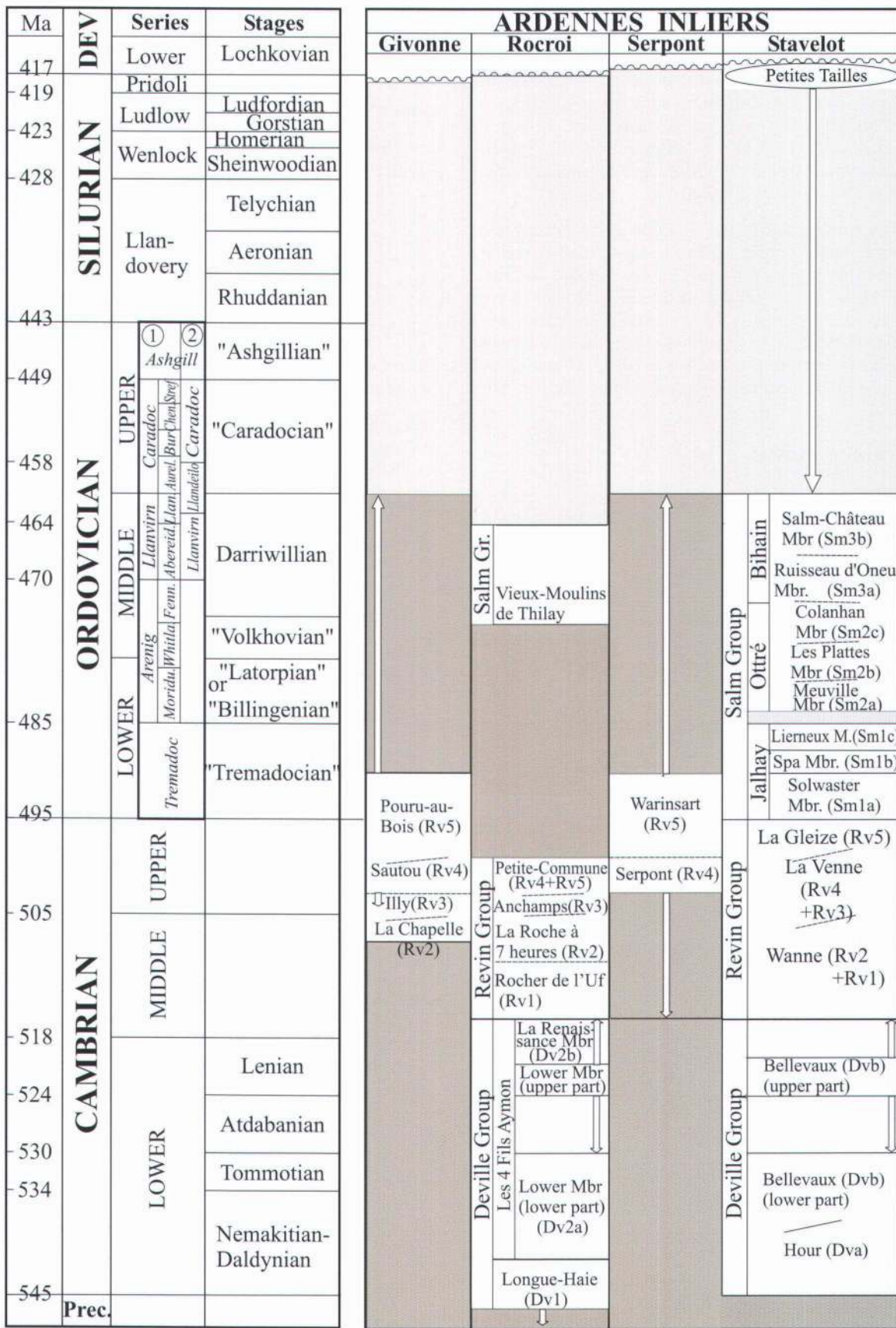


Figure 6. Chronostratigraphical position of the Lower Palaeozoic lithostratigraphic units in the Ardennes inliers (detail of fig. 3).

Neoproterozoic, but there is no evidence. The basement underlying the Lower Palaeozoic rocks in Belgium remains unknown.

It should also be mentioned that although some of the lowermost Devonian units have their bases in the uppermost Silurian, they will be discussed in the Lower Devonian section. The Les Tailles Fm in the Stavelot Massif with an age between Mid Ordovician and earliest Devonian is however described here.

The lithostratigraphy of the Condroz inlier has not been studied in detail during the last twenty years. A restudy will probably improve much of its descriptions and divisions. Most figures of the thickness of the units are estimates from geometry because only rarely the entire column of the unit is observable. The thickness is not corrected for compaction nor for tectonic thickening and hence should be regarded with a substantial range in error.

2. Brabant massif

2.1. Cambrian

2.1.1. Jodoigne Formation - JOD

Author: Malaise, 1883.

Description: Bluish grey or blackish slate sometimes pyritic, also black quartzite co-existing with light coloured quartzite. Neither the upper nor the lower boundary is observed.

Stratotype: Not yet defined; type area in the Gette valley near Jodoigne.

Area: In outcrops of the Jodoigne-Hoegaarden area, in a few boreholes near Gijzegem (De Vos *et al.*, 1993) and in the Hoesselt and Martenslinde boreholes (Dusar & Langenaeker, 1992).

Thickness: Not yet estimated.

Age: Unknown, because the formation cannot be dated palaeontologically. Several ages have been suggested, primarily based on lithological similarities with other formations or the geometrical relationship with the neighbouring formations. Malaise (1883) places the unit in the Blanmont Fm, in 1900 he places it as a separate unit below the latter formation and later in 1911 moves it in the Mousty Fm (cf. Fourmarier, 1920). Legrand (1968) considers the Jodoigne Fm (Rvb) older than the Mousty Fm (Rvc) but younger than the Oisquercq Fm (Rva). This stratigraphical position was accepted by De Vos *et al.* (1993). Dumont (1848) followed by Malaise (1900), Kaisin (1919), de la Vallée Poussin (1930), Raynaud (1952), Mortelmans (1955, 1977) and Lecompte (1957) consider the Jodoigne Fm as the oldest formation in the Brabant Massif (Dv0), older than the Blanmont Fm. In the latter hypothesis a Neoproterozoic or earliest Cambrian age is postulated.

Remarks: Magnetite was not observed. The unit was mined for roofing slates. Synonyms: "roches noires, phyllades et quartzites de Jodoigne" (Malaise, 1883);

"roches noires de Jodoigne" (Raynaud, 1952); "Assise de Jodoigne" (Legrand, 1968).

2.1.2. Blanmont Formation - BLM

Author: Malaise (1873).

Description: Mostly light-coloured, whitish, bluish, or greenish, massive, fine-grained quartzite. Stratification is not well marked, except by the presence of fine intercalations of grey or green compact slate. Earlier descriptions mention oblique stratification in coarse-grained arkose and also a fine-grained conglomerate (Orne and Gette). Magnetite was nowhere observed. The upper boundary with the Tubize Fm and the lower boundary with an unknown unit is nowhere observed.

Stratotype: Not yet defined; type area in the Orne valley (abandoned quarries and small outcrops).

Area: In the outcrop area of the southern border of the Brabant Massif: Senne, Dyle and Gette basins; many boreholes in the central part of the Brabant Massif.

Thickness: Not estimated.

Age: By the presence of the ichnofossil *Oldhamia*, first described by Malaise (1883), a Tommotian or Nemakitian-Daldynian age (early Early Cambrian) is proposed (A. Seilacher, pers. comm. 1998).

Remarks: Synonyms: Assise de Dongelberg (Legrand, 1968). The Rodenem, the Thorembais-St-Trond and the Jauchelette/Perwez facies (Nijs & Logier, 1990) are here all included in the Blanmont Fm.

2.1.3. Tubize Formation - TUB

Authors: Malaise, 1873; De Vos *et al.*, 1993; Herbosch, *et al.*, in press.

Description: The formation mainly consists of mudstone and siltstone, but sometimes also of sandstone, arkose, subarkose and greywacke, which is easily recognisable by the dominantly grey-green colour and the frequent presence of magnetite ("Assise de Tubize ou des quartzites et phyllades aimantifères" Malaise, 1879). Its best outcrop is in the Senne basin area, where Vander Auwera and André (1985) describe three new informal lithostratigraphic units: the lowermost Rogissart Unit, covered by the Fabelta Unit and the latter by the Forges Unit. The contacts between the members have nowhere been observed. Ongoing geological mapping (Herbosch, Ittre-Rebecq map) shows that the Rogissart Unit is sufficiently characteristic to define the Rogissart Member (ROG) and that the facies of the two other units correspond to the lower part of the "Assise de Oisquercq (Rva1)" as described by Legrand (1968, p. 15). Because magnetite is observed there, it seems more logical to include the latter unit in the upper member of the Tubize Fm: the Les Forges Mbr (FRG).

We agree with Legrand (1968) that a lowermost dominantly pelitic unnamed member occurs, although not often outcropping in the Senne outcrop area. The Rogissart Mbr contains light-coloured often greenish quartzitic sandstone, feldspathic sandstone, arkose, greywacke in

decimetric to metric beds, alternating with more or less clayey siltstone and green or rarely grey slate to claystone, together forming fining upward beds. Magnetite is often present, mostly in the siltstone or the slate. The coarser beds show plane bed (parallel), oblique and sometimes convolute laminations. The rhythmic sedimentation is interpreted as high density turbidite sequences of the Bouma (1962) type. In the Rogissart member, thick and coarse-grained sequences at the base seem to evolve upwards into thinner and finer-grained sequences.

In the Dyle outcrop area the general features such as green colour and presence of magnetite are present, with however an overall finer to clayey granulometry and without the arkose or coarse-grained greywacke of the thick Rogissart Mbr. Also the finer and sometimes grey-blue rocks of the Les Forges Mbr are absent. Possibly they belong to the unnamed lowermost member of the formation, here consisting of slate, massive or laminated siltstone with a few distal turbidite sequences. No contact is observed with the underlying Blanmont Fm or with the overlying Oisquercq Fm.

Stratotype: Not yet defined; typical facies in the Senne/Sennette basin around Tubize and in the Orne valley around Mont-St-Guibert.

Area: Brabant Massif: outcrop area: best developed in the Senne basin; also in the Dyle Basin; many boreholes in the central part of the Brabant Massif.

Thickness: Difficult to observe, but estimated to be much more than 1500 m, the Rogissart Mbr on its own is estimated to be about 800 to 1000 m thick.

Age: An Early Cambrian age is proposed because the only fossil present is the trace fossil *Oldhamia* (Malaise, 1883), a genus from the Lower and Middle Cambrian, not occurring below the Cambrian-Precambrian boundary (Crimes, 1992; Verniers & De Vos, 1995). According to new observations by A. Seilacher (pers. comm. 1998) *Oldhamia* sp. is more restricted in time and only present in the Tommotian or Nemakitian-Daldynian (early Early Cambrian), which is the proposed age of the formation.

Remarks: Synonyms: "Formation des quartzophyllades verts de Tubize" (Beugnies in Waterlot *et al.* 1973); the unnamed lower member "Rva1" of Legrand (1968) is considered a synonym of the Les Forges Mbr, Tubize Fm; "Tubize Group" (De Vos *et al.*, 1993).

2.1.4. Oisquercq Formation - OIS

Author: Malaise, 1873; Beugnies in Waterlot *et al.*, 1973; De Vos *et al.*, 1993; Herbosch *et al.*, in press.

Description: The Ripain Mbr (RIP), the lowermost of the two members in the formation, created by Beugnies in Waterlot *et al.* (1973), is made up of blue grey extremely homogeneous fine-grained slate (claystone). Stratification is very difficult to observe in the member. Green patches or pluricentimetric bands are frequently present and often unrelated to the bedding. The blue grey colour is very sensitive to weathering and can change

from purple over red to bordeaux red. The Asquemont Mbr (ASQ) is introduced here and forms the upper part of the formation, with its upper boundary formed by the Asquemont fault in the type area. It consists of greenish grey to green slate and frequently laminated siltstone. The transition between the two members is gradual over about ten meters and is only marked by a change of colour from greenish grey to bluish grey. The contact with the underlying Tubize Fm has nowhere been observed.

Stratotype: Not yet defined; type area in the Sennette valley between Oisquercq and Asquemont.

Area: Outcrop area on the southern border of the Brabant Massif: only in the Senne basin and in the Lessines borehole, Dendre valley (Herbosch *et al.*, 1991); in several boreholes to the west of the outcrop area (De Vos *et al.*, 1993).

Thickness: Difficult to estimate from the geometry, because of the poor stratification and the presence of folded zones; the presence of the Ripain Mbr in a 1600 m wide and generally steeply dipping band, suggests a thickness of more than 1000 m; the thickness of the Asquemont Mbr is estimated to be more than 500 m. There is a gradual transition of about 10 m between the two members.

Age: Based on acritarchs in the Asquemont Mbr in the Lessines borehole, Oudenaarde, Eine and Kruishoutem boreholes: latest Early Cambrian to Mid Cambrian (Vanguetaine, 1992); the Ripain Mbr is unfossiliferous and tentatively dated as late Early Cambrian.

Remarks: Synonym: "Formation des phyllades bleus de Ripain" (Beugnies in Waterlot *et al.*, 1973); "Formation du Ripain" (André *et al.*, 1991); "Oisquercq Group" (De Vos *et al.*, 1993). The Ripain Mbr and the Asquemont Mbr correspond respectively to the Rva2 unit and the Rva3 unit of Legrand (1968).

2.2. Cambrian/ordovician

2.2.1. Mousty Formation - MST

Author: Malaise, 1900.

Description: Shale or slate, sometimes mudstone, of grey-blue to grey-black colour, graphitic and pyritic. Massive bedded or finely laminated (with rhythmic variations in clay and organic matter content typical for black shale); stratification can also be marked by light or greenish coloured, more silty beds or laminae, or by banded, layer-parallel colour variations. Sometimes grey more or less clayey siltstone with pyrite occurs, and occasional centimetric to decimetric fining upward sandstone or siltstone bands, interpreted as distal turbidites. The high concentration of the element Mn is marked in outcrops by a black surface coating with an iridescent appearance and in thin sections by the presence of garnet and Mn-ilmenite. The middle part of the formation is clearly more silty with grey-black pyritic shale gradually passing downwards into a grey pyritic siltstone and sometimes a sandstone (Court-St-Etienne borehole). The

lower boundary is not observed. In the Dyle basin only faulted contacts with the underlying Tubize Fm are present. In the lower outcropping part of the formation occurs the Franquénies Mbr (FRQ) with siliceous beds or lenses of lydite within the typical black shale. The Tangissart Mbr (TAN), at the top of the formation, is characterised by an increasingly recurrent black shale or slate with abundant millimetric light-coloured silty laminae. The disappearance of the last black shale interval marks the boundary with the overlying Chevlipont Fm.

Stratotype: Not yet defined; the type area is in the Dyle-Thyle valleys; the Franquénies Mbr is defined in the old quarry at Franquénies, Cérroux-Mousty; the unnamed middle member is typical in the section at Km 31 and 32 of the railway between Court-St-Etienne to Genappe; the upper member, the Tangissart Mbr is defined along the railway Ottignies-Charleroi, north of the Laroche railway station, in the section between Km 36.20 and 36.15.

Area: Brabant Massif: outcrop area only in the Dyle basin; also in boreholes from Eine, Vollezele (Dender area), Leuven, Cortil-Noirmont and Sauvenière (north of Gembloux, Orneau Valley).

Thickness: Difficult to estimate; > 500 m is tentatively suggested.

Age: Mid Cambrian to the earliest Ordovician. Acritarchs from the top of the Mousty Fm, below the Tangissart Mbr, studied by Martin (1976), Vanguetaine *et al.* (1989) and Vanguetaine (1992 and unpublished data) indicate a Mid or Late Cambrian age. Graptolites (*Rhabdinopora* sp.) and acritarchs in the Tangissart Mbr prove the early Tremadoc age of that member (Lecompte, 1949; Martin, 1969a, b; André *et al.*, 1991).

Remarks: Synonyms: the Tangissart Mbr is a formal name for the informal "formation X" (in André *et al.*, 1991).

2.3. Ordovician

2.3.1. Chevlipont Formation - CHV

Authors: Anthoine & Anthoine, 1943, Martin, 1976, Servais *et al.* 1991.

Description: Grey siltstone (called "quartzophyllade" in older literature), with characteristic wavy bedding consisting of millimetric alternations of light grey siltstone and dark grey clayey siltstone and mudstone. Silty laminae occur characteristically in small lenses a few cm long and a few mm thick with oblique lamination. Small slumps occur frequently. This dominant facies, interpreted as low density turbidites (Stow model), can sometimes be replaced by decimetric beds showing graded bedding (sand fraction at the base to silt or clay at the top; typical Tede Bouma sequences) (Herbosch *et al.*, 1991). The lower boundary is gradual and marked by an upward increasing silt content and the disappearance of the black shale.

Stratotype: Not yet defined; type area in the Thyle valley, near Chevlipont, in the railway section between Court-St-Etienne and Fleurus, from Km 37.9 to 38.1.

Area: Present throughout the entire Brabant Massif: outcrop area: the Dender valley (Lessines borehole), the Marke, Senne and Sennette valleys and Dyle basins, and in many boreholes in the southern or northern part of the massif (see De Vos *et al.*, 1993). In the Condroz inlier: only in the Wépion Borehole (Graulich, 1961).

Thickness: In the order of 150-200 m in the Dyle valley, at least 92 m in the Lessines borehole (Herbosch *et al.*, 1991), at least 40 m in the Marke valley (Longueville, 1997 ms) and at least 140m in the Wépion borehole (Graulich, 1961).

Age: Early Tremadoc, for the lower part of the formation based on the presence of the dendroid graptolites *Rhabdinopora flabelliformis* ssp. *socialis* and *typica* (Lecompte, 1948, 1949), and based on acritarchs (Martin, 1969a, 1969b, 1976; Vanguetaine in André *et al.*, 1991).

Remarks: Synonyms: Part of the "Assise de Villers-la-Ville" (Malaise, 1911); "quartzophyllades de Chevlipont" (Anthoine & Anthoine, 1943); "quartzophyllades de Virginal" (Mortelmans, 1955), "couches de Chevlipont" (Michot, 1978); Virginal Fm (Servais *et al.*, 1993).

2.3.2. Abbaye de Villers Formation - ADV

Authors: Anthoine & Anthoine, 1943.

Description: Siltstone to mudstone, with a distinct lenticular lamination, grey or dark grey; frequent and abundant bioturbation often along bedding planes. Oblique stratification occurs in metric scale sets. The contact with the underlying Chevlipont Fm was nowhere observed, but it marks a very distinct sedimentological break.

In the Sennette valley just south of the Asquemont fault an unnamed member is present with decimetric grey quartzitic sandstone beds, often showing low amplitude convolute lamination, alternating with dark to medium grey siltstone and slate beds, unobserved in other units in the Brabant Massif; the lower or upper contacts are by faults and however not observable. The unnamed member is interpreted on the basis of the acritarch and the chitinozoan biozonations as either a lateral facies of the upper part of the Abbaye de Villers Fm or as a unit in between the Abbaye de Villers and the Tribotte Fms.

Stratotype: Thyle valley, just north of the old abbey of Villers, in the railway section between Court-St-Etienne and Fleurus, from Km 38.7 to 39.0.

Area: Outcrop area of the Brabant Massif: Senne and Dyle basins and the unnamed member in Sennette valley.

Thickness: Between 100 and 150 m with additionally > 25 m for the unnamed member.

Age: No macrofossils found. Chitinozoans in the lower third of the formation in the Dyle basin contain *Eremochitina brevis* (Samuelsson & Verniers, 2000), an

assemblage occurring in the Grès Armorica Fm in Brittany, indicating the middle Arenig, Whitlandian (*pro parte*) or possibly upper Arenig (Paris, 1981). Acritarchs in the middle and upper part of the formation indicate the upper Arenig or post-Arenig according to Martin (1976) and Vanguetaine (*in André et al.*, 1991), which is corroborated by the chitinozoans (Samuelsson & Verniers, 2000). One of the genera present, *Frankea*, does not appear below the uppermost Whitlandian, top middle Arenig, in levels of the upper part of the *gibberulus* graptolite zone, according to Servais (1993) and Brocke *et al.* (1995) or of the *hirundo* graptolite biozones upper Arenig. An important time gap is thus present between the Chevliopont and the Abbaye de Villers Fms. In the unnamed member no macrofossils are found. The acritarch assemblage is similar to the one in the Abbaye de Villers Fm and indicates an Arenig-Llanvirn age (Vanguetaine, 1978); the chitinozoans contain *Desmochitina ornensis* and *Conochitina pseudocarinata*, an assemblage occurring in Brittany above the Armorican Quartzite Fm (Paris, 1981) indicating a mid Arenig age (Samuelsson & Verniers, 2000).

Remarks: Synonyms: "Assise de Villers-la-Ville" (Malaise, 1911); "quartzophyllades siliceux de Villers" (Anthoine & Anthoine, 1943); "couches de l'Abbaye" (Michot, 1978); Abbaye de Villers-la-Ville formation (André *et al.*, 1991; Servais *et al.*, 1993); Senne valley: part of the "quartzophyllades zonaires de Quenast" (Beugnies *in* Waterlot *et al.*, 1973); lower part of the Quenast Fm (André *et al.*, 1991; Servais *et al.*, 1993). Synonyms of the unnamed mbr: Rv2, formation des phyllades et des quartzites noirs" (Beugnies *in* Waterlot *et al.*, 1973), "Grès noirs zonaires, quartzophyllades et phyllades noirs (Vanguetaine, 1978), unnamed (Asquempont) unit (Samuelsson & Verniers, 2000).

2.3.3. Tribotte Formation -TRO

Authors: Anthoine & Anthoine, 1943.

Description: In the Dyle basin the lower third contains brownish grey, clayey sandstone and siltstone with coarse laminations strongly bioturbated; some beds have metrical scale oblique stratification. The upper two thirds show yellowish grey to greenish grey sandstone and siltstone, clearly more clayey than below. Bioturbation is rather strong with dominating oblique to vertical burrows ("Fucoïdes" of the older literature). The upper part shows typical structures (as vertical bioturbation, flaser bedding) indicating an intertidal environment of deposition. In that upper part a rather mature, bioturbated, light grey, sandstone can be observed locally (called "grès et psammite de Strichon" by Anthoine & Anthoine, 1943). The lower boundary of the formation is gradual with an upward increasing sand fraction.

Stratotype: Not yet defined; type area in the Thyle valley, around the village Villers-la-Ville; lower third between the old abbey of Villers and the village Villers-la-Ville; upper two thirds around Gentissart in the railway section between Court-St-Etienne and Fleurus, from Km 42.6 and 42.7.

Area: Outcrop area of the Brabant Massif: Senne, Dyle basins and Orneau valley.

Thickness: 200 to 300 m in the Dyle basin and 150 to 200 m in the Senne basin.

Age: No macrofossils or acritarchs observed; a poor chitinozoan assemblage containing *Euconochitina vulgaris* indicates a mid Arenig to early Llanvirn age (Verniers, *et al.* 1999; Samuelsson & Verniers, 2000).

Remarks: Synonyms: "Assise de Villers-la-Ville" (Malaise, 1911), "Psammite de Tribotte et Grès et psammite de Strichon" (Anthoine & Anthoine, 1943), "Assise du Tribotte" (Michot, 1978), part of the "quartzophyllades zonaires de Quenast" (Beugnies *in* Waterlot *et al.*, 1973); (sandy) upper part of the "Formation de Quenast" (André *et al.*, 1991; Servais *et al.*, 1993).

2.3.4. Rigenée Formation - RIG

Authors: Malaise, 1909; Servais, 1993.

Description: Dark grey to bluish grey slate or mudstone, vaguely coarsely laminated or without any stratification, bearing locally pyrite. The lower boundary of the unit marks a rapid and sharp upward change from light clayey siltstone to dark mudstone, probably corresponding to a rapid increase in water depth.

Stratotype: Not yet defined; type area in the Thyle valley, north of Rigenée in the Vallon des Goutailles.

Area: Outcrop area of the Brabant Massif: Senne and Dyle basins and Orneau valley.

Thickness: 150 to 200 m in the Dyle valley, about 150 m in the Senne valley, > 80 m in the Sennette valley (Debacker *et al.* 2001; Debacker: unpublished data) and estimated at about 150 to 200 m in the Orneau valley.

Age: Probably Llanvirn; graptolites in the lower or middle part of the formation in the Sennette valley belong to the lower Llanvirn *D. artus* Biozone according to Martin and Rickards (1979) or after a restudy of the fauna by Maletz and Servais (1998) attributed to the *D. artus* and the *D. purchisoni* Biozones, corresponding to the entire Abereiddian (lower Llanvirn). Acritarchs from the Dyle basin indicated an (early) Llanvirn age (Martin, 1969a). Acritarchs studied by Servais (1993) indicate that for the base of the formation a late Arenig or younger age cannot be excluded. Higher levels of the formation seems to have (at least) a late Llanvirn or younger age indicated by the presence of *Frankea hamulata*, a species not found in rocks older than upper Llanvirn. A poor assemblage of chitinozoans with *Lagenochitina obelgis* and *Cyathochitina calix* indicates the same large age bracket (Verniers *et al.*, 1999; Samuelsson & Verniers, 1999, 2000).

Remarks: Synonyms: "Unité D" (Martin & Rickards, 1979; "Formation de La Tourette" (Lenoir 1987 ms; Servais *et al.*, 1993).

2.3.5. Ittre Formation - ITT

Authors: Beugnies in Robaszynski & Dupuis, 1983, fig. 9; Servais *et al.*, 1993.

Description: Alternation of distinct laminae or beds, with sharp bedding planes, of light grey fine sandstone, medium grey siltstone, and dark grey mudstone. The sandstone beds are often > 5 cm thick up to pluridecimeteric and show parallel, oblique and convolute lamination, fining upward graded bedding, with load casts and other current marks at their base; the siltstone shows parallel lamination and the mudstone no stratification. They are deposited as turbidites of the BOUMA type. The occurrence of a megaslump within the Ittre and the Bornival Fms has been observed in the Sennette valley (Debacker *et al.*, 2001). Thin volcanic tuffs or volcano-sedimentary beds have been described in the basal part of the formation in the Sennette valley (Corin, 1964; Martin & Rickards, 1979).

Stratotype: Sennette valley, along the large canal section south of Asquempont, on the territory of Ittre.

Area: Brabant Massif: Lessines borehole (Dender), Senne and Dyle basins and Orneau valleys in the outcrop area.

Thickness: estimated > 180 m in the Sennette valley (Debacker *et al.*, 2001; Debacker: unpublished data); > 82 m thick in the Lessines borehole, Dender valley (Herbosch *et al.*, 1991); not possible to estimate in the Dyle or Orneau valleys.

Age: Graptolites described by (Martin & Rickards, 1979 and Degardin in Herbosch *et al.*, 1991) indicate a Caradoc age and redescribed by Maletz and Servais (1998) indicate the *gracilis* or *multidens* Biozone (Aurelucian or Burrellian), with a preference for the latter biozone. The chitinozoans, moderately well preserved and diverse with the presence of *Belonechitina* cf. *robusta* indicate a Burrellian age. Both fossil groups together indicate a Burrellian age (Caradoc) (Verniers *et al.*, 1999; Samuelsson & Verniers, 2000).

Remarks: Synonyms: "Assise de Gembloux" (Malaise, 1911); "S11c, Llandeilien, formation des phyllades et quartzophyllades noirs à *Nemograptus gracilis*" (Beugnies in Waterlot *et al.*, 1973, fig. 48); "unité F" (Martin & Rickards, 1979); "Assise d'Ittre" (Beugnies in Robaszynski & Dupuis, 1983, fig. 9).

2.3.6. Bornival Formation - BNV

Authors: Van Grootel *et al.*, 1997; Van Grootel & Verniers, 1998 ms.

Description: A centimetric alternation of dark grey micaceous siltstone and dark grey to blackish mudstone with abundant silt grains distributed throughout; the bedding planes are rarely sharp and mostly gradual; occasional very fine sandstone beds, laminated or finely obliquely stratified and never > 5 cm in thickness. In the Sennette valley the formation can be subdivided into (at least) 3 members. The unnamed lower member can contain centimetric siltstone nodules irregularly distributed in the dark

grey mudstone. The unnamed middle member shows on some of the bedding planes small-scale ripples. Some isolated patches of millimetric to sub-millimetric pyrite crystals occur parallel to the bedding. In the unnamed upper member the sediments are finer grained: the very faint centimetric lamination caused by the varying amount of fine silt grains occurs in very dark grey to black shale. Brachiopods and ichnofossils are present only in the lower member while no macrofossils have been observed in the other two members. The megaslump affecting the Ittre and the Bornival Fms in the Sennette valley occurred between the deposition of the lower and the middle members (Debacker *et al.*, 2001). In the Orneau valley, a medium to dark grey mainly silty unit apparently overlays the Ittre Fm, and shows indistinct centimetric laminations without sandstone beds. It weathers often to light yellowish or greenish colours. Because of fault contacts, neither the lower boundary, supposedly with the Ittre Fm, nor the upper boundary, supposedly with the Huet Fm, is observed. Also the boundaries between the three members is unobserved because of the presence of fault contacts.

Stratotype: Not yet defined; type area in the Sennette valley, along the southern half of the large canal section south of Asquempont and in the Fauquez area, along the abandoned railway section north of the abandoned Huet quarry and in the crags at the crossing of the Ri de Fauquez and the Rue de Bornival.

Area: Sennette and Orneau valley.

Thickness: Estimated in the Sennette valley at minimum 244 m (lower member: minimum 95 m; middle member: minimum 85 m, upper member: about 64 m).

Age: No macrofossils were found and only chitinozoans were recovered. There is a significant break in composition of the chitinozoan assemblages in comparison with the three covering formations. The assemblages are poorer than in the Huet Fm and contain no *Lagenochitina baltica* or *L. prussica*. Samples contain *Belonechitina* cf. *robusta*, *Lagenochitina dalbyensis* and *Belonechitina hirsuta*. The latter two are the index species of Baltoscandian subzones from the Idavere stage, lower-middle Caradoc. A similar assemblage is also found in the Ittre Fm and in the equivalent Unit II of the Lessines borehole. It shows that there is a large stratigraphical hiatus between the Huet and the Bornival Fms (Van Grootel & Verniers, 1998 ms).

Remarks: Synonyms: the "Formation de Pierre de Gembloux" (Michot, 1980) and the Moulin Fm (Michot, 1980; Servais *et al.*, 1993) are probably parts of the formation. The name derives from the Rue de Bornival at Fauquez, where the type locality of member 2 is located.

2.3.7. Huet Formation - HUE

Authors: Van Grootel *et al.*, 1997; Van Grootel & Verniers, 1998 ms.

Description: Greenish to grey mudstone, siltstone and fine sandstone, poorly sorted, with characteristic orange-yellow alveoli of decalcified fossil fragments;

heterogeneous sub-metrical beds, with a faint fining upward granulometry, often a slightly undulating base, sometimes vague oblique stratification; some levels are rich in (often) decalcified macrofossils (bryozoans, brachiopods, crinoids, cystoids or trilobites); at the base of the beds the macrofossils are often fragmented. All the features mentioned point to a tempestite deposit. The base of the formation is not observed due to presence of faults, the top is observed via a rapid transition with the Fauquez Fm.

Stratotype: Sennette valley, in the Fauquez area, along the abandoned railway section and in the abandoned Huet quarry, 230 to 300 m north of the railway bridge in Fauquez.

Area: Sennette valley; Nivelles area; Orneau valley; possibly in boreholes of Western Flanders (Legrand, 1968).

Thickness: Sennette valley: minimum 60 m (Van Grootel *et al.*, 1997; Van Grootel & Verniers, 1998 ms).

Age: The brachiopods suggest a Caradoc or Ashgill age for the formation (Maillieux, 1926a). The cystoids from the Sennette and the Orneau valley studied by Regnell (1951), indicate an (upper) Caradoc age. The trilobites from the Orneau valley at the Lefèvre quarry, studied by Maillieux (1926a) indicated a (mid) Caradoc age. A new collection of trilobites in Grand-Manil studied by Richter and Richter (1951), point to an (early) Ashgill age. The location of the new collection is unclear and one cannot exclude that it was sampled from the covering unit, the Madot Fm. The chitinozoan assemblages containing abundantly *Lagenochitina baltica*, *L. prussica*, *Belonechitina robusta* and *Tanuchitina bergstroemi* indicate undoubtedly a late Caradoc; from which a latest Oandu (early Cheneyan, late mid Caradoc) as the oldest possible age for the Huet Fm is concluded in relation to the Baltoscandian stages (Van Grootel *et al.*, 1997; Van Grootel & Verniers, 1998 ms).

Remarks: Synonym: "Formation de la grauwacke fossilifère de Fauquez" (Leriche, 1920).

2.3.8. Fauquez Formation - FAU

Author: Maillieux, 1926a; Herbosch *et al.*, 1991; Van Grootel *et al.*, 1997; Van Grootel & Verniers, 1998 ms.

Description: Centimetric to subcentimetric alternation of black slate and dark grey silty slate; lamination often present and marked by millimetric to sub-millimetric pyrite crystals. From about 4 m above the base abundant graptolites are found. The rhythmicity, enhanced by the numerous pyrite levels, and the presence of rich graptolite levels point to a low-density turbiditic environment (Herbosch *et al.*, 1991). The dark colour indicates anoxic conditions. The lower limit is a rapid transition, with a distinct change in the granulometry, colour and strata thickness changing from decimetric in the Huet Fm to centimetric or millimetric in the Fauquez Fm. The upper limit of the Fauquez Fm with the Madot Fm is unobserved but supposed to be gradual.

Stratotype: Section in the sunken road "rue de Fauquez", the hamlet Fauquez, east side of the Sennette valley, territory of Ittre.

Area: Dender valley (described as "Unité I", in the Lessines borehole by Herbosch *et al.*, 1991) and Sennette valley.

Thickness: > 35 m in the Sennette valley (Van Grootel & Verniers, 1998 ms); > 58 m thick in the Lessines borehole, Dender valley (Herbosch *et al.*, 1991).

Age: The graptolites in the Dender valley and Sennette valley indicate a *clingani* or *linearis* biozone (Elles in Maillieux, 1926a, 1930a). A restudy by Bulman (1950) indicated the *clingani* biozone for the Dender valley and the *linearis* biozone for Fauquez in the Sennette valley. Maletz and Servais (1998) could not observe the nominal species of the biozone(s) after restudy of the collections but concluded to an assemblage possibly belonging to the *Pleurograptus linearis* and/or upper part of the *Dicranograptus clingani* Biozone (corresponding to the upper Caradoc and lowermost Ashgill of the British chronostratigraphy). The chitinozoans of the Fauquez Fm contain *Lagenochitina baltica*, *L. prussica*, *Belonechitina robusta* and *Tanuchitina bergstroemi* indicating undoubtedly a late Vormsi to early Pirlgu in terms of Baltoscandian stages, confirming the late Streffordian to early Pusgillian, latest Caradoc to earliest Ashgill time bracket obtained from the graptolite biozonation (Van Grootel *et al.*, 1997; Van Grootel & Verniers, 1998 ms).

2.3.9. Madot Formation - MAD

Authors: Van Grootel *et al.*, 1997; Van Grootel & Verniers, 1998 ms.

Description: Unit containing many volcanic rocks (volcanic breccias containing shale fragments and volcano-sedimentary rocks), interstratified with greenish-grey heterogeneous coarse siltstone and mudstone rich in macrofossils such as bryozoans, brachiopods, crinoids, trilobites, rugosa corals and pelmatozoans; also interstratified in black, dark grey to bluish shale and fine siltstone which often contain dispersed single crystals of volcanic origin. The upper boundary of the formation is limited by a fault in the Sennette valley; the lower boundary with the Fauquez Fm is probably gradual but not observed until now. Subdivided in the Sennette valley into 7 members; member 1: dark grey to bluish shale and fine siltstone, with no stratification observed and characteristic presence of large, coarse sandy grains, single or in clusters up to 25 cm long, interpreted as volcano-clastic material incorporated in the mud matrix; contact with member 2 is quite sharp. member 2: at least 7 sequences of poorly sorted grey greenish siltstone, sandstone and conglomeratic levels of volcano-clastic origin with a thin marine shale interval; the conglomerate contains centimetric to sub-centimetric shale clasts. member 3: homogeneous black to dark grey shale; the contact with the underlying member 2 is clear and the overlying member is abrupt. member 4: greenish-grey heterogeneous coarse siltstone with at its base a 10 cm thick coarse, breccia-like interval with clasts of

pelite or of probably volcanoclastic origin; no stratification observed; numerous macrofossils such as bryozoans, brachiopods, crinoids or trilobites; gradual change over 10 m to the covering member. member 5: dark grey to black shale dotted with clusters of light grey grains. In the upper part of the member a coarse, sandy bed is present. Within this unit a large boulder (>1 m) of volcanic origin can be observed. There is an abrupt transition to the coarse volcano-sedimentary rock of the overlying member. member 6: dacite, dacitic volcanic breccias, sometimes containing shale or slate fragments, volcano-sedimentary rocks and black shale. member 7: dark grey to black silty shale dotted with brownish to orange alveoli, caused by the dissolution of calcareous fossil fragments or the alteration of volcano-clastic grains or minerals.

Stratotype: Sennette valley, on the east side, close to the locality Madot, in the sections south of the Fauquez bridge along the canal between km 38.06 and 37.81, and on the west side of the valley in the crags of the Bois des Rocs.

Area: Senne and Sennette valleys, Nivelles area and Orneau valley; probably also in many boreholes in the central part of West-Flanders and southern East-Flanders; the Lichtervelde Fm in the Lichtervelde borehole (-291 to 415,10 m) is equivalent in definition (Legrand, 1964, 1966 in Martin, 1969a). The latter formation is not kept as a valid unit, because unfortunately few core samples are kept at the Belgian Geological Survey, a prerequisite for formal status of the unit. Also, according to the stratigraphic guide (Hedberg, 1976), stratotypes in outcrops are preferred to stratotypes in boreholes. Therefore the (junior synonym) Madot Fm is preferred.

Thickness: About 100 m on the east side of the Sennette valley and > 220 m on the west side of the valley, due to a marked thickness increase of the volcanics of member 6 (only 10 m in the east and estimated at > 130 m in the west in the Bois des Rocs). member 1: estimated at 85 m, member 2: 24 m, member 3: 7-10 m, member 4: about 52 m, member 5: 28-45 m, member 6: > 50 m and member 7: tentatively estimated at > 40 m.

Age: Macrofauna and flora include crinoids, bryozoans, brachiopods, trilobites, corals and pelmatozoans. The trilobites determined by Richter and Richter (1951), possibly deriving from this formation in the Orneau valley indicate an early Ashgill age. Graptolites are absent in the outcrop area but were found in several levels in the Lichtervelde borehole and were restudied by Maletz and Servais (1998). They belong for the middle part of the formation in the borehole to the *D. complanatus* biozone and for the top of the formation in the borehole to the *D. anceps* biozone (coarsely middle part of the Ashgill). Chitinozoans are the only (micro) fossil group providing an age for the outcrop area, by the presence of *Tanuchitina bergstroemi*, *Lagenochitina baltica*, *L. prussica* and *Belonechitina robusta* indicating possibly the Upper Vormsi or lowermost Pirgu of the Baltoscandian stages, latest Caradoc to early Ashgill age, correlated with the upper *linearis* and *complanatus* graptolite biozones.

2.4. Ordovician/Silurian

2.4.1. Brütia Formation - BRT

Authors: Delcambre & Pingot, in press a.

Description: The lower unit contains (greenish) medium to dark grey mudstone and slate, compactly bedded. At one third up in the unit, a mottled grey mudstone member occurs, a few meters thick, consisting of dark grey lenses (about 1-2 mm wide and 2-5 mm long) in a medium grey mudstone, interpreted as a bioturbation (*Chondrites* sp.). The fine-grained quartzitic tuff, very hard, white, light pink or yellow is the topmost part of the formation; by weathering it is transformed into kaolinite. It has locally been exploited by the ceramic industry.

Stratotype: Not yet defined; type area in the Orneau valley, Gembloux, hamlet of Grand-Manil, between the localities Try-al-Vigne and Brütia.

Area: Brabant Massif, outcrop area: Orneau valley and Thisnes valley (Monstreux-Nivelles); absent in the Sennette valley, due to the presence of faults.

Thickness: In the Orneau valley for the formation between 80 and 100 m, with about 40 m for the eurite of Grand-Manil in the Orneau valley (Delcambre & Pingot, in press a) and about 50 m for the eurite layer in the Nivelles area (Mourlon, 1900).

Age: Trilobites in the lower/middle part of the formation were described by Malaise (1903) without giving an age. The chitinozoans from the mottled mudstone member are dominated by *Belonechitina* cf. *gamachiana*, indicating a mid or late Ashgill, possibly Hirnantian age (Samuelsson & Verniers, 1999, 2000). Graptolites described from the top of the formation in slates below the eurite of Grand-Manil member in the Orneau valley, belong to the *C. cyphus* Biozone (Elles in Maillieux, 1930a). Graptolite collections in the same levels mentioned in Gerlache (1956) and determined by Bulman (1950) as *C. scalaris* indicated the *acuminatus* Biozone (basal graptolite biozone of the Rhuddanian) or slightly above or below. The graptolites described from within the eurite of Nivelles member indicated undoubtedly a *C. vesiculosus* Biozone (Rickards in Verniers & Van Grootel, 1991). The determinations from both valleys indicate a Rhuddanian (Early Llandovery) age for the top of the unit. A mid Ashgill ranging to the Rhuddanian age is proposed for the formation.

Remarks: Synonyms: lower part of the "Assise de Grand-Manil"; the upper volcanic layer has been called Eurite of Grand-Manil or Eurite of Nivelles.

2.5. Silurian

2.5.1. Deerlijk Formation - DEE

Authors: Legrand, 1966; Martin, 1969a.

Description: Mostly grey shale unit, with centimetric to sometimes decimetric alternation of thin fining upward

cycles from light grey fine sandstone to medium grey shale, and dark to black graptolitic shale.

Stratotype: Deerlijk, NW of Kortrijk; Van Neste-Verwee borehole (BGS N° 83E404) between depths of -150 to -188,25 m.

Area: Area in the subsurface of the SW of the Brabant Massif.

Thickness: > 83 m.

Age: Graptolites described by Legrand (1966, 1968) indicated the *acuminatus*, *vesiculosus* and *cyphus* biozones (Rhuddanian) and the *gregarius*, *convolutus* and *sedgwicki* biozones (Aeronian). A restudy by Maletz (1999) of the lower Rhuddanian Deerlijk 404 borehole confirmed the presence of the *acuminatus* (from the middle part upward) and the *vesiculosus* biozones; however the base of the Silurian is not reached in this borehole. A restudy of the graptolites in the Aeronian in boreholes by Zalasiewicz (*in* Van Grootel *et al.*, 1998), recognised the *triangulatus*, *magnus* and? *leptotheca* biozones (previously parts of the *gregarius* biozone), also the *convolutus* and *sedgwicki* biozones. The chitinozoans belong to the *maennili* and *alargada* global biozones (Van Grootel, 1990 ms; Van Grootel *et al.*, 1998). Both groups prove the presence of Rhuddanian and Aeronian (lower and middle Llandovery).

2.5.2. Lust Formation - LST

Authors: Legrand, 1961a; Martin, 1969a.

Description: Shale mostly light grey, sometimes very light greenish grey, seldom black, interbedded by many fine layers or laminae of clayey siltstone or fine sandstone, finely laminated. It differs from the Deerlijk Fm by the large relative proportion of sandstone beds (Legrand, 1961a; Martin, 1969a).

Stratotype: Kortrijk, brewery Lust borehole (BGS N° 83W44) between depths of -150 to -190 m.

Area: Area in the subsurface of the SW of the Brabant Massif (Kortrijk, brewery Lust borehole, St-Antonius borehole; Steenkerke borehole).

Thickness: > 54 m.

Age: Graptolites described by Legrand (1961a) indicated a *M. turriculatus* and *M. crispus* biozones; after a restudy by Zalasiewicz *in* Van Grootel *et al.* (1998) the *guerichi* biozone (lower part of the "traditional" *turriculatus* biozone) with the *gemmatus*,? *renaudi* and? *utilis* subzones and the *crispus* biozone were recognised. The rich chitinozoan assemblages indicate a *E. dolioliformis* global biozone. Both groups indicate the lower half of the Telychian (upper Llandovery) (Van Grootel, 1990 ms; Van Grootel *et al.*, 1998).

2.5.3. Bois Grand-Père Formation - BGP

Authors: Delcambre & Pingot, *in press a*.

Description: Mostly medium to dark grey shale or slate unit, dark greenish grey at the base; at certain levels

interbedding of many medium grey laminated siltstone beds and light coloured quartzitic very fine sandstone, a few to 20 cm thick, showing lamination or fine oblique stratification with undulating bedding planes; some beds can be calcareous; at least partly deposited as turbidites. The lower boundary is taken above the Eurite of the Grand-Manil member. The upper boundary is not observed.

Stratotype: Orneau valley, east side; small abandoned quarries and outcrops a few hundred meters south of the hamlet Grand-Manil and the localities Tri à la Vigne and Brütia.

Area: Brabant Massif: not observed in the Senne and Sennette valleys, probably due to faulting; present in the Thisnes valley (Nivelles) and the Orneau valley; possibly in the 8 km long subcrop infiltration galleries of Voroux-Goreux, where spilitic pillow lava and basalts were described (De La Vallée-Poussin & Renard, 1876). Some similarities of the Bois Grand-Père Fm exist with the Deerlijk and Lust Fms from the subsurface in the SW of the Brabant Massif, e.g., the dominantly grey colour, the thin bedded obliquely stratified fine sandstone beds alternating sharply with the thin shale/slate beds. However the high proportion of dark graptolitic shale in the subsurface of Western Flanders is not observed in the few outcrops present in the Orneau valley. Hence a separate unit is maintained. The emendation by Legrand 1961b, to include also higher laying green shale units into the formation, is not maintained; the latter units are placed in the Fallais Fm.

Thickness: About 200 m (Delcambre & Pingot, *in press a*); estimated at 375 to 500 m (Verniers, unpublished).

Age: Graptolites have been described earlier from the *cyphus*, the *convolutus* and the *crispus* biozones (Mailieux, 1930a, 1930b, 1933; Michot, 1930). A mid Rhuddanian to mid Telychian age is tentatively proposed.

Remarks: Equivalent to part of the "Assise de Grand-Manil" (Malaise, 1900), which contains too many lithologies to be kept as a unit. The lower part is now incorporated in the Madot and Brütia Fms, and the highest light green shale or slate part in the Fallais Fm.

2.5.4. Latinne Formation - LAT

Author: Verniers, 1976 ms, 1983a.

Description: Dark greenish grey or medium to dark grey, mudslate, siltslate and fine siltstone, quartzitic sometimes calcareous; Tde sequences thin to medium thick (average thickness of at least 20 cycles: 11-19 cm); Tcde sequences very often present (38-61% of all sequences) with about the same average thickness approaching that of Tde sequences (on average 20% thicker); with thin c-divisions (0.5 to 6 cm); lower and upper boundary unknown; contact via fault with supposedly covering Hosdin Fm.

Stratotype: Village Latinne, sections in the talus of the road, west of the small hamlet Les Ruelles; outcrops GH-3 and GH-9 in Verniers 1983.

Area: Until now only observed in the Mehaigne valley.

Thickness: Recorded sections: 22.6 m, outcropping sections: 27.6 m, formation: estimated at least 180 m.

Age: Telychian, upper Llandovery based on chitinozoan assemblage with *Conochitina vitrea* (= *Conochitina* sp. A in Verniers, 1982).

2.5.5. Hosdin Formation - HOS

Author: Verniers, 1976 ms, 1983a.

Description: Dark to medium grey mudslate, siltslate, siltstone and fine sandstone with quartzic pelite in the e-division; Tde sequences are often present (74%) and medium thick (17 cm on average); only one Tbcde sequence is observed (14.2 cm thickness); Tcde sequences are often present (24%) and thick (26 cm average); c-divisions are mostly thin, ranging from 0.5 to 18.5 cm and averaging 6.9 cm. The lower boundary is not observed due to a fault contact with the Hosdin Fm; upper boundary also via a fault with the Fallais Fm.

Stratotype: Village Latinne, section in the abandoned railway section south-west of the hamlet Hosdin, at the locality Trou du Loup; outcrop HH-6 in Verniers (1983).

Area: Until now only observed in the Mehaigne valley.

Thickness: Recorded sections: 11.5 m, outcropping sections: > 55 m, estimated thickness of formation: > 150 m.

Age: Telychian, upper Llandovery based on chitinozoan assemblage with *Conochitina vitrea* (= *Conochitina* sp. A in Verniers, 1982).

2.5.6. Fallais Formation - FLL

Author: Verniers, 1976 ms, 1983a.

Description: Unit of light green, olive-greenish grey, or light grey chloritic mudslate and mudstone, with rare siltstone and fine sandstone beds from distal turbiditic origin, mostly without laminated hemipelagite; in the Mehaigne area it can be subdivided into six members according to the frequency of siltstone and sandstone beds (except for member D and the volcanic Pitet layer): from top to bottom:

Member E: light or olive greenish grey, or light grey mudslate, mudstone, siltstone and fine sandstone, with non-calcareous chloritic pelite in the e-divisions; Tde sequences mainly between 8 and 11 cm; T (b) cde absent or rare (0-7%), generally about 75% thicker than the main Tde sequences, with the c-divisions between 11 and 20 cm thick; upper boundary placed below the first of frequently present obliquely stratified fine sandstone beds (a few per meter); lower boundary not observed but probably the top of the volcano-sedimentary layer of Pitet.

Volcano-sedimentary layer of Pitet (PTT): 20 m massive fining upward (very) coarse pure crystal tuff with slate and crystal lenses, passing gradually upwards into (medium) coarse tuff, heterogeneous with crystal and glass lenses; gradual transition into at least 5.5 m of (very) fine ash tuff or cinerite showing fine lamination, faint oblique stratification and compact sedimentation at the top; abrupt lower boundary observed with the member D.

Member D: medium to dark grey mudslate, mudstone and siltstone, quartzic, non-calcareous pelite; Tde sequences thin to medium thick (average of 12 cm); T (b) cde sequences frequent and generally thicker than Tde sequences; with thin c-divisions; lower boundary with member C not observed due to an observational gap of 30 m.

Member C: light greenish to olive-green mudslate, mudstone, siltstone and fine sandstone with non-calcareous chloritic matrix in the e-divisions; thin Tde sequences (on average 6-9 cm), T (b) cde sequences absent or rarely present (0-11%), generally about 60% thicker than the average Tde sequence; with c-divisions mostly between 0.5 and 9 cm and rarely (about 10%) between 11 and 16 cm; lower boundary with member B unobserved due to an observational gap of 7 m.

Member B: greenish mudslate, mudstone, siltstone and fine sandstone; in the e-division non-calcareous chloritic pelite; thin Tde sequences (about 10 cm); T (b) cde sequences frequent and much thicker (20-50 cm) than Tde sequences; lower boundary with member A not observed.

Member A: same lithology as Mbr C; lower boundary supposedly with the Latinne Fm via fault contact.

Stratotype: Mehaigne valley all around the village Fallais; the type sections of the members are: Mbr A in section IG-19, Fallais village centre, Mbr B and Mbr C in section KG-2. KG-3 and KG-4 in the sunken road north of the Ferme de Chantraine, Dreye; Mbr D in outcrop IF-9 in the hamlet Les Falihottes, Pitet; the volcano-sedimentary layer of Pitet in the abandoned quarry in the Butte St-Sauveur, Pitet and in the Bois Cornet, Pitet; Mbr E in section KF-2 in the sunken road 250-350 m south-east of the church of Dreye.

Area: Mehaigne and Burdinale valleys (type area); Orneau valley: a volcano-sedimentary rock is present at 20 m below the top of the formation. In the Thisnes valley (Monstreux; Verniers unpublished and Diependaele, 1997 ms) a volcano-sedimentary rocks ("porphyroid of Monstreux") is present at about 8 to 10 m below the Corroy Fm and from 11 to 22 m below the same formation a purple shale member is observed, the only purple-coloured bed in the Silurian of the Brabant Massif. In the Sennette valley a local member B with thin bedded sandstone layers, showing oblique stratification and undulating bedding planes is separating two green shale members (A and C) with rarer sandstone (Verniers, unpublished).

Thickness: Mehaigne area: estimated for the formation: > 626 m (Mbr E: 135 m, Volcano-sedimentary layer of Pitet: 31 m, Mbr D: > 22 m, Mbr C: 140 m, Mbr B:

> 28 m, Mbr A: 270 m, Verniers, 1983a); Orneau valley: difficult to estimate: 300-400 m (Delcambre & Pingot, in press a); Thisnes valley (Monstreux): difficult to estimate: > 450 m (Verniers, unpublished); Sennette valley: > 375 m (cut off at the base by a fault; Verniers, unpublished).

Age: Based on acritarchs Telychian, upper Llandovery (Martin, 1969a); chitinozoans from the Mehaigne area indicate the *longicollis* global biozone for members A, B and C, calibrated with a range post-*griestoniensis* to pre-*insectus* graptolite biozones. The *margaritana* global biozone is observed in members D, Pitet and E. According to the latest calibration by Mullins (1998) these three members would correspond to the *insectus* graptolite biozone, topmost Telychian, uppermost Llandovery (reinterpreted after Verniers, 1981, 1982).

2.5.7. Corroy Formation - COY

Author: Malaise, 1900; restricted herein.

Description: Mudslate, mudstone, siltstone and fine sandstone, alternating in thin beds, decimetric to a few cm thick. The sandstone is light-coloured, obliquely stratified, sometimes convolute bedding, with often undulating base and bounce and other current marks. Interbedded are dark grey laminated hemipelagite layers containing most of the graptolite levels. Some of the beds are slightly calcareous. The mudslate is greenish grey in the lower part of the formation, indicating its softer, chloritic composition with thin to medium thin Tde sequences (average between 6 and 14 cm); T (b) cde sequences frequent to very frequent (20-50%), generally twice as thick as the average Tde sequence, with c-divisions between 1 and 10 cm in 50 to 65% of all the c-divisions, and 10 to 22 cm in the rest of the cases. The colour changes to dark grey in the upper part of the formation, indicating a more quartzic or illitic composition. The lower boundary occurs via a gradual transition from the Fallais Fm and is marked by the lowest presence of at least three, decimetric, sandstone beds per meter of sediment. The upper boundary is marked by the presence of the highest sandstone bed (Tc division) of > 5 cm thickness.

Stratotype: Orneau valley, south of Gembloux, abandoned quarry "La Poudrière de Corroy", near the river.

Area: Present in Western Flanders subsurface (Houtem borehole, Martin, 1969a), in many boreholes for the A8 road in the Dender valley (Hance, pers. comm. 1992), at the Ferme des Chèvres in the Sennette valley (Verniers, unpublished), Rue du Gendarme (Monstreux, Nivelles area, Diependaele, 1997 ms), Orneau valley, Burdinale and Mehaigne valleys. There is an overall tendency to thinner turbidite sequences from east to west.

Thickness: Mehaigne area: thickness of recorded sections: lower part 48.0 m, upper part 26.1 m; thickness of outcropping sections: lower part 57.6 m and upper part 31.1 m; estimated thickness of the lower part: 82 ± 10 m and upper part: 32 m; 114 ± 10 m in total for

the formation. Orneau valley: about 100 m; Sennette valley: estimated at about 140 m.

Age: Graptolites in the Orneau valley belong to the *C. purchisoni* and *M. riccartonensis* biozones (Malaise, 1900; Legrand, 1961b); graptolites in the Burdinale and Mehaigne valleys indicate the presence of the *C. centrifugus*, *C. purchisoni* biozones in the lower part of the formation, and the upper part of the *M. riccartonensis* and the middle Wenlock *M. flexilis* biozones (now *M. dubius* biozone) in the upper part of the formation indicating the lower to middle Sheinwoodian (lower and basal middle Wenlock) for the formation (Verniers & Rickards, 1979). The chitinozoans were described as belonging to subzone C3 (Verniers, 1981, 1982) and belonging to the *M. margaritana* global biozone or to the *M. margaritana* local biozone for the lower member and to the *C. burdinalensis* local biozone for the upper part of the formation, with an extinction event and an impoverished assemblage in the top of the formation (Verniers, 1999). The *margaritana* biozone starts in the uppermost Telychian (*insectus* graptolite biozone, Mullins, 1998), and hence the Wenlock-Llandovery boundary cannot be located exactly with chitinozoans. The presence of Wenlock graptolites close to the base of the formation however suggests that the base of the Wenlock coincides or lies close to the base of the Corroy Fm. The acritarchs, described by Martin (1969a) from the Mehaigne area and the Houtem borehole also indicate an early Wenlock age.

Remarks: Synonyms: "partie inférieure de l'Assise de Corroy" (Verniers, 1983b); Bounia Fm or MB4 Fm in the Mehaigne area with two members: a lower green member MB4A and a upper dark grey member MB4B (Verniers, 1976 ms, 1983b; Verniers & Van Grootel, 1991).

2.5.8. Petit-Roelx Formation - PER

Authors: Doremus & Hennebert, 1995.

Description: Cleaved mudstones and siltstone (called "phyllades" in older literature), with decimetric beds of obliquely stratified sandstone and other thin sandstone beds; variable colours from unweathered greenish grey, dark grey to black to weathered light yellow. Sedimentologically an alternation of distal turbidites and laminated hemipelagites. The variations in frequency and thickness of the sandstone beds allows to distinguish two recurrent types: (1) Brainette type: sandstone beds of a few mm to 2 cm separated by mudstone beds of 10 cm to > 100 cm; (2) Senne type: thicker and more frequent sandstone beds, 2 to 10 cm thick, separated by mudstone beds of 2 to 20 cm. Pyrite cubes or their weathered rusty remnants are present in the upper third of the formation. Mica is rarely present.

Stratotype: Brainette type in the Brainette valley, between Petit-Roelx-lez-Braine and Braine-le-Comte; in the abandoned quarry near the hamlet Pirou or behind a chapel near the confluence of the Brainette and the Ri Ceriseau; Senne type in the Senne valley south-west of

the village Steenkerque in outcrops near the Ferme de l'Hotel or near the Ferme d'Horruette.

Area: Brabant Massif; outcrop area: Senne, Sennette and Thisnes valleys (Nivelles).

Thickness: Senne valley: about 430 m.

Age: Silurian, middle to upper Wenlock, based on chitinozoans, *Cingulochitina cingulata* global biozone (Verniers, pers. comm. 1995 in Doremus & Hennebert, 1995).

2.5.9. Steenkerque Formation - STK

Authors: Doremus & Hennebert, 1995.

Description: Cleaved mudstone and siltstone, dark grey when unweathered, frequently altered in light beige or brownish beige. Millimetric interbeds of fine sandstone or coarse siltstone are rare and mostly absent.

Stratotype: Senne valley, village of Steenkerque, outcrops less than 100 m south-east and north-east of the church.

Area: Brabant Massif, outcrop area: Senne and Sennette valleys.

Thickness: Between 290 and 380 m.

Age: Based on chitinozoans: *Cingulochitina cingulata* global biozone (Verniers, pers. comm. in Doremus & Hennebert, 1995), mid Sheinwoodian to early Homerian (mid to late Wenlock) in age.

2.5.10. Froide Fontaine Formation - FRF

Authors: Doremus & Hennebert, 1995.

Description: Cleaved mudstone and siltstone, of greenish grey to dark grey unweathered colours, with additionally decimetric beds of obliquely stratified rather coarse sandstone; often micaceous, a typical feature of the formation. Clearly more sandy (up to half sandstone and half slate) than the other two Silurian units of the Senne valley.

Stratotype: Senne valley, between the village of Horruet and its hamlet Froide Fontaine, in a road section at km 22.5 of the road N55, Enghien-Soignies.

Area: Brabant Massif, outcrop area: Senne and Sennette valleys.

Thickness: Between 160 and 270 m.

Age: Middle Wenlock to lower Ludlow based on chitinozoans (Verniers, pers. comm. in Doremus & Hennebert, 1995).

2.5.11. Les Vallées Formation - LVA

Authors: Verniers, 1976 ms; Verniers & Van Grootel, 1991.

Description: Grey mudslate, mudstone, siltstone and fine sandstone with non-calcareous quartzic pelite in the e-divisions; alternating distal turbidites with thin bedded

laminated hemipelagites. In the lower 125 m the Tde sequences are medium thick to thick (15 to 30 cm); between 125 and 185 m the Tde sequences are thick and very thick (up to 60 cm), and in the upper 35 m the Tde sequences are again medium thick to very thick (30 to 60 cm) with relatively thick d-divisions. T (b) cde sequences are sometimes present. The lower boundary with the underlying Corroy Fm is observed, the upper boundary is not observed in the field, but it is probably the Vissoul Fm.

Stratotype: The formation has only few outcrops in the Mehaigne area; the whole formation was visible in a temporary pipeline gully (1975), north of Bois Tier à Mehaigne, between the hamlet Dreye and the village Fumal; the base of the formation and the lowest 5 m are defined in the road section north of the old "Moulin de Bounia"; the upper part of the formation is well visible in the high energy turbidite unit in the northern part of the railway section of the Orneau valley, 350-500 m east and north-east of the "Ferme de Chenémont" (parastratotype section); Les Vallées is a local place name in the village of Burdinne, in the vicinity of which the unit is present.

Area: Mehaigne and Burdinale valleys.

Thickness: Recorded sections: 225 m; estimated thickness: > 225 m.

Age: Middle Wenlock, based on the relative position of the formation: above the underlying formation which contains at its top graptolites of a post-*riccartonensis* biozone (middle Wenlock) and below the covering formation also with middle Wenlock graptolites. The chitinozoans from the lower part of the formation belong to an interzone, subzone C4 (Verniers, 1982, 1999).

Remarks: Synonyms: MB5 Fm in Verniers (1981, 1983a); "partie moyenne de l'Assise de Corroy" (Verniers, 1983b).

2.5.12. Vissoul Formation - VSS

Authors: Verniers, 1976 ms, 1983a; Verniers & Van Grootel, 1991.

Description: Grey mudslate, mudstone, siltstone and fine sandstone with non-calcareous quartzic pelite in the e-divisions. Sedimentology: alternating distal to slightly proximal turbidites with thin bedded laminated hemipelagites; the Tde sequences are medium thick and the T (b) cde sequences are frequent (about 15% of all sequences) and normally thicker ($\pm 50\%$) than the average Tde sequences; c-divisions are thin (2-8 cm). Lower boundary probably with Les Vallées Fm and upper boundary probably with the Fumal Fm.

Stratotype: Quarry behind a house, previously called Cabaret au Congo, hamlet of Vissoul, village of Oteppe, Burdinale valley.

Area: Mehaigne and Burdinale valleys.

Thickness: Recorded sections: 9.4 m; thickness of the outcropping sections: 29.4 m; estimated thickness: > 30 m.

Age: Graptolites from the Burdinale valley are not characteristic for one biozone but the assemblage indicates a

range from the *dubius* to the *lundgreni* biozones, middle Sheinwoodian to lower Homerian (middle to upper Wenlock) (Verniers & Rickards, 1979; Zalasiewicz *et al.*, 1998); the chitinozoans belong to subzone D1 (Verniers, 1982) and to the *Cingulochitina cingulata* global biozone and possibly the *Conochitina pachycephala* global biozone of Verniers *et al.* (1995) spanning the same interval as the graptolites.

Remarks: Synonyms: MB6 fm in Verniers (1981, 1983a); "partie supérieure de l'Assise de Corroy" (Verniers, 1983b).

2.5.13. Fumal Formation - FUM

Authors: Verniers, 1976 ms, 1983a; Verniers & Van Grootel, 1991.

Description: Grey mudslate, mudstone, siltstone and fine sandstone with quartzic pelite in the e-divisions. Sedimentology: three types of sequential patterns occur: (a) thick Tde sequences (average between 24 and 28 cm) with absent or very rare T (b) cde sequences; (b): medium thick to thick Tde sequences (average between 17 and 25 cm) with rarely present to very frequent T (b) cde sequences (6 to 30% of all sequences) of about the same thickness as the Tde sequences; the c-divisions are either thicker or thinner than 10 cm but there is a higher frequency (80%) of c-divisions thinner than 10 cm. (c): medium thick to thick Tde sequences (average between 14 and 18 cm) and no T (b) cde sequences. Lower and upper boundaries are not observed: the upper boundary is situated in an observation gap of ± 20 m between this formation and the Vichenet Fm.

Stratotype: The area around the village of Fumal; stratotype sections in the three gullies in the steep slope in the Bois aux Guisses, 700 to 1000 m south-east of the church of Fumal (sections JD-1, to 3 in Verniers, 1983); parastratotype in the outcrops just south to south-west of the church of Fumal.

Area: Mehaigne area and Orneau valley.

Thickness: Mehaigne area: thickness of recorded sections: 242 m; estimated thickness of formation: 330 m (Verniers, 1983a).

Age: The chitinozoans, the only fossils found in this formation in the Mehaigne area, belong to the *Cingulochitina cingulata* global biozone and possibly the *Conochitina pachycephala* global biozone of Verniers *et al.* (1995), middle Sheinwoodian to lower Homerian (middle to upper Wenlock). More accurately, most of the upper two thirds of the formation can be assigned to the Welsh *Conochitina subcyatha* biozone, lower Homerian (upper Wenlock), and the uppermost part of the formation to the subzone D3 (Verniers, 1982), corresponding to the *Sphaerochitina lycoperdoides* global biozone of Verniers *et al.* (1995), lower to middle part of the Homerian (upper Wenlock) (Verniers, 1999). This implies a mid Wenlock age for the lower third, and an early Homerian for the upper two thirds of the formation (Verniers, 1999).

Remarks: Synonym: MB7 Fm (Verniers, 1981, 1983a).

2.5.14. Vichenet Formation - VCH

Author: Malaise, 1910; Mortelmans, 1953; Legrand, 1961.

Description: Grey mudslate, mudstone, siltstone and rare fine sandstone with often calcareous quartzic-chloritic pelite in the thick e-divisions; alternating distal thick-bedded turbidites with thin-bedded laminated hemipelagites. In the Mehaigne area the formation was described in detail: thick to very thick Tde sequences (on average between 21 and 51 cm), with T (b) cde sequences (0 to 35% of all sequences), an average 50% thicker than the average Tde sequences; c-divisions range between 0.8 and 13 cm. Characteristic are the very thick Tde turbidite sequences, grey to greenish colour sometimes calcareous. Neither the lower nor the upper boundary have been observed.

Stratotype: 350 m long road section north of the abandoned station of Vichenet-Bossière and east of the castle of Vichenet, Orneau valley; the section exposes the lower part of the formation.

Area: Orneau valley, type area; Burdinale valley, Mehaigne area; Landenne area.

Thickness: Estimated thickness in the Orneau valley: > 200 m; Mehaigne area: recorded sections: 50 m; thickness of outcropping sections: 86 m; estimated thickness of the formation: > 210 m (Verniers, 1983a); Landenne area: recorded sections: 12 m; estimated thickness of the formation: > 350 m (De Winter, 1998 ms).

Age: No fossils found or studied in the Orneau valley; estimated middle to upper Wenlock, based on its relative position in relation to a fossil locality below the unit (Rickards, pers comm. in Verniers, 1983b). Chitinozoans are the only fossils found in the Mehaigne area in the middle of the formation. The assemblage belongs to the *Sphaerochitina lycoperdoides* global biozone of Verniers *et al.* (1995), lower to middle part of the Homerian (upper Wenlock) (Verniers, 1982; 1999). In the Landenne area the chitinozoans belong to the same biozone for most of the formation and for the lower part of the formation to the *Cingulochitina cingulata* biozone, middle of the Sheinwoodian (middle Wenlock) to the middle Homerian, upper Wenlock (De Winter, 1998 ms).

Remarks: Unit created by Malaise (1910) with type locality at the Vichenet railway station (Orneau valley) to represent the Ludlow in the Brabant Massif. A graptolite locality described by him, could not be located, nor could the fossils in his collection. Michot (1954) proposed the name Ronquières Fm for the Ludlow and the "Assise de Vichenet" was abandoned. The type locality in Vichenet was not described in detail until now. The Oteppe Fm described in detail by Verniers (1976 ms) and the MB8 fm (Verniers, 1981, 1982, 1983a; Verniers & Van Grootel, 1991), both in the Mehaigne area, are considered to be junior synonyms. The Landenne Fm described in the Landenne area by De Winter (1998 ms) is also considered a junior synonym.

2.5.15. Ronquières Formation -RON

Authors: Malaise, 1883, emend. Michot, 1954, enlarged by Legrand, 1967, described in detail by Louwye *et al.*, 1992 and Verniers *et al.*, 1992.

Description: Dominated by grey mud-grade turbidites with compact or finely parallel laminated, fine silty slate and mudstone with quartzic pelites in the e-divisions, finely parallel laminated or obliquely stratified very fine sandstone; occasionally parallel laminated anoxic laminated hemipelagites, sometimes calcareous; very rarely oxic laminated hemipelagite, metabentonite or calcareous nodules. The Ronquières Fm varies from dark to light grey, caused by the quartzic and illitic composition. Changes in the relative frequency of the different Bouma mud-grade turbidites and laminated hemipelagites and of the thickness of each of the divisions allow in the type area the distinction of 11 units divided into subunits (Louwye *et al.*, 1992).

The formation is different from the Llandovery formations and the Corroy Fm which have a light greenish or olive colour caused by the chloritic composition. The middle and upper Wenlock Les Vallées, Vissoul and Fumal Fms have the same colours and lithology as the Ronquières Fm, but lack the typical high frequency of Tbcde sequences, the thick Tb divisions and thin Tc divisions. The Vichenet Fm is characterised by much thicker often lightly calcareous Tde sequences. The upper boundary is not observed due to the cover of the Devonian unconformity. The lower boundary is not observed either.

Stratotype: outcrops around the village of Ronquières, Sennette valley; sections east of the bridge over the canal at Ronquières (along the canal, the road and the hill side called Mont Godart) (Michot, 1954) and sections on both sides of the large excavation for the inclined shiplift "Plan Incliné de Ronquières" (Legrand, 1967).

Area: Sennette valley, Landenne area and Burdinale valley.

Thickness: Minimum recorded thickness in the Sennette valley: 538 m (Louwye *et al.*, 1992); observed min. 9 m, estimated > 125 m in the Mehaigne area (Verniers, 1983a).

Age: Graptolites in Ronquières in the Sennette valley indicate the *Neodiversograptus nilssoni* Biozone (Leriche, 1912) or the *Neodiversograptus nilssoni*, *Lobograptus scanicus* and possibly the *Pristiograptus tumescens* biozones forming together the Gorstian stage (B. Rickards, 1984; pers. comm. in Louwye *et al.*, 1992). The chitinozoans in Ronquières belong to the *Cingulochitina convexa*-*C. serrata* biozone and have an early Ludlow (Gorstian) and possibly a latest Wenlock age (Van Grootel, 1990 ms; Van Grootel in André *et al.*, 1991; Louwye *et al.*, 1992). The same biozone was found in the Mehaigne area (Verniers, 1982) and in the Landenne area (De Winter, 1998 ms).

Remarks: Junior synonym of the Velaine fm (De Winter, 1998 ms) in the Landenne area and of the MB9 fm (Verniers, 1983a) or the Boin fm in the Burdinale valley, Mehaigne area (Verniers, 1976 ms; Verniers & Van

Grootel, 1991: fig. 7). The > 61 m thick Mont Godart Fm (Louwye *et al.* 1992; Verniers *et al.* 1992), distinguished by its high frequency in Tc divisions and relatively thick laminated hemipelagite beds is reduced here in rank and considered to be the lowest of the 11 unnamed units of the Ronquières Fm.

2.5.16. Bellegem Formation - BLG

Author: Van Grootel, 1990 ms.

Description: Dark to medium grey mostly shale and mudstone (compact bedded), also siltstone and fine sandstone (laminated or obliquely stratified), deposited as distal turbidites and less frequently as laminated hemipelagites; the decimetric sequences are most frequently (81%) Tde, with a mean thickness of 19 cm, less frequently (7%) Tcde and 12% Tbc (d) e; telson fragments of the Archaeostraca crustacean *Ceratocaris* sp. are not rare; characteristic is the bioturbation of the Tc divisions, not present in the presumably underlying Ronquières Fm and the absence of the pyrite hemispheres often present in lower units.

Stratotype: Borehole in Bellegem, south of Kortrijk, (BGS N° 97E865 and 97E874).

Area: Only in the subsurface of the SW part of the Brabant Massif.

Thickness: At least 24 m.

Age: Based on the chitinozoans (*E. lagenomorpha* and *B. lauensis*): uppermost Gorstian and lower Ludfordian (Ludlow) (Van Grootel, 1990 ms).

2.5.17. Rekkem Formation - REK

Author: Van Grootel, 1990 ms

Description: Dark and medium grey, silty and clayey shale, with no sandstone present; compact, laminated or obliquely stratified; deposited as distal turbidites; 82% of the sequences are Tde, with a mean thickness of 3.5 cm; less frequently (3%) Tc (d) e and 15% Tbc (d) e; characteristic is the bioturbation with irregular tubes and absence of hemispheric pyritospheres.

Stratotype: borehole in Rekkem, south-west of Kortrijk, (BGS N° 96E77).

Area: Only in the subsurface of the SW part of the Brabant Massif.

Thickness: at least 13 m.

Age: Based on the chitinozoans, a tentative Pridoli age is proposed (Van Grootel, 1990 ms).

3. Condroz inlier or Sambre-et-Meuse strip

3.1. Ordovician

3.1.1. Chevlipont Formation - CHV

Authors: Anthoine & Anthoine, 1943; Graulich, 1961; Martin, 1969a.

Description: Dark grey laminated shale, siltstone and sandstone ("quartzophyllades" in the older literature).

Stratotype: see above at 2.3.1.

Area: Condroz inlier, only in the Wépion borehole (216 to 423.90 m).

Thickness: > 140 m.

Age: Graptolites in the Wépion borehole indicate the lower Tremadoc *Rhabdinopora* (*Dictyonema*) *flabelliforme* aff. *norvegica* biozone (Graulich, 1961); the rich acritarch assemblage is typical for the Tremadoc (MARTIN, 1969a).

Remarks: Synonym: "Assise de Wépion" Martin (1969a); the toponym for the name Assise de Wépion, proposed by Martin (1969a) after Graulich (1961), had already been used earlier for the "Grès de Wépion", an Emsian formation (Gosselet, 1888; Godefroid *et al.*, 1994).

3.1.2. Huy Formation - HUY

Authors: Malaise, 1888, 1910; Martin, 1969a; Servais & Maletz, 1992.

Description: Black, silky, finely micaceous shale, with cone-in-cone structures and white-veined blackish quartzite beds (Malaise, 1900); fine-grained and slightly micaceous black slate or shale (Martin, 1969a); dark or greyish black graptolitic mudstone (Servais & Maletz, 1992).

Stratotype: Huy, Meuse valley, in the railway sections east and west of the tunnel between the stations of Huy (-Nord) and Huy-Statte.

Area: Condroz inlier; at Sart-Bernard and at Huy-Statte; in the Wépion borehole the black shale with *Didymograptus bifidus* rests conformably on the Wépion Fm (Graulich, 1961).

Thickness: > 150 m (Michot, 1957); > 120 m Wépion borehole (Graulich, 1961).

Age: Graptolites were first attributed completely to the *Didymograptus bifidus* biozone (lower Llanvirn) (Maillieux, 1926a), but later some lower levels were placed lower down in the top of *Didymograptus hirundo* biozone (Fennian, late Arenig) (Bulman, 1950); restudy and recollection of the graptolites proved beyond doubt the presence of pendent didymograptids, ranging only in the Abereiddian part of the Llanvirn, other species indicate the *D. artus* Biozone, lower Abereiddian, lower Arenig (Servais & Maletz, 1992); the characteristic acritarch assemblage indicates a Late Arenig to Early Llanvirn age according to Martin (1965, 1969a) while the rich assemblages studied by Servais and Maletz (1992) restrict the range to the Llanvirn only.

Remarks: Synonyms: Schistes de Huy et de Sart-Bernard (Malaise, 1900); Assise de Huy; possibly synonym of the Sart-Bernard Fm (Michot, 1954; Martin, 1969a), but this is not accepted in Servais and Maletz (1992).

3.1.3. Sart-Bernard Formation - SBN

Authors: Maillieux, 1939; Martin, 1969a; Servais & Maletz, 1992.

Description: Micaceous and sandy shale (Michot, 1957).

Stratotype: In the railway section north-west of the village Sart-Bernard, between km 73.1 and 73.3 (Martin, 1969; Servais & Maletz, 1992).

Area: Condroz inlier.

Thickness: Not estimated yet.

Age: The restudied graptolite assemblage points to a *Didymograptus bifidus* biozone, Llanvirn (Bulman, 1950); this is not accepted by Servais and Maletz (1992) who follow the definition of Maillieux (1939) and include in the unit strata containing a macrofauna of several fossil groups of an ex-Llandeilo age.

Remarks: Synonym: Schistes de Sart-Bernard; Assise de Sart-Bernard.

3.1.4. Vitriaval-Bruyère Formation - VTB

Authors: Maillieux, 1926a; emend. Michot, 1954.

Description: Blackish, silky and fine micaceous shale with quartzite intercalations and graptolites (Maillieux, 1926a); micaceous pelitic unit (Michot, 1928); the higher part contains clayey quartzitic sandstone in thick beds, covering black or blue shale with intercalations of black or dark coloured mudstone, siltstone and fine sandstone.

Stratotype: Outcrops in the river bed of the Ruisseau Le Treko, west of the hamlet La Bruyère, 500 to 1050 m east of the church of the village Vitriaval.

Area: Condroz inlier; possibly the Oxhe Fm is a lateral equivalent or synonym for the unit in the Oxhe inlier.

Thickness: Not estimated yet, except for the upper part with quartzite beds: 20-30 m.

Age: Graptolites in a locality at Vitriaval-Bruyère in the upper part of the unit indicate the *Climacograptus peltifer* biozone (Maillieux, 1933). A restudy of the fauna by Bulman (1950) confirmed the presence of the *Climacograptus peltifer* biozone (now equivalent to the *foliaceus* biozone), which is situated in the uppermost Costonian to lower Longvillian substages, uppermost Aurelucian and most of the Burrellian stages, Caradoc (Fortey *et al.*, 1995).

3.1.5. Basse-aux-Canes Formation - BCN

Authors: Michot, 1934, 1954; Martin, 1969a; Delcambre & Pingot, in press c.

Description: Greenish grey or dark grey silty shale, often sandy siltstones, with irregular jointing. White mica often present. The siltstones weather with dark or rusty patches of iron and manganese oxides, described as a characteristic shining blue colour on freshly broken

surface. No sandstone beds observed. The formation overlies the Sart-Bernard Fm.

Stratotype: Not defined yet; in the southern part of the Puagne area, south-east of Sart-Eustache.

Area: Puagne-Sart-Eustache area, in the southern structural unit of the western part of the Condrosz inlier.

Thickness: 100 to 150 m.

Age: Without fossils, tentatively estimated as Llanvirn or early Caradoc, Mid or Late Ordovician.

Remarks: Synonyms: the "unfossiliferous Basse-aux-Canes shale unit" which was considered as a part of the Vitriaval-Bruyère Fm (Michot, 1934, 1954; Martin, 1969a). The unit resembles slightly the Vitriaval-Bruyère Fm, but has no sandstone beds; it is possibly a lateral facies change of (a part of) that formation.

3.1.6. Ombret Formation - OMB

Authors: Martin *et al.*, 1970.

Description: An upper sandstone-slate member of turbiditic nature in its upper part with obliquely stratified quartzitic sandstone up to several dm thick; a lower member with black shale with rare always thin micaceous sandstone intercalations (Martin *et al.*, 1970). The upper sandstone-slate member has a similarity with the Ittre Fm in the Brabant Massif.

Stratotype: Large outcrop along the road N90, north-west of the church of Ombret-Rawsa, below the hill Tier d'Ohe.

Area: Northern side of the Condrosz inlier, NW of Huy.

Thickness: Upper sandstone-slate member: about 300 m; lower black shale member: > 50 m.

Age: Based on acritarchs and chitinozoans a definite Late Ordovician age is proposed, and probably Caradoc (Martin *et al.*, 1970).

3.1.7. Oxhe Formation - OXH

Authors: Malaise, 1900; emend., Maillieux, 1926a; Michot, 1954; Dean, 1991.

Description: Black micaceous shale with isolated black quartzite beds (Dewalque, 1894); blackish, micaceous and fossiliferous quartzite and black shale (Malaise, 1900); blackish green coarse shale with greenish quartzite intercalations (Martin, 1969a); most commonly micaceous mudstone and siltstone (sometimes cleaved), occasional thin (up to 10 cm) impersistent beds of fine-grained sandstone within the mudstone; all rocks are blue grey when fresh, and brown or brown-green on weathering (Dean, 1991); dark grey micaceous mudstone, compact bedded, with intercalated centimetric to decimetric quartzitic sandstone and siltstone beds, often very micaceous, laminated to obliquely stratified; the dark grey colour changes by weathering to (dark) brown or greenish-brown (De Geest, 1998 ms).

Stratotype: Not defined exactly, but contains the outcrops in the middle and western part of the Oxhe geological inlier, along the river Ri d'Oxhe/Ohe, at the localities of Fond d'Ohe and Petit Fond d'Ohe.

Area: Only in the Oxhe inlier (Condrosz inlier).

Thickness: Estimated in the western part of the inlier: 200 m (Dean, 1991); possibly up to 900 m (De Geest, 1998 ms).

Age: Longvillian, upper substage of Burrellian, Caradoc, based on trilobites (Dean, 1991); acritarchs indicate an Arenig-Llanvirn (ex-Llandeilo) interval (Martin *in* Dean, 1991); the chitinozoan assemblages from the upper half of the formation compare well with those from the Burrellian stage in the Caradoc type area in U.K. (De Geest, 1998 ms).

Remarks: Synonyms: Included as part of the Vitriaval-Bruyère Fm by Michot (1954); Assise of, shale of, sandstone of, quartzite and shale of, horizon of Oxhe or Fond d'Oxhe; Horizon of Oxhe with *Trinucleus concentricus*, considered equivalent of the *Climacograptus wilsoni* zone (Maillieux, 1926a) and later considered equivalent of the base of the *Pleurograptus linearis* zone (Maillieux, 1930a); "Schistes d'Oxhe" with *Cryptolithus gibbifrons* (Maillieux, 1930a); "Zone à *Cryptolithus gibbifrons*" (Michot, 1954); Oxhe Fm (Dean, 1991).

3.1.8. Fosses Formation - FOS

Authors: Gosselet, 1873; Malaise, 1900; Michot, 1954; Martin, 1969a; Tourneur *et al.*, 1993.

Description: From top to bottom green and dark green fine sandy shale, with trilobites and brachiopods; grey-wacke, calcareous shale with locally some limestone beds rich in brachiopods (Michot, 1934).

Composed of two members: a lower Bois de Presles Member - (BDP): clayey limestone, calcareous shale, fossiliferous with brachiopods, cystoids and trilobites (Martin, 1969a after Michot, 1927, 1934); an alternation of thin-bedded muddy limestone and calcareous shale; calcareous shale with thin limestone layers in the upper part of the member; rather rich in brachiopods, crinoids, trilobites, bryozoans, corals, echinoderm debris, cystoids, molluscs and algae; the lowest beds contain a coarse crinoidal limestone above a basal conglomerate (Cocriamont conglomerate) (Tourneur *et al.*, 1993).

An upper Faulx-les-Tombes Member - (FLT): "schistes mouchetés" of Lassine (unpublished in Martin, 1969); green sandy shale with on breaking surfaces blackish elliptic or fusiform spots and a rare macrofauna level (Martin, 1969a after Michot, 1927, 1934); bioturbated calcareous shale (Tourneur *et al.*, 1993).

Stratotype: 1 km east of the city of Fosses, in the northern bank of the Fuelle and Rosière rivers (Malaise, 1873); also between the city of Fosses and the village Sart-Eustache.

Area: Condrosz inlier, also in the Puagne area.

Thickness: 100-110 m (Michot, 1957); upper member: 50 m, lower member: about 50 m (Tourneur *et al.*, 1993).

Age: Based on trilobites, brachiopods etc., considered to be Caradoc or Caradoc and Ashgill (see Martin, 1969a); the cystoids studied by Regnell (1951) indicated the Ashgill. A restudy of the brachiopods and trilobites indicated the pre-Hirnantian Ashgill (Sheehan, 1987; Lespérance & Sheehan, 1987).

Remarks: Synonym: Assise de Fosse; Schistes de Fosse; Horizon de Fosse; Grauwacke de Fosse.

3.2. Silurian

3.2.1. Génicot Formation - GNC

Authors:

Description: Black shale, dark grey laminated siltstone and often thin beds of medium grey sandstone. Occasionally a conglomeratic sandstone bed occurs. Sometimes dark-coloured microbioturbations a few mm long (*Chondrites* sp.?) are present in the shale or siltstone. The base of the formation is located above the highest macrofossiliferous horizon of the Fosses Fm, the top of the formation above the highest siltstone/sandstone bed below the Criptia Group, in which a clear green-grey shale appears.

Stratotype: Not defined yet; area between the city of Fosses and the village Sart-Eustache.

Area: Puagne-Sart-Eustache area, in the southern structural unit of the western part of the Condrosz inlier.

Thickness: At least 150-200 m.

Age: Early to mid Llandovery, based on one graptolite level (Michot, 1927) from the *Monograptus convolutus* biozone, Aeronian (mid Llandovery).

Remark: The relation with the similar Faulx-les-Tombes Mbr with its "schistes mouchetés" (Fosses Fm) is not yet understood.

3.2.2. Criptia Group - CRI

Authors: Michot, 1928; Delcambre & Pingot, in press c.

Description: A group for a thick unit of shale and silty shale, homogeneous with various colours (greenish, grey, ochre) and a stratification difficult to distinguish. In the group a green to greenish grey soft shale unit can be differentiated. The Génicot Fm is supposed to be the underlying unit. The covering unit is a more silty and darker coloured unnamed shale unit.

Stratotype: Not defined yet; area between the city of Fosses and the village Sart-Eustache.

Area: Puagne-Sart-Eustache area; in the southern structural unit, western part of the Condrosz inlier (Puagne point structural area).

Thickness: Unknown, tentatively estimated at several hundred meters.

Age: Without fossils, a late Llandovery or possibly Wenlock to early Ludlow age is tentatively postulated.

Remarks: Synonymy: The unit was already described as "Schistes de Criptia" by Michot (1928).

3.2.3. Dave Formation - DAV

Authors: Michot, 1932; emend. Michot, 1954.

Description: In the type area: bluish black shale, often fine micaceous or sandy, locally calcareous; around Fosses and Tihange black shale and mudstone with thin dark micaceous siltstone or sandstone intercalations. In the area around Neuville-sous-Huy keratophyre lavas, feldspathic tuffs and tuffites are present (Michot, 1954); in the area around Neuville-sous-Huy: in the middle part, a > 48 m coarse shale, slightly quartzitic, brownish grey or dark greenish grey, compact bedded, rarely laminated, containing the lowest volcanoclastic bed of the area; the upper part (>94 m) consists of an alternation of greenish grey, olive green and red fine shale, compact bedded, with some minor clayey fine sandstone and at least 8 layers of keratophyre or volcano-sedimentary arkose (Maes *et al.*, 1978).

Stratotype: Southern flank of the Fond de Dave valley, near the village of Dave, 450-550 m east of the railway Namur-Dinant (Michot, 1932, 1934).

Area: Condrosz inlier.

Thickness: Estimated at 280 m (Michot, 1957).

Age: The following graptolite biozones have been recognised: *Cephalograptus acuminatus*, *Mesograptus modestus*, *Monograptus convolutus* (black shale level of the Gazelle river), *Monograptus sedgwicki*, *M. turriculatus*, *Monograptus crispus*, *Monograptus crenulatus*, ranging from the bottom to the top of the Llandovery (Michot, 1954). Graptolites from Neuville-sous-Huy were described of the *M. turriculatus*, *M. crispus*, *M. griestoniensis* and *M. crenulata* biozones (Telychian, upper Llandovery) (Maes *et al.*, 1978). A characteristic acritarch assemblage is present in the upper Telychian, dominated by many *Domasia* spp. (Martin, 1969a); Red beds occur from the top or above the *M. turriculatus* biozone till the lower Wenlock, but mostly in the *griestoniensis* and lower *M. crenulata* biozones. The 12 volcanic or volcano-sedimentary beds are situated from the *M. turriculatus* till the lower Wenlock (Maes *et al.*, 1978). Samples from the Neuville-sous-Huy area contain chitinozoans from the *dolioliformis* and *longicollis* global biozones confirming the Telychian age for this part of the formation (Verniers, unpublished data).

Remarks: Synonym: Schistes de Dave, Assise de Dave.

3.2.4. Naninne Formation - NAN

Authors: Malaise, 1900; emend. Michot, 1954.

Description: Laminated mudstone, generally calcareous, with some micaceous siltstone or fine sandstone intercalations (Michot 1954; Martin, 1969a); laminated fine sandy or silty shale, blue-grey, green, greenish grey or brownish grey, resistant, often calcareous, with intercalations of micaceous clayey sandstone, fine beds of red

shale; intercalations of olive green shale at the top; three (quartz) keratophyre levels occur in Neuville-sous-Huy (Maes *et al.*, 1978).

Stratotype: Village of Naninne, the road to Sart-Bernard (Michot, 1934).

Area: Condroz inlier.

Thickness: \pm 50 m (Michot, 1957); $>$ 90 m (Vandeveldel, 1976 ms; Maes *et al.*, 1978).

Age: Graptolites of the *Cyrtograptus purchisoni* and the *Monograptus riccartonensis* biozones were described by Lassine (1913); the *C. centrifugus* biozone and other lower Wenlock graptolites assemblages were described by Rickards (*in* Maes *et al.*, 1978). Samples from Neuville-sous-Huy contain the typical chitinozoans assemblage of the *M. margaritana* global biozone, however without the type species, confirming the early Wenlock age (Verniers, unpublished data).

Remarks: Synonyms: Assise de Naninne.

3.2.5. Jonquoi Formation - JON

Author: Michot, 1954.

Description: Unfossiliferous homogeneous unit of green shale (Michot, 1954); mudstone and green shale with rare thin clayey micaceous siltstone or fine sandstone beds (Martin, 1969a); olive green shale with intercalated grey-blue, green or grey-brown finely laminated shale, sometimes sandy, and a rare calcareous decimetric nodule level (Maes *et al.*, 1978).

Stratotype: Not clearly defined; area around the hamlet of Jonquoi, near the city of Fosses (Martin, 1969).

Area: Condroz inlier.

Thickness: \pm 300 m (Michot, 1957).

Age: At Haute-Calange the *Cyrtograptus rigidus* graptolite biozone was found (Michot, 1954); in the park of Neuville-sous-Huy two levels from the *C. rigidus* or *C. lundgreni* graptolite biozones and 700 m east of Neuville-sous-Huy the *C. linnarsoni* (= *C. rigidus*) biozone were recognised (late Sheinwoodian or early Homerian, mid or late Wenlock) (Rickards *in* Maes *et al.*, 1978).

3.2.6. Thimensart Formation - THM

Authors: Malaise, 1900; emend. Michot, 1954.

Description: Shale and micaceous siltstone and fine sandstone with graptolites (Malaise, 1900); laminated with locally some thin red shale beds (Michot, 1954); olive green shale, micaceous, with compact bedding, lamination or fine oblique stratification.

Stratotype: Right bank of the Fvette river, between the road to Fosses and the old Ferme de Thimensart, east of Fosses (Martin, 1969).

Area: Condroz inlier.

Thickness: Difficult to estimate but in the order of 100 m (Michot, 1957).

Age: The graptolite biozones *Monograptus nilssonii*, *M. scanicus* and *M. tumescens* were recognised, Gorstian, early Ludlow in age (Michot, 1954); the *P. nilssonii* and the *L. scanicus* biozones were recognised by Rickards *in* Maes *et al.* (1978).

Remarks: Synonyms: Assise de Thimensart, Schistes de Thimensart.

3.2.7. Colibeau Formation - CLB

Authors: Maillieux, 1930a; emend. Michot, 1954.

Description: Dark grey or brownish black coarse-grained shale with rare intercalations of clayey sandstone, quartz-rich and rather strongly micaceous (Maillieux, 1930a; Martin, 1969a).

Stratotype: Railway section along railway Namur-Arlon, at locality Colibeau, near Naninne (Martin, 1969).

Area: Condroz inlier.

Thickness: \pm 650 m (Michot, 1957).

Age: Brachiopod fauna in the upper part of the unit, with *Spirifer elevatus*, *Plethorhyncha percostata* and *Stropheodonta simulans*, one specimen of each, similar to the Whitcliffe Flags in Wales, U.K. (Malaise, 1913; Maillieux, 1930a); Ludfordian (late Ludlow) age.

3.2.8. Longues Royes Formation - LGR

Authors: Delcambre & Pingot, in press b.

Description: Green silty shale and micaceous siltstone including a few darker beds; the amount of micaceous siltstones increases towards the top; lower boundary not observed, upper boundary with the Montcheret Fm.

Stratotype: Outcrops along the Ri d'Acoz valley, south of Bouffioulx, Charleroi.

Area: In the western part of the Condroz inlier along the Ri d'Acoz valley, in a part supposed to belong to the para-autochthonous northern part of the Condroz inlier.

Thickness: Poorly known, at least 150-180 m (if section is not faulted).

Age: Ludlow and/or Pridoli, based on spores (Steenmans, unpublished data *in* Delcambre & Pingot, in press b).

3.2.9. Moncheret Formation - MCH

Authors: Michot, 1928; Delcambre & Pingot, in press b.

Description: Dark green, silty shale with either metric dark sandstone beds, divided in lenticular layers, or centimetric to decimetric lenses of the same dark sandstone. The shale is often punctuated with patches of rusty iron oxides or of dark manganese oxide. The top of the formation is unknown because of faulting of the Midi thrust fault.

Stratotype: Outcrops along the Ri d'Acoz valley, south of Bouffioulx, Charleroi.

Area: In the westernmost part of the Condroz inlier, along the Ri d'Acoz valley near Bois de Châtelet; in an area supposed to belong to the para-autochthonous northern part of the Condroz inlier.

Thickness: Poorly known, at least 50-70 m in the Ri d'Acoz.

Age: Ludlow or Pridoli, based on trilete spores (*Brochotriletes sanpetrensis*) together with reworked Ordovician acritarchs (Stemans, 1994 and unpublished data of 1995 in Delcambre & Pingot, in press b).

Remarks: According to the palynofacies the sedimentation environment was littoral or continental (Stemans, 1995 and unpublished data). Michot (1928) classified this unit as the Vitriyal-Bruyère Fm. The recently studied palynology indicates the presence of a previously not described unit.

4. STAVELOT MASSIF

4.1. Deville Group - old Dv

Description: Greenish, purplish and grey coloured slate and quartzite group, subdivided into the Bellevaux and the Hour Fms.

4.1.1. Hour Formation - HUR (old: Dva)

Author: After Geukens, 1999.

Description: Thick beds of light coloured to light greenish quartzite and green slate. The white sandstone is locally altered into a reddened sandstone.

Stratotype: Outcrop in the Rocher de Hourt along the road N28 between Trois-Ponts and Vielsalm.

Area: In two anticlinal structures (Grand-Halleux and Ligneuville) in the southern part of the Stavelot Massif.

Thickness: > 150 m.

Age: Due to the absence of macrofossils and acritarchs in the formation, a possible Neoproterozoic to Early Cambrian age is tentatively proposed (Mortelmans, 1977; Vanguetaine, 1992).

4.1.2. Bellevaux Formation - BEL (old: Dvb)

Author: After Geukens, 1999.

Description: Alternation of greenish and purple slate and shale; greenish shale and white quartzite.

Stratotype: Amblève valley east of the city of Stavelot and in the Salm valley north of Rochelival.

Area: In two anticlinal structures (Grand-Halleux and Ligneuville) in the southern part of the Stavelot Massif.

Thickness: 150 m.

Age: The only fossils present are the trace fossils *Oldhamia antiqua* and *O. radiata*. Because the genus *Oldhamia* is present in the Lower and Middle Cambrian only and not below the new GSSP of the Cambrian-Precambrian boundary (Crimes, 1992), an Early Cambrian age was proposed by Verniers and De Vos (1995). According to new observations by A. Seilacher (pers. comm., 1998) *Oldhamia* is more restricted in time and only present in the Tommotian or Nemakitian-Daldynian (early Early Cambrian), which would be the age of the formation. Acritarchs are recorded in the uppermost part of the formation, above the *Oldhamia* occurrences. They are assigned to the Zone 0 (Vanguetaine, 1974) indicating a mid or late Early Cambrian to early Mid Cambrian age (Vanguetaine, 1974, 1992).

4.2. Revin Group - old Rv

Description: Dark to light grey coloured slate and quartzite group, subdivided into the Wanne, La Venne and La Gleize Fms.

4.2.1. Wanne Formation Rv1-2 or WAN

Author: Geukens, 1999.

Description: Dark green-blue fine slate and greenish quartzite, alternating with dark slaty quartzite; some rare 10-15 cm thick conglomerate beds with slaty, quartzitic and sometimes phosphatic pebbles. The lower part comprises black silty slate (called "quartzophyllade" in the older literature), sometimes slate and black finely stratified quartzite. Some interstratified volcanic lavas or tuffs are present.

Stratotype: Not yet defined; type area in the outcrops of the Salm valley south of the village Trois Ponts.

Area: Stavelot Massif.

Thickness: 550-650 m.

Age: The presence of the inarticulate brachiopod *Acrothele cf. bergeroni* indicates a Mid Cambrian age (Vanguetaine & Rushton, 1979); the acritarchs belong to the biozones 1, 2 and 3, dated as Early (?) to Mid Cambrian (Vanguetaine, 1974, 1992; Vanguetaine & Van Looy, 1983).

4.2.2. La Venne Formation - Rv3-4 or VEN

Author: Geukens, 1999.

Description: Heterogeneous unit characterised by the alternation of black slate and dark quartzite. The quartzite is sometimes very clayey and micaceous. In the middle part very thick beds occur of grey-bluish quartzite which can contain thin gravel layers. The lower part is characterised by a rhythmic sedimentation with units consisting of, from base to top, coarse sandstone, fine sandstone, siltstone and slate, and also by well-stratified blue quartzite and by micaceous sandstone beds. Volcanic intrusions are present, mostly acid in composition.

Stratotype: Not yet defined; type area in the Amblève valley, along the railway sections between La Gleize and Coö.

Area: Stavelot Massif.

Thickness: 500 m.

Age: Mid to Late Cambrian based on acritarchs (Vanguetaine & Van Looy, 1983; Ribecai & Vanguetaine, 1993).

4.2.3. La Gleize Formation - Rv5 or GLE

Author: Geukens, 1999.

Description: In the north: black slate and silty slate (called "quartzophyllade" in the older literature); the upper part contains sometimes dolomite nodules with cone-in-cone structures; the lower part bluish-black slate with thick laminations. Some acid intrusions and lava flows can occur. In the south: graphitic slate occurs at Hébronval.

Stratotype: Not yet defined; type area in the Amblève valley, along the railway section east of the abandoned station of La Gleize.

Area: Stavelot Massif.

Thickness: In the north: 300 m; in the south: unknown.

Age: Late Cambrian based on acritarchs (Vanguetaine, 1974).

4.3. Salm Group - old Sm

Description: The group consists of three formations: from base to top: the Jalhay, Otré and Bihain Fms.

4.3.1. Jalhay Formation - JAL (old: Sm1)

Author: Geukens, 1999.

Description: Blue-green slate, sandstone and silty slate (called "quartzophyllade" in the older literature) subdivided into three members.

The Solwaster Mbr - (SLW, old: Sm1a): dark green-blue "quartzophyllade", black or green-blue slate, with at the base sandstone beds containing black shale fragments; occurrence of flattened nodules encircled by cone-in-cone structures, and of dendroid graptolite levels. Locally at the transition with the underlying Revin-Deville Group homogeneous graphitic black slate can occur.

The Spa Mbr - (SPA, old: Sm1b): dark bluish grey and greenish grey sandy "quartzophyllade". Many sandstone beds have characteristic sedimentary structures (slumping, convoluted bedding and oblique stratification).

The Lierneux Mbr - (LIE, old: Sm1c): North of the Xhoris fault, olive green clayey "quartzophyllade"; south of the fault: greyish "quartzophyllade", green sandy slate with reddish patches, magnetite-bearing slate. White sandstone levels in the Lierneux-Vielsalm-Bihain area; light green "quartzophylladic" slate; traces of bioturbation.

Stratotype: Not yet defined; type area of the formation around the village of Jalhay, more precisely around the Gileppe dam; type area of the Solwaster Mbr: around Solwaster, in the section along the forestry track south of the Gospinal Farm; type area of the Spa Mbr: outcrops in the Wayai valley around the city of Spa, more precisely the section along the road to the mineral water factory; type area of the Lierneux Mbr: section along the road from Lierneux to Sart, just south of Lierneux.

Area: See description above.

Thickness: Jalhay Fm: > 400 m (Laloux *et al.*, 1996); Lierneux Mbr: 80 m; Spa Mbr: not estimated; Solwaster Mbr: 60-150 m.

Age: The early Tremadoc age is proven by the presence of the dendroid graptolite *Rhabdinopora flabelliformis* in the lower two members of the formation; the subspecies *flabelliformis* is dominating in the lower part of the Solwaster Mbr, while the subspecies *anglica* and *norvegica* are occurring in the upper part of the Solwaster Mbr and in the Spa Mbr (Malaise, 1874a; Geukens, 1950, 1954; Bulman & Geukens, 1970). Vanguetaine (1974, 1992) confirmed this age on the base of acritarchs. He could also on the base of acritarchs, assign the uppermost part of the formation, without graptolites, to the late Tremadoc.

4.3.2. Otré Formation - Sm2 or OTT

Author: Geukens, 1999.

Description: Purplish slate and silty slate (called "quartzophyllade" in the older literature) subdivided into 3 members.

The Meuville Mbr - (MEU, old: Sm2a), in the north: red or purple slate and "quartzophyllade", purple slate with calcareous nodules, garnet bearing slate. In the north a gradual transition exists between the green "quartzophyllade" of the Lierneux Mbr and the purple "quartzophyllade" of the Meuville Mbr.

The Les Plattes Mbr - (PLA, old: Sm2b), in the north: purplish slate and sandy "quartzophyllade", calcareous levels with iron and manganese nodules. In the south: "quartzophyllade", purple or with purple patches containing levels with interstratified coticule, andalusite, garnet and volcanic rocks. The base is formed by a slaty sandstone, light green, with coarse otrellite crystals.

The Colanhan Mbr - (COL, old: Sm2c), in the north: purple coloured slate with a few levels of green slate; in the south: purple and green compact layered slates, containing otrellite.

Stratotype: Not yet defined; type area in the syncline south of Otré; type area of the Meuville Mbr: outcrops in the Lienne valley north of Chevron; type area of the Les Plattes Mbr: abandoned or active quarries for the "coticule" between Hébronval and Bihain; type area of the Colanhan Mbr: the hill south of Lierneux between the villages of Verleumont and Hébronval and the northern flank of the crest south-west of Vielsalm.

Area: See description.

Thickness: Colanhan Mbr: 50 m; Les Plattes Mbr: 30 m; Meuville Mbr: 70 m; total thickness: 150 m.

Age: Neither micro- nor macrofossils observed; by geometry supposedly between Late Tremadoc (Early Ordovician) and Mid Ordovician.

4.3.3. Bihain Formation - Sm3 or BIH

Author: Geukens, 1999.

Description: Black silty slate (called "quartzophyllade" in the older literature) and greenish sandstone. The Salm-Château Mbr - (SCH, old: Sm3b): cleaved "quartzophyllade", with thick bands of slates, often rich in pyrite, with many bioturbations. The Ruisseau d'Oneu Mbr - (ONE, old: Sm3a): greenish sandy slates with thin beds (5 cm) of sandstone with current bedding (convolute bedding and slumping).

Stratotype: Not yet defined; type area in the Bihain syncline; type area of the Salm-Château Mbr in the "cluse" of the Salm valley between Vielsalm and Salm-Château; type area of the Ruisseau d'Oneu Mbr in the tributaries of the ruisseau de Groumont, south-east of Lierneux.

Area: In the southern part of the Stavelot Massif; in the metamorphic zone the slate contains small crystals of a particular chloritoid (ottrelite).

Thickness: Salm-Château Mbr: > 150 m; Ruisseau d'Oneu Mbr: 30 m; total thickness: > 180 m.

Age: Mid and/or Late Ordovician based on acritarchs and chitinozoans (Vanguetaine, 1974, 1986) in the Salm-Château Mbr.

4.3.4. Petites Tailles Formation - PET

Author: Geukens, 1965, 1986, 1999.

Description: Whitish quartzitic sandstone, often breccia, compact bedded chloritic slate and conglomeratic sandstone with greenish shale pebbles.

Stratotype: Not yet defined; type area in the vicinity of Baraque de Fraiture and the hamlet Petites Tailles.

Area: Southern part of the Stavelot Massif.

Thickness: (>75 m).

Age: Without macrofossils and only long-ranging acritarchs present (Vanguetaine, unpublished); by its stratigraphical position supposedly between Mid or Late Ordovician (age of the underlying Bihain Fm) and the late Lochkovian (age of covering Fozz Fm, Hance *et al.*, 1992). Geukens (1999) accepts for at least part of the formation an equivalence with the Colanhan Mbr of the Otré Fm.

5. Rocroi massif

5.1. Deville Group - old Dv

Description: Equivalent of the "Système Devillien" of Dumont (1847). It consists of two formations from base

to top: the La Longue-Haie and the Les 4 Fils Aymon Fms. The upper boundary of the Deville Group with the Revin Group is placed by Beugnies (1960) at the top of the Renaissance Mbr (Les 4 Fils Aymon Fm); its lower boundary is not observed.

5.1.1. La Longue-Haie Formation - LLH (old: Dv1)

Author: Beugnies, 1960.

Description: Subdivided into two members. The unnamed lower member (old: Dv1a), contains at its top an alternation of green slate and 10 to 20 cm thick beds of green fine-grained quartzite, laminated or cross-bedded; at its base 5 to 6 m thick whitish quartzite beds, alternating with 1 to 2 m thick green slate layers. The lower boundary of the formation is not observed (Beugnies, 1960). The Sainte-Anne Member (SAN, old: Dv1b) alternation of quartzite beds, a few centimetres thick, and of purple, red or green slate, 0.10 to 1.50 m thick.

Stratotype: Not yet defined; type area of the formation: in the Semois valley, south-east of Monthermé; stratotype of the Sainte-Anne Mbr: abandoned roofing slate quarry, west of the city of Fumay, right bank of the Meuse river.

Area: It occurs in a northern and a southern region of the Rocroi Massif, at the centre of two anticlinal structures. In the southern part of the massif in the metamorphic area, magnetite octahedrons are present in all lithologies of the Sainte-Anne Mbr, but slates contain more of them than the quartzite; the purple to red colours of the slate in the northern areas are replaced by light colours in the south. Both the presence of magnetite and the light colours are characteristic for the formation in the south.

Thickness: At least 130 m with 4 to 9 m for the Sainte-Anne Mbr (Beugnies, 1960).

Age: No fossils are described from the formation: an early Early Cambrian to possibly Proterozoic age is tentatively postulated.

5.1.2. Les 4 Fils Aymon Formation - QFA (old: Dv2)

Author: Beugnies, 1960.

Description: Subdivided into two members. the unnamed lower member (old: Dv2a): at the base several meters of quartzite beds occur, covered by an alternation of quartzite, one meter thick, and slate a few centimetres thick. The less coarse-grained quartzite is light-coloured (white, pink or greenish), the slate is green or red; the slate contains some ilmenite, but no or very little magnetite. The sediments of this unit are generally coarser than the La Longue-Haie Fm. Beds are lens-shaped. The quartzite beds of one meter thickness or more are often conglomeratic. The La Renaissance Member - (LRE, old: Dv2b): in the north is a vein of light-coloured, purple/violet, red roofing slate; only one quartzite bed occurs within the member; in the south the colour is green.

Stratotype: Crags of "Les 4 Fils Aymon" north of the village Château-Regnault, Meuse valley; stratotype of the La Renaissance Mbr in the abandoned roofing slate quarry, south-east of Fumay, right bank of the Meuse.

Area: The unnamed lower mbr has a composition changing according to the area. It is quartzitic and slaty in the south, the region of Deville and Monthermé, quartzitic in the north-east, the region of Fumay, Haybes, Oignies, Rimogne and Eteignières, and coarse arkosic in the north-west, the region of Bruly, Gué d'Hossus and Petite-Chapelle (Beugnies, 1960).

Thickness: 95 to 270 m for the formation, with 15 to 25 m for the La Renaissance Mbr (Beugnies, 1960).

Age: The ichnofossil *Oldhamia radiata* is present in the slaty lower part of the formation in the north of the massif (Dewalque *in* Malaise, 1874b; Beugnies, 1960); this genus appears above the Cambrian-Precambrian boundary (Crimes, 1992). According to new observations by A. Seilacher (pers. comm., 1998) the genus *Oldhamia* is restricted in range to only the Tommotian or Nemakitian-Daldynian (early Early Cambrian). Acritarchs in the upper part of the lower mbr, above the *Oldhamia* occurrences, belong to the Zone 0, correlated with the Early Cambrian to early part of the Mid Cambrian (Vanguetaine, 1992). Thus an Early Cambrian to early Mid Cambrian age is proposed for the lower mbr.

5.2. Revin Group - old Rv (equivalent of the "Système Revinien" Dumont, 1847).

Description: Equivalent of the "Système Revinien" of Dumont (1847). It consists of four formations from base to top: Rocher de l'Uf, La Roche à 7 Heures, Anchamps and Petite-Commune. The upper boundary of the Revin Group with the Salm Group is here placed at the base of the Vieux-Moulins de Thilay Fm.

5.2.1. Rocher de l'Uf Formation – RUF (old: Rv1)

Author: Beugnies, 1960

Description: Formation subdivided into two members. The unnamed lower member – (old: Rv1a) is made of an alternation of quartzite and slate beds up to 30 cm thick; beds seem often to be truncated; green at the base passing gradually into dark grey at the top (Beugnies, 1960; Belanger, 1998 ms). The Les Peureux Member (PEU, old: Rv1b) is a vein of black slate, not very thick, with slab or flag jointing; exploited for roofing slate.

Stratotype: Section in the crag of "le Rocher de l'Uf", south of Fumay, Meuse valley.

Area: Rocroi Massif.

Thickness: 40 to 120 m; the Les Peureux Mbr is 3 to 5 m thick (Beugnies, 1960).

Age: The acritarchs from the upper part of the formation belong to the Zone 1, dated as Early Cambrian to Mid Cambrian (Vanguetaine, 1992).

Remarks: New name for unnamed formation in Beugnies, 1960.

5.2.2. La Roche à 7 Heures Formation – RSH (old: Rv2)

Author: Beugnies, 1960.

Description: Formation subdivided into two members. The unnamed lower member – (old: Rv2a) has at the base thick quartzite beds; the thickness of the basal quartzite beds diminishes laterally to the east. The unit contains more quartzite than slate and becomes gradually more slaty than quartzitic upward; characterised by grey quartzite in 1 to 4 m thick beds; slumps and convolute laminations are often present; locally conglomeratic bands occur, mostly in the lowermost part of the unit; the less frequent slate is black, fine-grained with a mat appearance and is exploitable as roofing slate (Beugnies, 1960; Belanger, 1998 ms). The La Folie Member – (LFO, old: Rv2b), is a black slate vein, composed of an alternation of grey quartzite beds a few decimetres or more thick and of slate layers up to several meters thick.

Stratotype: Outcrops in the crags "La Roche à 7 Heures", north-east of Monthermé, Meuse valley. The La Folie Mbr has its stratotype in the abandoned roofing slate quarry, south of Fumay, left bank of the Meuse.

Area: Rocroi Massif.

Thickness: 170 to 400 m, with 10 to 30 m for the La Folie Mbr (Beugnies, 1960).

Age: Most of the formation contains acritarchs of the Zone 2, dated as the upper part of the Middle Cambrian (Vanguetaine, 1992).

5.2.3. Anchamps Formation – ANC (old: Rv3)

Author: Beugnies, 1960.

Description: Formation subdivided into three members: the unnamed lower member (old: Rv3a) black slate, slightly micaceous with a few thin black quartzite beds; the Crapaude-Pierre Member (CRP, old: Rv3b): a few black, pyritic, fine-grained quartzite beds, 4 m thick at most; the unnamed upper member (old: Rv3c): alternation of black "psammitic" slates and thin to medium bedded black pyritic quartzite (a few cm to 2 m). Towards the top the beds are increasingly thicker and the slate more and more sandy and micaceous. The boundary with the covering Petite-Commune Fm is placed below the first appearance of a quartzite bed of at least 5 m thickness. Many sedimentary structures of turbidites including convolute bedding are present. The cleavage planes of the slate beds have a polished aspect. Some slate beds contain chloritoids (Beugnies, 1960; Belanger, 1998 ms).

Stratotype: Not yet defined; type area in the outcrops along the Meuse valley south of Fumay.

Area: Rocroi massif; the Crapaude-Pierre Mbr seems to have a remarkable continuity.

Thickness: 200 to 600 m. The upper member takes up two thirds of the thickness of the formation (Beugnies, 1960).

Age: Most of the formation contains acritarchs of the Zone 4b, dated as Mid to Late Cambrian (Vanguetaine, 1992).

5.2.4. Petite-Commune Formation – PCO (old: Rv4)

Author: Beugnies, 1960.

Description: Thick beds of 5 to 10 m of black quartzite, rich in pyrite, coarse-grained, micaceous, alternating with micaceous coarse-grained pyritic slate, and fine-grained graphitic slate. Some cross-bedding can affect the alternation of quartzite and slate. The quartzite bedding planes are sometimes mammillary in form or covered by mud-cracks. The slate has a mat appearance and frequently contains in the metamorphic zone millimetric chloritoid crystals. In the top of the formation an unnamed member contains black micaceous slate, very soft, with some nodule-like structures, often pyritic, resembling the remainder of the Petite-Commune Fm, but with more slate than quartzite and with roofing slate veins. The latter member was formally called unit Rv5 (Beugnies, 1960; Belanger, 1998 ms).

Stratotype: Not yet defined; type area in the outcrops along the Meuse valley east of Laifour.

Area: Rocroi Massif.

Thickness: 500 m (Beugnies, 1960).

Age: The acritarchs studied by Vanguetaine (1978) from a sample located in the lowest part of the formation belong to the Zone 4b, dated as Mid to Late Cambrian. Outcrops in the upper part of the formation (east of the road from Vieux-Moulins-de-Tilhay to Willerzie, along the chemin de la Croix- Scaille) contain an acritarch assemblage of the Upper Cambrian (Roche *et al.*, 1986), named the cf. Zone 5 in Vanguetaine (1986). Another outcrop studied by Ribecai and Vanguetaine (1993) in the Willerzie quarry, also located in the upper part of the formation, contains an acritarch assemblage of the cf. Zone 6 of Vanguetaine (1986) also dated as Late Cambrian.

5.2.5. Vieux-Moulins de Thilay Formation - VMT

Description: Dark and light grey laminated siltstone and slate, "quartzophyllades zonaires" from the literature, with black slate levels.

Stratotype: Not yet defined; type area in the outcrops north of the hamlet of Vieux-Moulins de Thilay, close to Croix Scaille.

Area: In the core of a fold in the eastern part of the massif at Vieux-Moulins de Thilay, Franc-Bois de Willerzie, les Hubiets (Geukens, 1981; Roche *et al.*, 1986).

Thickness: Unknown.

Age: Outcrops west of Vieux-Moulins de Thilay are dated with acritarchs as Arenig to Llanvirn (Early to

Middle Ordovician) by Roche *et al.* (1986). New evidence on the range of the genus *Frankea* and the species *F. sartbernardensis* (Servais, 1993; Brocke *et al.*, 1995) allow to restrict the age of the unit from late Arenig to Llanvirn (Mid Ordovician).

Remarks: Here defined after Beugnies, 1960.

6. Givonne massif

6.1. La Chapelle Formation – LCH (old: Rv2)

Author: Beugnies, 1960.

Description: Formation subdivided into two members. The unnamed lower member (old: Rv2a), is an alternation of black quartzite in 1 to 4 m thick beds and thin bedded black roofing slate. The Olly Member (OLL, old: Rv2b) is a vein of black roofing. The lower boundary of the formation is not observed (Beugnies, 1960).

Stratotype: Not yet defined; type area in the outcrops north of the village La Chapelle and close to Illy; the Olly Member has its type area in the outcrops along the Ruisseau de la Hatrelle, east of Illy.

Area: Givonne Massif.

Thickness: At least 100 m, with the Olly Mbr only a few meters thick (Beugnies, 1960).

Age: The acritarchs in the Olly Mbr and the upper part of the lower member belong to the Zone 4b, dated as Mid to Late Cambrian. The acritarchs in the lower part of the lower member belong to the Zone 3 dated as probable Middle Cambrian (Vanguetaine, 1992); see also discussion on the ages at the Illy Fm.

6.2. Illy Formation – ILL (old: Rv3)

Author: Beugnies, 1960.

Description: Black slate and silty slate (called "quartzophyllade" in the older literature), micaceous with not frequently thin sericite laminae; the middle and upper part of the formation show frequent alternations of black slate and quartzite beds never exceeding 0.50 to 1 m in thickness. In the slate beds often microfolds are observed and more rarely millimetric chloritoid crystals (Beugnies, 1960).

Stratotype: Not yet defined; type area in the outcrops along the Ruisseau de la Hatrelle, east of Illy.

Area: Givonne Massif.

Thickness: 850 m (Beugnies, 1960).

Age: The acritarchs in the lower part of the formation belong to the Zone 4b, indicating a Mid to Late Cambrian age (Vanguetaine, 1992). This result confirms at least certain lithostratigraphic correlations of Beugnies (1960) and contradicts those of Graulich (1954) and of Fourmarier (1960) who put the Givonne massif formations at a level below the Deville Group.

6.3. Sautou Formation – SAU (old: Rv4)

Author: Beugnies, 1960.

Description: Thick beds of black pyritic quartzite of 5 to 10 m thick, separated by layers of coarse sandy and silty slate, or more rarely of graphitic fine slate or of chloritoid-bearing slate (Beugnies, 1960).

Stratotype: Not yet defined; type area in the outcrops east and north of the Sautou castle, north-east of Bosseval, specially in the Terne de la Borne valley.

Area: Givonne Massif.

Thickness: 250 m (Beugnies, 1960).

Age: Unfossiliferous: undated till now.

6.4. Pouru-au-Bois Formation - PAB (old: Rv5)

Author: after Beugnies, 1960.

Description: Subdivided into three members: the unnamed lower member (old: Rv5a): black slate, easily affected by microfolds (Beugnies, 1960); the unnamed middle member (old: Rv5b): some lenticular grey quartzite beds of 0,50 to 1 m thick, alternating with slate layers of the same thickness; the unnamed upper member (old: Rv5c): black slate and silty slate (called "quartzophyllade" in the older literature), sometimes laminated and often intensely deformed by microfolds.

Stratotype: Not yet defined; type area in the valley of the Pouru, in and north of the village of Pouru-au-Bois.

Area: Givonne Massif.

Thickness: 410 - 415 m with 100 m for the upper member, 10 to 15 m for the middle member and 300 m for the lower member (Beugnies, 1960).

Age: No fossils discovered yet; correlated by Beugnies (1960) on lithological grounds with the upper part of the Revin Group and the lower part of the Salm Group.

Remarks: Synonyms: originally described as the "Assise de Muno" (Beugnies, 1960); however, the locality name Muno was already in use for a Lockhovian unit by Maillieux & Demanet (1929); hence the name is here replaced by Pouru-au-Bois, the locality of the parastratotype section of the unit as mentioned by Beugnies (1960).

7. Serpont massif

7.1. Serpont Formation – SRP (old: Rv4)

Author: Beugnies, 1960.

Description: Black coarse-grained slate and silty slate (called "quartzophyllade" in the older literature), very rich in ilmenite and chloritoid crystals (small to 4 mm in size); the base of the unit is not observed (Beugnies, 1960).

Stratotype: Not yet defined; type area in the outcrops along the N89 (Saint-Hubert -Recogne).

Area: Serpont Massif.

Thickness: At least 250 m (Beugnies, 1960).

Age: No palaeontological data collected; Geukens and Richter (1962) place this formation partly as an equivalent of the Salm Group.

7.2. Warinsart Formation – WAS (old: Rv5)

Author: Beugnies, 1960.

Description: Subdivided into three members: the unnamed lower member (old: Rv5a): black fine-grained slate; the unnamed middle member (old: Rv5b): some thick bedded grey quartzite beds; the unnamed upper member (old: Rv5c): black fine-grained slate alternating with thin beds of quartzite (Beugnies, 1960).

Stratotype: Not yet defined; type area in the sections along the railway Namur-Arlon, west of the Bois de Warinsart.

Area: Serpont Massif.

Thickness: Upper mbr: 150 m, middle mbr: 20 m, lower mbr: 600 m (Beugnies, 1960).

Age: No palaeontological data collected; this formation is correlated by Beugnies (1960) on lithological grounds with the upper part of the Revin Group and the lower part of the Salm Group. However, Geukens and Richter (1962) restrict the entire formation to only the Revin Group.

8. Acknowledgements

We would like to thank the Belgian National Committee for Geological Sciences, and especially P. Bultynck and L. Dejonghe, for having stimulated this synthesis on lithostratigraphic units of Belgium and co-ordinated this effort with the other seven National Subcommissions on the Stratigraphy of Belgium. We also thank M. Laloux of the Ministry of the Walloon Region for checking the abbreviations of groups, formations and members.

9. References

- ANDRÉ, L., 1991. The concealed crystalline basement in Belgium and the "Avalonia" concept: constraints from the Caledonian magmatic and sedimentary rocks. *Annales de la Société géologique de Belgique*, 114 (2): 114-139.
- ANDRE, L., HERBOSCH, A., VANGUESTAINE, M., SERVAIS, T., VAN GROOTEL, G., LOUWYÉ, S. & VERNIERS, J., 1991. Guidebook of the excursion on the stratigraphy and magmatic rocks of the Brabant Massif, Belgium. In: L. ANDRE, A. HERBOSCH, M. VANGUESTAINE & J. VERNIERS, Proceedings of the International Meeting on the Caledonides of the Midlands and the Brabant Massif, Brussels, 20-23 september 1989. *Annales de la Société géologique de Belgique*, 114 (2): 283-323.

- ANTHOINE, R. & ANTHOINE, P., 1943. Les assises de Mousty et de Villers-la-Ville du bassin supérieur de la Dyle. *Annales de la Société géologique de Belgique*, 66: M53-181.
- BELANGER, I., 1998 ms. Effets d'une déformation hétérogène sur un ensemble mécaniquement anisotrope: le cas du Massif de Rocroi (Ardenne franco-belge). Ph.D. thesis, Université Catholique de Louvain, Belgium, p. 1-267 (unpublished).
- BEUGNIES, A., 1960. Stratigraphie comparée du Cambrien des massifs ardennais. Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie, 69: 91-106.
- BEUGNIES, A., 1963. Le Massif de Rocroi. Bulletin du Service de la Carte Géologique de France, 270: 59.
- BEUGNIES, A., 1973. Le Cambro-Silurien brabançon et le Dévonien-Carbonifère du flanc septentrional de Namur. Coupe de Tubize-Quenast-Fauquez-Feluy. Ardennes. Guides Géologiques Régionaux. Itinéraire 10: 89-98. Masson, Paris.
- BOUMA, A.H., 1962. Sedimentology of some flysch deposits. Elsevier, Amsterdam.
- BROCKE, R., FATKA, O., MOLYNEUX, S.G. & SERVAIS, T., 1995. First appearance of selected Early Ordovician acritarch taxa from Peri-Gondwana. In Cooper, J.D., Droser, M.L. & Finney, S.C., eds., Ordovician Odyssey. The Pacific Section Society for Sedimentary Geology, 77: 473-476.
- BULMAN, O.M.B., 1950. On some Ordovician graptolite assemblages of Belgium. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique*, 26 (5): 1-8.
- BULMAN, O.M.B. & GEUKENS, F., 1970. A new *Diclytonema* fauna from the Salmian of the Stavelot Massif. *Bulletin de la Société belge de Géologie*, 79: 213-224.
- CONSEIL GÉOLOGIQUE, 1929. Légende générale de la carte géologique détaillée de la Belgique. *Annales des Mines de Belgique*, 30: 39-80.
- CORIN, F., 1964. Sur les roches éruptives de la tranchée d'Hasquemont, canal de Charleroi. *Bulletin de la Société belge de Géologie*, 72 (1963): 94-98.
- CRIMES, T.P., 1992. Changes in the trace fossil biota across the Proterozoic-Phanerozoic boundary. *Journal of the Geological Society of London*, 149: 637-646.
- DE GEEST, P., 1998 ms. Het venster van Fond d'Oxhe (Ordoviciem-Siluur): kartering, lithostratigrafie en biostratigrafie met Chitinozoa. M. Sc., Laboratorium voor Paleontologie, Ghent University (unpublished).
- DE LA VALLEE-POUSSIN, J., 1930. Contribution à l'étude du massif "cambrien" dans la vallée de la Dyle et de la Gette. Mémoire de l'Institut de géologie, Université de Louvain, VI (III): 319-353.
- DE LA VALLEE-POUSSIN, Ch. & RENARD, A.F., 1876. Mémoire sur les caractères stratigraphiques et minéralogiques des roches dites plutoniennes de la Belgique et de l'Ardenne française. Mémoire couronné de l'Académie royale de Belgique, 40: 1-264.
- DE VOS, W., VERNIERS, J., HERBOSCH, A. & VANGUESTAINE, M., 1993. A new geological map of the Brabant Massif. In Pharaoh, T.C., Molyneux, S.G., Merriman, R.J., Lee, M.K. & Verniers, J., eds. Special Issue on the Caledonides of the Anglo-Brabant Massif. *Geological Magazine*, 130 (5): 605-611.
- DE WINTER, W., 1998 ms. Kartering, lithostratigrafie en biostratigrafie met Chitinozoa van het Siluur te Landenne, Massief van Brabant. M. Sc., Laboratorium voor Paleontologie, Ghent University (unpublished).
- DEAN, W., 1991. Ordovician trilobites from the inlier at Le Petit Fond d'Oxhe, Belgium. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique*, Sciences de la Terre, 61: 135-155.
- DEBACKER, T., SINTUBIN, M. & VERNIERS, J., 2001. Large-scale slumping deduced from structural relations and sedimentary features: a study in the Lower Palaeozoic Anglo-Brabant fold belt, Belgium. *Journal of the Geological Society, London*, 158: 341-352.
- DELCAMBRE, B. & PINGOT, J.L., in press a. Carte Chastre-Gembloux n°40/5-6, Carte Géologique de Wallonie, échelle 1/25.000. Ministère de la Région Wallonne, Namur.
- DELCAMBRE, B. & PINGOT, J.L., in press b. 2000. Carte géologique de Wallonie n°46 - 7/8 et Notice explicative de la carte Fontaine-l'Evêque - Charleroi. Ministère de la Région Wallonne, Namur, p. 1-108, 3 planches.
- DELCAMBRE, B. & PINGOT, J.L., in press c. Carte géologique de Wallonie n°53 - 1/2, Notice explicative de la carte Biesme-Mettet. Ministère de la Région Wallonne.
- DEWALQUE, G., 1894. Un nouveau gisement de fossiles siluriens à Ombret. *Annales de la Société géologique de Belgique*, 21: 80-81.
- DIEPENDAELE, B., 1997 ms. Het Ordoviciem-Siluur van Montreux-Nivelles, Massief van Brabant, litho- en biostratigrafische studie met Chitinozoa, 130 p. M. Sc., Laboratorium voor Paleontologie, Ghent University (unpublished).
- DOREMUS, P. & HENNEBERT, M., 1995. Carte Lens-Soignies n°38/7-8, Carte Géologique de Wallonie, échelle 1/25.000. Ministère de la Région Wallonne, Namur.
- DUMONT, A.H., 1848. Mémoire sur les terrains ardennais et rhénan de l'Ardenne, du Rhin, du Brabant et du Condroz. II. Terrain rhénan. *Mémoires de l'Académie royale de Belgique, Classe des Sciences*, 22: 1-451.
- DUSAR, M. & LANGENAEKER, V., 1992. De oostrand van het Massief van Brabant, met beschrijving van de geologische verkenningboring te Martenslinde. *Professional Paper*, Belgische Geologische Dienst, 1992/5, 255: 1-22.
- FORTEY, R.A., HARPER, D.A.T., INGHAM, J.K., OWEN, A.W. & RUSHTON, A.W.A., 1995. A revision of Ordovician series and stages from the historical type area. *Geological Magazine*, 132 (1): 15-30.
- FOURMARIER, P., 1920. La tectonique du Brabant et des régions voisines. *Mémoires de l'Académie royale de Belgique, Classe des Sciences*, 2è serie, tome 4 (6), 95: 41-50.
- FOURMARIER, P., 1960. Rapports sur le mémoire de M.A. Beugnies, Le massif cambrien de Givonne. *Mémoire de la Société géologique de Belgique*, 83: 28-32.
- GERLACHE, L., 1956. Contribution à l'étude du massif siluro-cambrien du Brabant dans la vallée de l'Orneau. *Bulletin de l'Institut Agronomique de Gembloux*, 24 (2): 131-141.
- GEUKENS, F., 1950. Quelques nouveaux gîtes à *Diclytonema flabelliforme* dans le massif de Stavelot. *Bulletin de la Société belge de Géologie*, 59: 163-169.
- GEUKENS, F., 1954. Quelques remarques au sujet de la répartition des *Diclytonema flabelliforme* dans le massif cambrien de Stavelot (Belgique). Congrès Géologique International, Alger, sect. 13, fasc. 15: 45-52.
- GEUKENS, F., 1965. Problème stratigraphique relatif aux planchettes Odeigne-Bihain. *Bulletin de la Société belge de Géologie*, 74: 214-219.
- GEUKENS, F., 1981. Observations géologiques dans la région de Willerzie. *Annales de la Société géologique de Belgique*, 104: 67-73.
- GEUKENS, F., 1986. Commentaire à la carte géologique du Massif de Stavelot. *Aardkundige Mededelingen*, 3: 15-29.
- GEUKENS, F., 1999. Notes accompagnant une révision de la carte structurale du Massif de Stavelot. *Aardkundige Mededelingen*, 9: 183-190.
- GEUKENS, F. & RICHTER, D., 1962. Problèmes géologiques dans le massif de Serpont (Ardennes). *Bulletin de la Société belge de Géologie*, 70: 196-212.
- GODEFROID, J., BLIECK, A., BULTYNCK, P., DEJONGHE, L., GERRIENNE, P., HANCE, L., MEILLIEZ, F., STAINIER, P. & STEEMANS, P., 1994. Les formations du Dévonien inférieur de la Vesdre, de la Fenêtre de Theux et du Synclinorium de Dinant (Belgique, France). *Mémoires pour servir à l'Explication des Cartes Géologiques et Minières de la Belgique*, 38: 1-144.
- GOSSELET, J., 1873. Esquisse géologique du département du Nord et des régions contrées voisines. Premier fascicule. Terrains primaires. Lille, p. 1-107.

- GOSSELET, J., 1888. L'ardenne. Mémoire des Cartes géologiques détaillée de la France, 1888, Paris, p. 1-889.
- GRADSTEIN, F. & OGG, J., 1996. A Phanerozoic time scale. *Episodes*, 19 (1-2).
- GRAULICH, J.M., 1954. Le Cambrien-Trémadocien. In Fourmarier, ed., *Prodrôme d'une description géologique de la Belgique*. Imprimerie Vaillant Carmanne, Liège, p. 21-28.
- GRAULICH, J.M., 1961. Le sondage de Wépion. *Mémoires pour servir à l'explication des Cartes géologiques et minières de la Belgique*, 2: 1-102.
- HANCE, L., DEJONGHE, L. & STEEMANS, L., 1992. Stratigraphie du Dévonien inférieur dans le Massif de la Vesdre (Belgique). *Annales de la Société géologique de Belgique*, 115: 119-134.
- HEDBERG, H.D., 1976 (ed.). *International stratigraphic guide, a guide to stratigraphic classification, terminology, and procedure*. Wiley & Sons, New York, p. 1-200.
- HERBOSCH, A., VANGUESTAINE, M., DEGARDIN, J.M., DEJONGHE, L., FAGEL, N. & SERVAIS, T., 1991. Etude lithostratigraphique, biostratigraphique et sédimentologique du sondage de Lessines (Massif du Brabant). *Annales de la Société géologique de Belgique*, 114 (1): 195-212.
- HERBOSCH, A., VERNIERS, J., DEBACKER, T., BILLIAERT, B., DE SCHEPPER, S., BELMANS, M. 2001. The Lower Palaeozoic stratigraphy and sedimentology of the Brabant Massif in the Dyle and Orneau valleys and of the Condroz Inlier at Fosses: an excursion guidebook. Pre-symposium excursion of the International Symposium on "Early Palaeozoic Palaeogeographies and Biogeographies of Western Europe and North Africa", Lille USTL, September 22-26, 2001, 77 p. (submitted to *Geologica Belgica*).
- HOLLAND, C.H. & BASSETT, M.G., 1989 (eds). A global standard for the Silurian System. National Museum of Wales, Geological Series, 9: 1-325. Cardiff.
- KAISIN, F., 1919. Esquisse sommaire d'une description géologique de la Belgique. *Uystruyt*, Louvain, p. 1-154.
- LASSINE, A., 1913. Sur les gites fossilifères du silurien de la planchette de Tamines Fosse. *Bulletin de la Société belge de Géologie*, 27: 72-76.
- LECOMPTE, M., 1948. Existence du trémadocien dans le massif du Brabant. *Bulletin de l'Académie Royale des Sciences, Lettres et Beaux Arts de Belgique, Classe des Sciences*, 5è Série, 34: 677-687.
- LECOMPTE, M., 1949. Découverte de nouveaux gites à Dictyonema dans le Trémadocien du massif du Brabant. *Bulletin de l'Institut royal des Sciences Naturelles de Belgique*, 25 (45): 1-8.
- LECOMPTE, M., 1957. Schistes et quartzites de Jodoigne. In Pruvost, P. & Waterlot, G., eds, *Lexique Stratigraphique International*. Volume 1: Europe, Fascicule 4a1: France, Belgique, Pays-Bas, Luxembourg, Antécambrien et Paléozoïque Inférieur, p. 268.
- LEGRAND, R., 1961a. Le Tarannonien à graptolites reconnu sous Courtrai (Flandre occidentale). *Bulletin de la Société belge de Géologie*, 70: 174-185.
- LEGRAND, R., 1961b. Mise à jour de la légende stratigraphique du Gothlandien inférieur du massif du Brabant. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie*, 70: 186-195.
- LEGRAND, R., 1964. Le forage de Lichtervelde (1935-1939); la coupure faunique entre le Silurien et l'Ordovicien par rapport à l'unité géologique de l'Ashgillien. *Bulletin de la Société belge de Géologie*, 73: 53-64.
- LEGRAND, R., 1966. Sondage à Deerlijk. *Professional Paper of the Belgian Geological Survey*, 4: 1-17.
- LEGRAND, R., 1967. Ronquières, documents géologiques. *Mémoires pour servir à l'explication des Cartes géologiques et minières de la Belgique*, 6: 1-60.
- LEGRAND, R., 1968. Le Massif du Brabant. *Mémoires pour servir à l'explication des Cartes géologiques et minières de la Belgique*, 9: 1-148.
- LENOIR, J.L., 1987 ms. L'étude cartographique, pétrographique et palynologique de l'Ordovicien inférieur du bassin de la Senne. M. Sc. thesis, Université Libre de Bruxelles (unpublished).
- LERICHE, M., 1920. L'étage de Caradoc dans la vallée de la Sennette. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie*, 30: 56-59.
- LESPÉRANCE, P.J. & SHEEHAN, P.M., 1987. Trilobites et Brachiopodes ashgilliens (Ordovicien supérieur) de l'"Assise" de Fosse, Bande de Sambre-Meuse (Belgique). *Bulletin de l'Institut royal des Sciences Naturelles de Belgique, Sciences de la Terre*, 57: 91-123.
- LONGUEVILLE, G., 1997 ms. Geologische kartering, litho- en biostratigrafie van het Onder-Paleozoïcum in de Markvallei (Massief van Brabant). M. Sc., Laboratorium voor Paleontologie, Ghent University, 72 p. + 98 p. annexes (unpublished).
- LOUWYÉ, S., VAN GROOTEL, G. & VERNIERS, J., 1992. The stratigraphy of the type locality of the? late Wenlock/early Ludlow Mont Godart Formation and the early Ludlow Ronquières Formation, Brabant Massif, Belgium. *Annales de la Société géologique de Belgique*, 115 (1): 307-331.
- MAES, G., RICKARDS, B., ROMBOUTS, L. & VANDEVELDE, N., 1979. Silurian formations between Neuville-sous-Huy and Ombret; their correlation, age and structure. *Annales de la Société géologique de Belgique*, 101 (1978): 31-36.
- MAILLIEUX, E., 1926. Remarques sur l'Ordovicien de la Belgique. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie*, 36: 67-85.
- MAILLIEUX, E. & DEMANET, F., 1929. L'échelle stratigraphique des terrains primaires de la Belgique. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie*, 38: 124-131.
- MAILLIEUX, E., 1930a. Observations nouvelles sur le Silurien de Belgique sur la présence du Ludlowien supérieur dans le Silurien de Sambre-Meuse. *Bulletin du Musée Royal d'Histoire naturelle de Belgique*, 6 (15): 1-8.
- MAILLIEUX, E., 1930b. Contribution à l'étude du silurien du sous-sol de Hesbaye. *Bulletin du Musée Royal d'Histoire naturelle de Belgique*, 6 (14): 1-4.
- MAILLIEUX, E., 1933. Terrains, roches et fossiles de la Belgique, 2 édition. *Publications du Musée Royal d'Histoire naturelle de Belgique*, p. 13-38.
- MAILLIEUX, E., 1939. L'Ordovicien de Sart-Bernard. *Mémoire du Musée Royal d'Histoire naturelle de Belgique*, 86, 1-59.
- MALAISE, C., 1873. Description du terrain Silurien du centre de la Belgique. *Mémoire couronné de l'Académie royale de la Belgique*, 37: 1-122.
- MALAISE, C., 1874a. Sur la découverte du *Dictyonema sociale* Salt. de la faune primordiale dans le massif de Rocroi. *Bulletin de l'Académie royale de la Belgique*, 36: 464-465.
- MALAISE, C., 1874b. Sur l'âge de quelques couches du terrain ardenais des environs de Spa. *Bulletin de l'Académie royale de la Belgique*, 2ième série, 37: 800-801.
- MALAISE, C., 1879. Sur l'arsenopyrite et l'eau arsenicale de Court St-Etienne. *Bulletin de l'Académie Royale de la Belgique*, 2ième série, 47: 29-34.
- MALAISE, C., 1883. Etudes sur les terrains silurien et cambrien de la Belgique. *Bulletin de l'Académie Royale de la Belgique, Classe des Sciences*, 5: 1-30.
- MALAISE, C., 1888. A propos des schistes siluriens de Huy. *Bulletin de la Société malacologique de Belgique*, 23.
- MALAISE, C., 1900. Etat actuel de nos connaissances sur le Silurien de la Belgique. *Annales de la Société géologique de Belgique*, *liber memoriales*, 25bis, in -4.
- MALAISE, C., 1903. Compte rendu de la session extraordinaire de la Société Géologique de Belgique tenue à Namur, le 19, 20 septembre 1903. *Annales de la Société géologique de Belgique*, 30: 132-134.

- MALAISE, C., 1909. Echelle stratigraphique du silurien de Belgique et âge géologique des schistes noirs de Mousty. *Annales de la Société géologique de Belgique*, 36: 31-39.
- MALAISE, C., 1910. Stratigraphie du Massif Cambro-Silurien du Brabant. *Annales de la Société Géologique de Belgique*, 38: 136-142.
- MALAISE, C., 1911. Sur l'évolution de l'échelle stratigraphique du Siluro-cambrien de Belgique. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie*, 24: 415-437.
- MALAISE, C., 1913. Communications et rectifications siluriennes. *Annales de la Société géologique de Belgique*, 40: B377, B447.
- MALETZ, J. & SERVAIS, T., 1998. Upper Ordovician graptolites from the Brabant Massif, Belgium. *Geobios* 31 (1): 21-37.
- MALETZ, J., 1999. Lowermost Silurian graptolites of the Deerlijk 404 well, Brabant Massif (Belgium). *Jahrbuch für Geologie und Paläontologie, Abhandlungen*, 213 (3): 335-354.
- MARECHAL, R., 1992. De geologische structuur. In Denis, J., ed., *Geografie van België*. Gemeentekrediet, Brussel, p. 36-86.
- MARTIN, F., 1965. Les acritarches de Sart-Bernard (Silurien belge). *Bulletin de la Société belge de Géologie*, 74: 423-444.
- MARTIN, F., 1969a. Les acritarches de l'Ordovicien et du Silurien belge. Détermination et valeur stratigraphique. *Mémoires de l'Institut Royal des Sciences naturelles de Belgique*, 160: 1-176.
- MARTIN, F., 1969b. Ordovicien et Silurien belge: données nouvelles apportées par l'étude des acritarches. *Bulletin de la Société belge de Géologie*, 77: 175-181.
- MARTIN, F., 1976. Acritarches du Cambro-Ordovicien du Massif du Brabant, Belgique. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 51 (1) (1975): 1-33.
- MARTIN, F. & RICKARDS, B., 1979. Acritarches, chitinozoaires et graptolithes ordoviciens et siluriens de la vallée de la Sennette (Massif du Brabant, Belgique). *Annales de la Société géologique de Belgique*, 102: 181-197.
- MARTIN, F., MICHOT, P. & VANGUESTAINE, M., 1970. Le flysch caradocien d'Ombret. *Annales de la Société géologique de Belgique*, 93: 337-362.
- MICHOT, P., 1927. Sur un gîte de graptolithes du Silurien. *Annales de la Société géologique de Belgique*, 50 (6): B184-185.
- MICHOT, P., 1928. La bande silurienne de Sambre-et-Meuse entre Fosse et Boufioulx. *Annales de la Société géologique de Belgique*, 51: M57-103.
- MICHOT, P., 1930. Sur un gîte à graptolithes à Voroux-Goreux. *Annales de la Société géologique de Belgique*, 53: B198-200.
- MICHOT, P., 1932a. La tectonique de la bande silurienne de Sambre-et-Meuse entre Huy et Ombret. *Annales de la Société géologique de Belgique*, 55: M73-94.
- MICHOT, P., 1932b. La tectonique de la bande silurienne de Sambre-et-Meuse entre Dave et la rivière de Samson. *Annales de la Société géologique de Belgique*, 55: B129-144.
- MICHOT, P., 1934. La stratigraphie du Silurien de la bande Sambre-et-Meuse. *Académie royale Belge, Classe des Sciences, Mémoires in -8, 2^e série*, 13 (2): 1-108.
- MICHOT, P., 1954. Le Silurien. In: Prodrôme d'une description géologique de la Belgique. Imprimerie Vaillant Carmanne, Liège, p. 39-82.
- MICHOT, P., 1957. Description of different formations. In Pruvost, P., & Waterlot, G. eds, *Lexique Stratigraphique Internationale*. Volume 1: Europe, Fascicule 4a1: France, Belgique, Pays-Bas, Luxembourg: Antécambrien et Paléozoïque Inférieur, p. 1-432.
- MICHOT, P., 1978. L'Ordovicien de la vallée de la Thyle (Brabant); structure tectonique, stratigraphie et lithologie. *Annales de la Société géologique de Belgique*, 100: 223-231.
- MICHOT, P., 1980. Belgique: Introduction à la géologie générale. 26th International Geology Congress, Guidebook G16. Paris, p. 487-576.
- MORTELMANS, G., 1955. Considération sur la structure tectonique et la stratigraphie du Massif du Brabant. *Bulletin de la Société belge de Géologie*, 64: 179-218.
- MORTELMANS, G., 1977. Le groupe Devillien: Cambrien ou Précambrien? *Annales des Mines de Belgique*, 1977: 309-334.
- MOURLON, M., 1900. In Archives of the Geological Survey of Belgium, point 128^e38 (24/04/1900).
- MULLINS, G.L., 1998. Shelf to basin correlation: integrating the Silurian Chitinozoan and graptolite biostratigraphical schemes. Programme and Abstracts of the CIMP Symposium and workshops (September 11-15, 1998). Pisa, p. 19-20.
- NIJS, R. & LOGIER, B., 1990. Petrographical characteristics of the Cambrian ("Devillien") quartzites from the Brabant Massif. *Natuurwetenschappelijk Tijdschrift*, 72: 90-102.
- PARIS, F., 1981. Les Chitinozoaires dans le Paléozoïque du Sud-Ouest de l'Europe. *Mémoire de la Société Géologique et Minéralogique de Bretagne*, 26: 1-412.
- PHARAOH, T.C., MOLYNEUX, S.G., MERRIMAN, R.J., LEE, M.K. & VERNIERS, J., 1993. The Caledonides of the Anglo-Brabant Massif reviewed. In Pharaoh, T.C., Molyneux, S.G., Merriman, R.J., Lee, M.K. & Verniers, J., eds, Special Issue on the Caledonides of the Anglo-Brabant Massif. *Geological Magazine*, 130 (5), 561-562.
- RAYNAUD, J., 1952. Contribution magnétique à la connaissance géologique du massif de la Gette. *Annales de la Société géologique de Belgique*, 75: 283-291.
- REGNELL, G., 1951. Revision of the Caradocian-Ashgillian cystoid fauna of Belgium with notes on isolated pelmatozoan stem fragments. *Mémoires de l'Institut Royal des Sciences Naturelles de Belgique*, 120: 1-47.
- RIBECAL, C. & VANGUESTAINE, M., 1993. Latest Middle-Late Cambrian acritarchs from Belgium and northern France. *Special Papers in Palaeontology*, 48: 45-55.
- RICHTER, E. & RICHTER, R., 1951. Trilobiten von Ashgill-Alter aus dem Massif du Brabant (Grand-Manil). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique*, 27 (16): 1-6.
- ROBASZYNSKI, F. & DUPUIS, C., 1983. Belgique. Guides Géologiques Régionaux. Masson, Paris, p. 1-204.
- ROCHE, M., SABIR, M., STEEMANS, P. & VANGUESTAINE, M., 1986. Palynologie du sondage et de la région de Willerzie. *Aardkundige Mededelingen*, 3: 149-190.
- SAMUELSSON, J. & VERNIERS, J., 1999. Middle to Late Ordovician Chitinozoan Biozonation of the Sennette, Dyle-Thyle and Orneau Valleys, Brabant Massif, Belgium. *Acta Universitatis Carolinae-Geologica*, 43 (1/2): 299-302.
- SAMUELSSON, J. & VERNIERS, J., 2000. Ordovician chitinozoan biozonation of the Brabant Massif, Belgium. *Review of Palaeobotany and Palynology*, 113: 105-129.
- SERVAIS, T., 1993. A critical review of some Ordovician acritarch taxa and their stratigraphical implications in Belgium and Germany, 3 volumes. Ph.D. Thesis (Université de Liège).
- SERVAIS, T., HERBOSCH, A. & VANGUESTAINE, M., 1993. Review of the stratigraphy of the Ordovician in the Brabant Massif, Belgium. *Geological Magazine*, 130: 699-710.
- SERVAIS, T. & MALETZ, J., 1992. Lower Llanvirn (Ordovician) graptolites and acritarchs from the «Assise de Huy», Bande de Sambre-et-Meuse, Belgium. *Annales de la Société géologique de Belgique*, 115: 265-285.
- SHEEHAN, P.M., 1987. Late Ordovician (Ashgillian) Brachiopods from the region of the Sambre and Meuse rivers, Belgium. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Sciences de la Terre*, 57: 5-81.
- STEEMANS, P., 1994. Géologie de la région de Puagne, Bande de Sambre-et-Meuse (Belgique). Hypothèses basées sur l'état de maturation des palynomorphes fossiles. *Compte rendu de l'Académie des Sciences*, Paris, série II, 318: 1551-1556.

- TOURNEUR, F., VANGUESTAINE, M., BUTTLER, C., MAMET, B., MOURAVIEFF, N., POYT, E. & PRÉAT, A., 1993. A preliminary study of Ashgill carbonate beds from the lower part of the Fosses Formation (Condroz, Belgium). *Geological Magazine* 130 (5): 673-679.
- VANDER AUWERA, J., et ANDRE, L., 1985. Sur le milieu de dépôt, l'origine des matériaux et de faciès métamorphique de l'Assise de Tubise (Massif du Brabant, Belgique). *Bulletin de la Société belge de Géologie*, 94 (2): 171-184.
- VANDEVELDE, N., 1976 ms. Chitinozoa uit het Llandovery-Wenlock te Neuville-sous-Huy (met stratigrafische opnamen). M. Sc. Thesis, Laboratorium voor Paleontologie, Ghent University (unpublished).
- VAN GROOTEL, G., 1990 ms. Litho- en biostratigrafische studie met Chitinozoa in het westelijk deel van het Massief van Brabant. Deel 1: 90 p. + annexes 40 p.; deel 2: 108 p., 55 fig. 13 pl. Ph.D. thesis, Laboratorium voor Paleontologie, Ghent University (unpublished).
- VAN GROOTEL, G., VERNIERS, J., GEERKENS, B., LADURON, D., VERHAEREN, M., HERTOGEN, J. & DE VOS, W., 1997. Timing of magmatism, foreland basin development, metamorphism and inversion in the Anglo-Brabant fold belt. *Geological Magazine*, 134 (5): 607-616.
- VAN GROOTEL, G., ZALASIEWICZ, J., VERNIERS, J. & SERVAIS, T., 1998. Chitinozoa and graptolite biozonation of the Aeronian and lower Telychian in the Brabant Massif (Belgium). *Temas Geológico-Mineras ITGE* (Madrid), 23: 135-136.
- VAN GROOTEL, G. & VERNIERS, J., 1998 ms. The Upper Ordovician of the Fauquez area (Brabant Massif, Belgium). Lithostratigraphy and Biostratigraphy. Unpublished report to the Belgian Geological Survey, 17-80.
- VANGUESTAINE, M., 1974. Espèces zonales d'Acritarches du Cambro-Trémadocien de Belgique et de l'Ardenne Française. *Review of Palaeobotany and Palynology*, 18: 63-82.
- VANGUESTAINE, M., 1978. Données palynologiques nouvelles dans l'Ordovicien inférieur de la Senne, Massif du Brabant, Belgique. *Annales de la Société géologique de Belgique*, 100 (1977): 193-198.
- VANGUESTAINE, M., 1986. Progrès récents de la stratigraphie par acritarches du Cambro-Ordovicien d'Ardenne, d'Islande, d'Angleterre, du pays de Galles et de la Terre Neuve orientale. *Annales de la Société Géologique du Nord*, 105 (2): 65-76.
- VANGUESTAINE, M., 1992. Biostratigraphie par acritarches du Cambro-Ordovicien de Belgique et des régions limitrophes: synthèse et perspectives d'avenir. *Annales de la Société géologique de Belgique*, 115: 1-18.
- VANGUESTAINE, M. & RUSHTON, A., 1979. Découverte d'un brachiopode inarticulé, *Acrotele* cf. *bergeroni* WALCOTT, dans le Revinien inférieur de Trois-Ponts, Cambrien du Massif de Stavelot, Belgique. *Annales de la Société géologique de Belgique*, 102: 295-301.
- VANGUESTAINE, M. & VAN LOOY, J., 1983. Acritarches du Cambrien Moyen de la vallée du Tachedirt (Haut-Atlas, Maroc) dans le cadre d'une nouvelle zonation du Cambrien. *Annales de la Société géologique de Belgique*, 106: 69-85.
- VANGUESTAINE, M., SERVAIS, T. & STEEMANS, P., 1989. Biostratigraphy of 28 boreholes in the Brabant Massif. Abstracts of the International Meeting on the Caledonides of the Midlands and the Brabant Massif, p. 46.
- VERNIERS, J., 1976 ms. Het Siluur van de Mehaigne, Stratigrafie en Chitinozoa, three parts and figures, 171 + 127 + 63 p + fig. + plates. Ph.D. thesis, Laboratorium voor Paleontologie, Ghent University (unpublished).
- VERNIERS, J., 1981. The Silurian of the Mehaigne Valley (Brabant Massif, Belgium); Biostratigraphy (Chitinozoa). *Review of Palaeobotany and Palynology*, 34: 165-174.
- VERNIERS, J., 1982. The Silurian Chitinozoa of the Mehaigne area (Brabant Massif, Belgium). *Professional Paper of the Belgian Geological Survey* 1982/6, 192: 1-76, 10 figs., 9 pl.
- VERNIERS, J., 1983a. The Silurian of the Mehaigne area (Brabant Massif, Belgium); Lithostratigraphy and features of the sedimentary basin. *Professional Paper of the Belgian Geological Survey*, 203: 1-57, 17 fig., 34 maps, profiles.
- VERNIERS, J., 1983b. L'Ordovicien-Silurien du Massif du Brabant et le Dévono-Carbonifère du Synclorium de Namur dans la Vallée de l'Orneau. Première journée: L'Ordovicien et le Silurien du Massif du Brabant. In Robaszynski, F. & Dupuis, C., eds, Belgique. Guides Géologiques Régionaux. Itinéraire 9: 147-151. Masson, Paris, ISBN 2-225-75394-6.
- VERNIERS, J., 1999. Calibration of Wenlock Chitinozoa versus graptolite biozonation in the Wenlock of Builth Wells district (Wales, U.K.), compared with other areas in Avalonia and Baltica. *Bollettino della Società paleontologica italiana*, 38 (2-3): 359-380.
- VERNIERS, J. & DE VOS, W., 1995. Recent research on the Brabant Massif. Proceedings of the Europrobe TESZ Symposium, Liblice, Czech Republik, October 1993. *Studia geophysica & geodaetica*, 39: 347-353.
- VERNIERS, J. & RICKARDS, B., 1979. Graptolites et Chitinozoaires siluriens de la vallée de la Burdinale, Massif du Brabant, Belgique. *Annales de la Société géologique de Belgique*, 101 (1978): 149-161, 5 figs., 2 pl.
- VERNIERS, J. & VAN GROOTEL, G., 1991. Review of the Silurian in the Brabant Massif, Belgium. In Andre, L., Herbosch, A., Vanguestaine, M. & Verniers, J., Proceedings of the International Meeting on the Caledonides of the Midlands and the Brabant Massif, Brussels, 20-23 September 1989. *Annales de la Société géologique de Belgique*, 114 (1): 163-193.
- VERNIERS, J., LOUWYE, S. & VAN GROOTEL, G., 1992. Lithostratigraphical descriptions of the Mont Godart and the Ronquières Formations in their type localities and evaluation of the previous descriptions. *Professional Paper of the Belgian Geological Survey*, 1992/2, 252: 1-67.
- VERNIERS, J., NESTOR, V., PARIS, F., DUFKA, P., SUTHERLAND, S. & VAN GROOTEL, G., 1995. A global Chitinozoa biozonation for the Silurian. *Geological Magazine*, 132 (6): 651-666.
- VERNIERS, J., SAMUELSSON, J., VAN GROOTEL, G., DE GEEST, P. & HERBOSCH, A., 1999. The Ordovician in Belgium: new litho- and biostratigraphical data with Chitinozoa from the Brabant Massif and the Condroz Inlier (Belgium). *Acta Universitatis Carolinae-Geologica*, 43 (1/2): 93-96.
- WATERLOT, G., BEUGNIES, A., BONTE, A., CHARLET, J.M., CORSIN, P., BINTZ, J., HARY, A., & MULLER, A., 1973. Ardenne - Luxembourg. Ardennes. Guides Géologiques Régionaux. Itinéraire 10: 89-98. Masson, Paris.
- WEBBY, B.D., 1998. Steps towards a global standard for the Ordovician stratigraphy. *Newsletter Stratigraphy*, 36 (1): 1-33.
- ZALASIEWICZ, J., WILLIAMS, M., VERNIERS, J. & JACHOWICZ, M., 1998. A revision of the graptolite biozonation and calibration with the chitinozoa and acritarch biozonations for the Wenlock succession of the Builth Wells district, Wales, U.K. *Temas Geológico-Mineras ITGE* (Madrid), 23: 141.