Proposal to NCS – Upper Devonian lithostratigraphy

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- Newly defined units are indicated in green.

- Units defined in recent literature (mostly Carte géologique de Wallonie), formally introduced here are in blue.

- Units changing of statute (formation > members, members > facies) are indicated in yellow.

- Significative changes to existing units are indicated in red.

Aisemont Formation – AIS

Origin of name. From Aisemont, *Assise d'Aisemont* in Graulich (1961, p. 39, 68). This term does not have to be confused with the *Grès et psammites d'Aisémont* of Cornet (1923, p. 181) and the *Psammites d'Aisémont* of Cornet (1927, p. 496), which have fallen into disuse; they would correspond to the Rouillon Member of the Rivière Formation (see Denayer et al., this volume).

Description. In its type area, the Aisemont Formation rests abruptly on the limestones of the Lustin Formation and is covered by the shales of the Franc-Waret Formation (Delcambre & Pingot, 2014). It is characterised by two carbonate members (*premier* and *second biostrome à Phillipsastrea* sensu Coen, 1974; Coen-Aubert, 1974a, 1974b; Coen et al., 1976; Coen-Aubert & Lacroix, 1979) that are separated by a shaly interval. These lower, middle and upper terms or members of the literature (e.g. Lacroix, 1999a; Poty & Chevalier, 2007; Denayer & Poty, 2010) are formally named herein and are the following, in ascending order: the Tchafornis, Mallieue and Fond des Cris members.

In its stratotype at Engis, the c. 6 m thick Tchafornis Member – TCH (from the disused Tchafornis quarry at Engis) begins with bioturbated limestone rich in siliceous sponge spicules, crinoid ossicles and colonial corals (*Frechastraea*, *Alveolites*) (Poty & Chevalier, 2007). This is followed by an almost 4 m thick biostromal episode formed by the accumulation of laminar and discoid colonies of rugose corals (mainly *Frechastraea*), which can represent up to 90% of the volume of the rock (Poty & Chevalier, 2007). The biostromal level passes vertically to argillaceous limestones, more or less dolomitised, with numerous rugose (*Frechastraea*, *Hankaxis* and *Phillipsastrea*) and tabulate (*Alveolites*, auloporides) corals, then to clayey dolomites. In more distal areas, tabulate corals and scarce stromatoporoids are also present in various proportions (Poty & Chevalier, 2007).

The Mallieue Member – MLL (from the La Mallieue section along the road N617 at Engis) is essentially composed of green to brown and black shales. In its type section, where it reaches 13 m in thickness, it starts with a 0.7 m thick bed of calcareous shale, more or less dolomitised, followed by 4 m of grey shale, then 7.3 m of shale, sometimes calcareous and ends with 1 m of calcareous shale passing into argillaceous limestone. Brachiopods (e.g. lingulides, productidines, spiriferides) can be abundant, but numerous molluscs (bivalves, orthoconic cephalopods, gastropods) are also present, essentially in its third part (Mottequin et al., 2015; Goolaerts et al., 2017). The Mallieue Member may incorporate very locally (Chaudfontaine boreholes 134E/303, 134E/310, 134E/396) grey and red, or even pink limestones that were interpreted as being of biohermal origin (Graulich, 1967; Coen-Aubert, 1974a; Graulich & Vandenven, 1978; Dejonghe, 1987a; Boulvain, 1993b), but these limestones could correspond to biostrome such as those of the Tchafornis Member that are reddish in the area and thickened by local tectonics. The Mallieue Member corresponds to the Lower Kellwasser Event (Poty & Chevalier, 2007; Denayer & Poty, 2010; Mottequin & Poty, 2016).

The Fond des Cris Member – FDC (from the disused Fond des Cris quarry at Ninane) consists of grey to black stylonodular bioclastic limestone, often dolomitised, with numerous oncoids and rugose (*Potyphyllum*, *Frechastraea*) and tabulate (*Alveolites*) corals (Denayer & Poty, 2010). This term does not have to be confused with the Famennian *psammites du Fond des Crys* introduced by Mourlon (1875b, p. 772), a local name that is no longer in use.

Stratotype and sections. The stratotype of the Aisemont Formation is located in the northern part of the former Moreau quarry at Aisemont (e.g. Lecompte, 1960; Lacroix, 1974a; Delcambre & Pingot, 2014), which was transformed as a controlled landfill (Lacroix, 1999a); therefore, the section is now almost lost. The Tchafornis and Mallieue sections (e.g. Poty & Chevalier, 2007; Denayer & Poty, 2010; Mottequin et al., 2012), both situated on the left bank of the Meuse River valley at Engis, are easily accessible and selected herein as the respective stratotypes of the eponymous members. Moreover, the Mallieue section (road and disused quarry) exposes the entire formation. In the latter section, the proximal facies of the Fond des

Cris Member are dolomitised as is the case at Aisemont. The Fond des Cris section, located in the disused quarry close to the Ninane cemetery in the Fond des Cris Creek valley near Chaudfontaine, was described by Denayer & Poty (2010) and is selected here as the stratotype of the eponymous member.

Area and lateral variations. The Aisemont Formation is recognised in the Brabant Parautochthon, from the meridian of Marchovelette (Asselberghs, 1936; Delcambre & Pingot, 2015), east of the Orneau River valley, where it lies on the Rhisnes Formation, to the east of the Mehaigne River valley (Delcambre & Pingot, 2015), where it rests on the Huccorgne Formation. In the Campine Basin, the Aisemont Formation lies directly on top of the siliciclastic Booischot Formation (Booischot borehole) and probably on the Rhisnes Formation (rather than the Huccorgne Formation) in the Heibaart borehole (Lagrou & Coen-Aubert, 2017). The Aisemont Formation overlies the Marlagne Formation in the bottom of the Wépion borehole (Graulich, 1961; Coen-Aubert, 1988), i.e. in the central part of the Brabant Parautochthon. The formation is also recognised in the Visé area, in the eastern extension of the Brabant Massif (e.g. Poty, 1982, 1992; Poty & Delculée, 2011) and in the Bolland borehole (Graulich, 1975a, 1984) on the Booze–Le-Val-Dieu ridge where it overlies the Richelle Formation. Outside the Brabant Parautochthon and the Campine Basin, this lithostratigraphic unit invariably overlies the Lustin Formation. In the Haine-Sambre-Meuse Overturned Thrust sheets, the Aisemont Formation is known from Landelies (Delcambre & Pingot, 2000a) to Engis (Delcambre, in press, a); on the northern flank of the Dinant Synclinorium, it outcrops between Lesves (Delcambre & Pingot, 2017) to the west and Remouchamps (Coen, 1974; Marion et al., in press) to the east, and from both localities, it progressively passes laterally to the Neuville Member of the Marche-en-Famenne Formation (Delcambre & Pingot, 2004; Bellière, 2015; Marion & Barchy, in press, a).

The Aisemont Formation is known from the Vesdre area, up to Raeren and the German border (Coen-Aubert, 1974a). In this area, the limestone of the Tchafornis Member is sometimes red-coloured (see below) (Delcambre et al., in press) and the Fond des Cris Member can form a thick carbonate mass separated by some shaly horizons (Coen-Aubert, 1974a; Laloux et al., 1996a).

According to Lacroix (1999a) and Poty & Chevalier (2007), lateral variations are observed in the thickness and the abundance of the rugose corals and brachiopods in the Tchafornis Member and in the dolomitisation and dedolomitisation of the Fond des Cris Member (for more details, see, e.g., Coen-Aubert, 1974a; Dejonghe, 1987b; Denayer & Poty, 2010).

Thickness. Significant thickness changes occur laterally. In the Brabant Parautochthon, it varies a lot: 0 m, west and east of the Orneau River valley, 10–15 m in the Gelbressée Creek valley (Delcambre & Pingot, 2015), 25 m in the Mehaigne River valley (Delcambre & Pingot, 2014), and 33 m in the Wépion borehole (Coen-Aubert, 1988). It is 25–30 m thick in the Campine Basin (Lagrou & Coen-Aubert, 2017). In the Haine-Sambre-Meuse Overturned Thrust sheets, the following thicknesses are reported: 10 m at Landelies in the Sambre River valley (Delcambre & Pingot, 2000a), 15 m at Dave in the Meuse River valley (Delcambre & Pingot, 2017), 27 m at Huy-Statte (Coen-Aubert & Lacroix, 1979), and 29 m at Engis (Poty & Chevalier, 2007). On the northern limb of the Dinant Synclinorium, it thickness is less than 30 m at Lustin in the Meuse River valley (Delcambre & Pingot, 2017), 35 m at Vierset-Barse in the Hoyoux River valley (Coen-Aubert, 1973; Coen-Aubert & Lacroix, 1979), 46 m in Baugnée (Poty & Chevalier, 2007), and up to 60 m at Remouchamps in the Amblève River valley (Marion et al., in press). In the Vesdre area, its thickness should be quite variable (25 to 100 m), notably due to the great development of the Mallieue Member (c. 65 m) in the Les Surdents area and that of the Fond des Cris Member (c. 25 m) between Pepinster and Ensival–Lambermont (Coen-Aubert, 1974a; Laloux et al., 1996a); nevertheless, these figures seem to be overestimated, probably as a result of the local tectonics.

Age. Late Frasnian, Lower and lowest part of the Upper *rhenana* conodont zones (Coen-Aubert & Lacroix, 1979, 1985; Bultynck & Dejonghe, 2002). Coen et al. (1976) reported two associations, namely *faune 1* and *faune 2* in the Tchafornis and Fond des Cris members, respectively. Both associations are dominated by *Frechastraea limitata and Potyphyllum ananas.* The first contains additionally *Hankaxis insignis*, whereas the second is characterised by the occurrence of *Macgeea gallica and Frechastraea pentagona* (Coen-Aubert, 1974a, 1974b, 2012, 2015, 2016). The smooth rhynchonellides *Calvinaria megistana* (probably misidentified with the spiriferide *'Minatothyris maureri'* in the Belgian literature) and *Navalicria compacta* are known from the base of the formation as is the case of the spiriferide *Tiocyrspis bironensis* (see Marche-en-Famenne Formation).

Bois de la Rocq Formation – BDR

Origin of name. From the Bois de la Rocq quarry in the Samme River valley near Feluy, *Membre du Bois de la Rocq* in Doremus & Hennebert (1995a, p. 11). Note that Mourlon (1875b, p. 789) introduced the *psammite de la Roq* that clearly refers to this formation.

Description. The Bois de la Rocq Formation corresponds to the *complexe arénacé basal* or *séquence de base arénacée* of the literature (e.g. Coen-Aubert et al., 1981) and rests on the top of the Frasnian shale of the Franc-Waret Formation. It contains reddish and greenish coarse-grained sandstone with some red shale intercalation near its lower boundary. Locally (e.g. Tournai borehole), conglomerate occurs at the base. The sandstone is micaceous and usually displays a dolomitic cement or, occasionally, a calcareous cement. In the lower part of the formation, the sandstone beds are usually thin, and their thickness increases upsection. The dominant colour passes from red to greyish-yellowish tints. Locally (Orneau River valley), fine-grained dark limestone with ostracods occurs near the base. In the upper part, calcareous sandstone, commonly fossiliferous (e.g. bivalves), occurs. The upper boundary is defined by the first thick bed of calcareous or dolomitic sandstone of the overlying Feluy Formation.

Stratotype and sections. The stratotype corresponds to the disused Bois de la Rocq quarry along the Samme River north of Feluy. The Falnuée railroad section (Conil, 1964; Delcambre & Pingot, 2008) in the Orneau valley offers a good parastratotype.

Area and lateral variations. The formation is known from the Brabant Parautochthon from Tournai (Tournai and Leuze boreholes; Coen-Aubert et al., 1981) to the Ligne River valley; it then reappears eastwards in the Orneau River valley and up to the Somme River valley (Vezin) where it disappears along the Landenne Fault (Delcambre & Pingot, 2014; Delcambre, 2023).

Thickness. In its type locality, the formation is c. 50 m thick (Doremus & Hennebert, 1995a). A similar thickness is known in the Tournai borehole (Coen-Aubert et al., 1981). In the Orneau River valley, the top is probably lacunar and the formation is 45 m thick and directly overlain by the Tournaisian Pont d'Arcole Formation (Delcambre & Pingot, 2014). In Marche-les-Dames it reaches 60 m in thickness (Delcambre & Pingot, 2015).

Age. Leriche (1922) indicates the occurrence of *Holoptychius* and *Archaeopteris* in the Mévergnies quarries. Coen-Aubert et al. (1981) report *Quasiendothyra communis* in the carbonate unit at the top of this formation, suggesting a latest Famennian (Strunian) age. In the Bossuit borehole, north of Tournai, Higgs et al. (1992) mention the lower Tournaisian VI to

HD palynozones for the upper part of the *complexe arénacé basal*, i.e. the top of the Bois de la Rocq Formation and the base of the overlying Feluy Formation.

Use. Locally used as building stone.

Main contributions. Mourlon (1875b), Asselberghs (1936), Conil (1959), Bouckaert & Conil (1970), Coen-Aubert et al. (1981), Higgs et al. (1992), Doremus & Hennebert (1995a), Hennebert & Eggermont (2002).

Bois des Mouches formation

Remarks. The Bois des Mouches formation is a disused unit introduced by Delcambre & Pingot (2000a, p. 25) corresponding to the Condroz Formation. It encompasses the entire Famennian succession between the basal Famennian shale (Franc-Waret Formation) and the Tournaisian carbonate (Anseremme Group) in the Landelies area (Haine-Sambre-Meuse Overturned Thrust sheets). In this area, a basal unit of massive sandstone interpreted as the *Grès de Watissart* (Beugnies, 1973) corresponds to a local facies of the Esneux Formation (see this unit). Eastwards, the Esneux Formation is individualised (map Malonne-Naninne, Delcambre & Pingot, 2017) below the Bois des Mouches formation. The upper part of the formation corresponds to the Comblain-au-Pont Formation whereas the intermediate unit displays the typical facies of the Montfort and Évieux members of the Condroz Formation. In consequence, this name should be abandoned in favour of the Condroz Formation.

Dolhain Facies (Comblain-au-Pont Formation)

Description. The Dolhain Facies (*Formation de Dolhain* in Laloux et al., 1996b, p. 36) is formed genuine biostromes rich in strmatoporoid, corals and brachiopods, only known from the Vesdre area Conil (1964).

Lesse Facies (Comblain-au-Pont Formation)

The Comblain-au-Pont Formation shows an increase in offshore features towards the south and west and passes to the Etrœungt Formation in the western part of the Dinant Synclinorium. Therefore, the successions exposed notably in Anseremme and Gendron-Celles sections are rather different from that exposed in the type locality, notably through an increase of the limestone proportion. In this area, these rocks were often designated under the name *Calcaire d'Etrœungt* (e.g. Conil, 1964; Bouckaert et al., 1974b), but their facies are not those typical of this formation either. They are thus distinct from the usual facies of the Comblain-au-Pont and are designated here as the **Lesse Facies**.

Condroz Formation – CDZ

Origin of name. Psammites jaunâtres qui recouvrent, entre autres, les plateaux de la contrée nommée Condros, the typical Famennian sandstone in the Condroz area, introduced by d'Omalius d'Halloy (1839, p. 448), and *psammites du Condros* in d'Omalius d'Halloy (1853, p. 555, footnote).

Remarks. The modern lithostratigraphic scale of the Famennian of southern Belgium is based on the tremendously detailed works of J. Thorez, R. Dreesen, M. Streel and their colleagues, who developed a sedimentary and palaeogeographic depositional model for the *Psammites du Condroz*. However, most of the units they defined are based on the analysis of palaeoenvironments and have proven to be hardly distinguishable in the field. The revision of the geological map of Wallonia pointed towards a systematic grouping of all the lithostratigraphic units developed between the Souverain-Pré and the Comblain-au-Pont formations. Hence, it is proposed to preserve the original subdivisions of J. Thorez and his colleagues at the level of facies rather than members, and therefore to downgrade the formations into members. The lithostratigraphic mappable unit embracing the late Famennian *Psammites du Condroz*, whatever the depositional settings recorded, is consequently designated as the Condroz Formation. Attention is to be drawn on the definition as it does not correspond to the 'Psammites du Condroz' Group [sic] introduced by Thorez & Dreesen (1986, p. 287) since the latter includes all the strata between the lower Famennian disused Famenne group (see Marche-en-Famenne Formation) and the Dinantian carbonates.

Thorez (1973) and Thorez et al. (1977) introduced the Ciney Formation for the sandy limestone-rich succession observed in the Bocq River valley. Later, Bultynck & Dejonghe (2002) considered the Ciney Formation sensu Thorez et al. (1977) to be an inshore equivalent of the Souverain-Pré Formation. However, the definition of the Ciney Formation was extended by Delcambre & Pingot (1993) to the entire mixed siliciclastic sequence overlying the Souverain-Pré Formation. This definition was subsequently used to designate the mapped units in the southwestern part of the Condroz and Entre-Sambre-et-Meuse area (south of the Bocq River valley and west of the Meuse River valley). Thorez et al. (2006) came to a stratigraphic concept close to that proposed by Delcambre & Pingot (1993) but considered the well identified marine carbonate at the top as corresponding to the Comblain-au-Pont Formation. This last definition is retained here. The Ciney Member includes the Dorinne Facies at its base and the Haversin Facies. The latter was previously considered as a member of the Souverain-Pré Formation by Thorez et al. (1988) and as a separate formation by Thorez et al. (2006).

Description. The Condroz Formation is made up of interfingering siliciclastic and subordinate carbonate units. The facies is heterolithic: sandstone, arkose, siltstone, shale, often micaceous and dolomitic, marked by various types of sedimentary figures and commonly arranged in sequences, cycles or sets. The reddish and variegated colours, together with the development of primary dolostone, occur in the more proximal areas and locally invade the entire upper part of the formation. The numerous units composing the Condroz Formation (previously described as formations and members) are presented here in a stratigraphical order but not all members and facies are stratigraphically superimposed as they are mostly laterally stacked and pass to each other.

The Poulseur Member – POU (*Membre de Poulseur* in Bouckaert et al., 1970, p. 28) is dominated by brownish to greyish sandstone and micaceous arkosic sandstone in thin beds either with planar or wavy bedding and alternating with bioturbated greyish to greenish shale and siltstone. Balls-and-pillows are frequent, particularly at the base (*niveau des calamanes* in the literature). Thorez et al. (1977) referred these facies to an open marine-proximal subtidal depositional environment.

The Montfort Member – MTF (*psammite grisâtre, micacé et schistoïde de Montfort* in Davreux, 1833, p. 208; *assise des psammites de Montfort à Cucullaea Hardingii* in Mourlon, 1875a, p. 648) includes the strata traditionally designated as *Assise de Montfort* (Conseil de Direction de la Carte, 1892, p. 226, 1896, p. 53; Conseil géologique, 1929, p. 65) or *Monfort* (Conseil de Direction de la Carte, 1900, p. 37, 1909, p. 1652) that was often quarried to produce cobblestones (*Grès à pavés*). In the Ourthe and Amblève river valleys, the member begins with balls-and-pillows beds (*calamanes* of the quarrymen; Ancion & Macar, 1947; Macar, 1948). Thorez et al. (1977) divided this unit into three members that are here interpreted as facies, from the base to the top: (1) a package of rhythmic shallowing-upwards deposits of arkosic sandstone, bioturbated or with planar laminations, siltstone (dominant) and shale with occasional crinoidal limestone at the base and micritic limestone with ostracods at the top of some rhythms (Bon-Mariage Facies; *Membre de Bon-Mariage* in Thorez, 1973, p. 34, table 5; *Membre de Bon Mariage* in Thorez et al., 1977, p. 26 and inset fig. 1d–e); (2) quartzitic and arkosic sandstone arranged in metre-thick beds displaying a systematic reverse grading either massive or with planar and oblique laminations and mega-ripples (Gombe Facies; *Membre de La Gombe* in Thorez, 1973, p. 34, table 5; Thorez et al., 1977, inset fig. 1d–e); (3) greyish to blueish quartzitic and arkosic sandstone with massive texture or marked by (mega-)ripples intercalated with sandy and micaceous primary dolomite beds with abundant sedimentary structures such as channels, ripples, mud-cracks, flat pebbles and pseudomorphs of anhydrite clasts (Barse Facies; *Membre de Barse* in Thorez, 1973, p. 34, table 5; Thorez et al., 1977, inset fig. 1d–e; to not be confused with disused Gosselet's (1888, p. 598) *Schistes de Barse* [recte Basses, an hamlet near Haversin, and not Barse in the Hoyoux River valley]). Locally in the Ourthe River area, rhythmically-arranged arkosic siltstone and sandstone with abundant load casts, channels and oblique laminations are developed (Rivage Facies; *Membre de Rivage* in Thorez, 1973, p. 32, table 5; Thorez et al., 1977, inset fig. 1 d–e). North of the Condroz Inlier occurs a massive package of reddish sandstone and arkosic sandstone in metre-thick beds (Citadelle de Huy Facies; Huy Citadel Member/Formation in Thorez et al., 2006, p. 31 (fig. 4) and p. 32), which encloses some rare reddish siltstone and shale. It is known in the old literature as the *psammites rouges de Huy* (Mourlon, 1876, p. 855; see also Mourlon, 1875b, p. 744) and the *psammite rouge amarante de Huy* (Mourlon, 1886, legend of figs 1–3). Note that the *Schistes noirs de Huy* (Malaise, 1900, p. 211) and the c*alcaire de Huy* (Dumont, 1832, p. 73) correspond nowadays to the Ordovician Huy and to the Frasnian Lustin formations, respectively. The Montfort Member recorded a sand barrier and associated depositional environment as well as tidal-influenced shore environment with back-barrier evaporitic lagoon (sabkha).

The Ciney Member – CIN (*Formation de Ciney* in Thorez, 1973, p. 36, table 5; *Formation des Grès de Ciney* in Thorez et al., 1977, p. 26 and inset fig. 1d–e) is here re-defined as a unit of mixed siliciclastic and calcareous deposits corresponding to a distal equivalent of the Montfort and Évieux members and does not include the sandstone–shale–limestone alternations attributed to the Comblain-au-Pont Formation, unlike Delcambre & Pingot (1993). This member begins with thick beds of sandstone overlying the nodular argillaceous limestone beds of the Souverain-Pré Formation. It passes to bioturbated sandy calcareous siltstone rich in brachiopod coquina beds (e.g. spiriferides) deposited as stacked 20–100 cm thick tempestites, with planar horizontal and hummocky-cross stratifications (Dorinne Facies; *Membre de Dorinne* in Thorez, 1973, p. 36, table 5; Thorez et al., 1977, inset fig. 1d–e). Thickly-bedded and often lenticular sandstone beds alternating with siltstones and shales develop. The siltstone and shale become dominant in the upper part of the member (Haversin Facies; *Schistes à nodules calcaires d'Haversin* in Mourlon, 1882, p. 519) but sandstone beds with oblique bedding and a calcareous cement still occur; some pseudonodule beds are present locally. Recurrent limestone (or dolostone) nodules and clasts embedded in sandstone are not rare in the lower part of the member but tend to decrease in thickness and frequency upwards (fluxoturbidites after Thorez & Dreesen, 1973). Some continuous sandy limestone beds, mostly brachiopod coquinas, appear near the top of the member. Metre-thick beds of greyish to blueish micaceous and arkosic sandstone and siltstone with rare intercalations of micritic limestone (Beverire Facies; *Membre de Beverire* in Thorez, 1973, p. 34, table 5; *Formation des Grès, Schistes et Calcaires de Beverire* in Thorez et al., 1977, p. 26, inset fig. 1d–e) are interfingered into the Évieux Member. They were initially restricted to the southern part of the Ourthe River valley, but Dreesen & Thorez (1994) reported them in the Dinant area as well. The Ciney Member reflected an open marine subtidal depositional environment with tempestites and turbidites.

The Comblain-la-Tour Member – CBT (*Formation de Comblain-la-Tour* in Thorez, 1973, p. 32, table 5; Thorez et al., 1977, inset fig. 1d–e; equivalent to the *Comblain Member* in Bouckaert et al., 1970, p. 28) is developed in the North-east of the Dinant Synclinorium. It is composed of thinly-bedded crinoidal and bioclastic limestone with hummocky cross-stratifications alternating with shale, siltstone and quartzitic sandstone, deposited as tempestites. It passes vertically and laterally to the Montfort Member.

The Évieux Member – EVX (*assise des psammites d'Évieux à végétaux* in Mourlon, 1875a, p. 649) corresponds to the traditional *Assise d'Évieux* and consists of a heterolithic complex of shale, siltstone, arkosic sandstone and (very) micaceous sandstone, with subordinate calcareous sandstone and dolomite. The red colour varies from pinkish or dark red (*amarante, lie-de-vin*) to purple and is due to an iron hydroxide coating of the quartz grains (Thorez, 1969). The lower boundary traditionally used for this unit is the occurrence of the first red beds (palaeosols). However, this criterion is hardly applicable in the field as red beds are also known from older strata. We here propose to define the base of the Évieux Member by the change from the dominantly sandy to more argillaceous lithologies. Thorez (1973) and Thorez et al. (1977) recognised three members based on the dominant colour and the dolomitic content: (1) at the base, a heterolithic package of red beds (sandstone, siltstone) and greyish to greenish shale and siltstone, alternating with abundant primary dolostone and palaeosols (aridisols and dolcretes with rhizocretions, pedoturbations and desiccation cracks) (Royseux Facies; *Membre de Royseux* in Thorez et al., 1977, inset fig. 1d–e; to not be confused with the *Dolomie de Royseux* in Groessens (1975, p. 79), a disused local dolomitised limestone member in the uppermost part of the Tournaisian Landelies Formation (see also Conil et al., 1967; Paproth et al., 1983)); (2) a remarkable intercalation of sandy micritic limestone with ostracods and oncolites suggesting a lagoonal environment (Fontin Facies; *Membre de Fontin* in Thorez, 1973, p. 35, table 5; Thorez et al., 1977, inset fig. 1d–e); and (3) a package of red beds with interstratified primary dolomite and palaeosols passing to greenish shale with fluvial channels (Crupet Facies; *Membre de Crupet* in Thorez, 1973, p. 35, table 5; Thorez et al., 1977, inset fig. 1d–e). The diverse continental macrofauna (e.g. arthropods, vertebrates) and macroflora (*Flore d'Évieux* of the Belgian literature; e.g. Crépin, 1874; Stockmans, 1948; Fairon-Demaret, 1996) of the Belgian upper Famennian are from this unit. The Évieux Member recorded a continental flood plain environment with fluvial channels, supratidal sabkha and lagoon.

In western Entre-Sambre-et-Meuse area, the typical sandy facies of the *Psammites du Condroz* is progressively shalier and passes to the Sains Member – SNS (*schistes calcarifères de Sains, schistes de Sains* in Gosselet, 1879b, p. 389, 395, 397) which is made of greyish, greenish or purple micaceous shale alternating with calcareous shale, often nodular, and rare thin sandstone beds. The sandstone is micaceous and argillaceous, rarely calcareous and displays oblique laminations. The limestone nodules are usually centimetric to decimetric in size and passes to continuous beds that look like those of the Souverain-Pré Formation. Brachiopods form frequent coquina beds in the shale and nodular shale. Upwards, the facies is more coarse-grained (Epinette Facies, former *Strunien gréseux* or *Schistes de l'Epinette* in Conil, 1969, p. 187). The latter starts with siltstone with millimetre-thick sandstone laminae and interstratified decimetre-thick beds of quarzitic micaceous sandstone. The sandstone becomes dominant in the middle third of the member and displays commonly large ball-and-pillows. The upper third is again dominated by siltstone and subordinated sandstone beds.

Stratotype and sections. No continuous section exposes the whole Condroz Formation but numerous outcrops and quarries offer good exposures of the various members and facies.

The Poulseur Member and Comblain-la-Tour Facies are defined in the disused Comblain-la-Tour quarry and along N654 road in the Ourthe River valley.

The Montfort Member is exposed along a railroad section, 1700 m south of the Esneux railway station in the Ourthe valley; the Bon-Mariage and Gombe facies can be observed in the Esneux ('Belle Pierre') quarry; the Rivage Facies is exposed in the eponymous quarry and along the railroad at the Rivage station; the Barse Facies is visible in the Ereffe quarry in at Marchin; the Citadelle de Huy Facies outcrops along the section and cliffs along the Namur–Huy road (N90), just north of the Huy Citadel in the Meuse River valley.

The Évieux Member is well developed in the eponymous quarry and railroad south of the Esneux station; the Royseux Facies is visible in the Chabôfosse quarry in the Hoyoux River valley at Marchin; the Fontin Facies is exposed along the railroad south of the Esneux station; the Crupet Facies can be observed in the Tienne des Marteaux quarry and along the railroad in Spontin.

The Ciney Member is well exposed along the Brussels–Luxembourg railway NW of Leignon. The Dorinne Facies can be observed in the Rochette quarry in Spontin. The Haversin Facies can be seen along the Brussels–Luxembourg railway south of Haversin; the Beverire Facies is exposed in disused quarries at Comblain-au-Pont, on the left bank of the Ourthe River (private property). The railroad section between Sains-du-Nord and Féron in Avesnois (France) shows the Sains Member and Epinette Facies.

Area and lateral variations. The Condroz Formation is present in the Dinant Synclinorium, Haine–Sambre–Meuse Overturnet Thrust sheets, Vesdre area and Campine Basin, but the various members are confined to more restricted areas. The Poulseur Member occurs in the northern area but lacks in the Dinant Synclinorium and Campine Basin; the Montfort Member lacks in the Haine–Sambre–Meuse Overturnet Thrust sheets, (Citadelle de Huy Facies only); the Ciney Member is mainly present in the southern part of the Dinant Synclinorium, but its Beverire and Comblain-la-Tour facies occur in some parts of the northern part; the Évieux Member is recognised in throughout the basin. Eastwards, the Condroz Formation is known up to Aachen (Kasig et al., 1979).

Thickness. In the central and northern parts of the Dinant Synclinorium, the Condroz Formation is 290 m thick in the Hoyoux River and Bocq River valleys (Delcambre & Pingot, 2018a; Barchy & Marion, 2021; Mottequin et al., 2021) and up to 350 m in the Lesse River valley (Delcambre & Pingot, 1993). In the eastern part of this Variscan tectonic unit, it is about 400 m thick in the Ourthe River valley. In the northern tectonic areas (Haine–Sambre–Meuse Overturned Thrust sheets and Vesdre area), it does not reach 200 m (Delcambre, 2014, 2024; Laloux et al., 1996).

Age. As a whole, the Condroz Formation extends from the upper part of the middle Famennian (former 'Fa2b', see Thorez et al., 2006) to the uppermost Famennian ('Fa2d'), former *expansa* conodont zone (*marginifera* to *ultimus*, Dreesen & Thorez, 1994), DFZ4 to DFZ7 foraminifer zones (Devuyst & Hance in Poty et al., 2006) and GF to LL–LE palynozones (Higgs et al., 2013). The diachronism of some members and facies has been pointed out by several authors (e.g. Thorez et al., 2006).

The Poulseur Member extends from the Uppermost *marginifera* to Lower *postera* conodont zones (Dreesen & Thorez, 1994) and GF Palynozone. The Montfort Member extends from the Uppermost *marginifera* to Upper *trachytera* conodont zones and GF Palynozone. The Évieux Member spans the interval of the Lower *postera* to the Upper *expansa* conodont zones and the VCo to LL palynozones. The Ciney Member extends from the

Upper *expansa* to *ultimus* conodont zones (Dreesen & Thorez, 1994). In the Anseremme railway section, the first *Quasiendothyra kobeitusana*, i.e. the marker of the uppermost Famennian (Strunian) substage, occur in the *Strunien gréseux* sensu Conil (1964), thus at the top of the Ciney Member. Brachiopods of the Condroz Formation remain poorly known (Maillieux 1941a, 1941b; Lecompte & Waterlot, 1957), but the rhynchonellide *Sartenaerus letiensis* is considered as the characteristic taxon of the Sains Member (Gosselet, 1887; Mottequin & Brice, 2016).

Famelette Formation – FML

Origin of name. From the Famelette road in the Mehaigne River valley, *Schistes de la Famelette* in Paproth et al. (1983, p. 213).

Description. The Famelette Formation encompasses the shaly units comprised between the top of the Frasnian Aisemont Formation and the dolostone of the Tournaisian Engihoul Formation. It begins with greenish-greyish shale that is occasionally fossiliferous and contains rare micaceous sandstone beds with calcareous cement, often decalcified at the surface. Ferruginous sandstone beds with horizontal laminations occur in the middle part of the formation. About 2 m above the base, a discontinuous horizon of haematitic or chamositic oolites occurs in a sandy or calcareous matrix. In the Mehaigne River valley, the ore is divided into several centimetre thick lenses separated by shale and siltstone beds. In the disused Couthuin mine, the ore is formed of a lower horizon 1.1–1.2 m thick of haematitic oolites and an upper 0.1–0.3 m thick horizon of chamositic oolites enclosed in a pyritic matrix (Delmer, 1913) and falls to c. 0 m in the Famelette road (Delcambre & Pingot, 2013).

Thickness. From 12 m in the Mehaigne River valley up to 21 m in the Moha–Fosseroule borehole (Van Leckwijck & Ancion, 1956).

Stratotype and sections. Section along the road connecting the Mehaigne valley to the E42 motorway southeast of Huccorgne.

Area and lateral variations. The formation is only known in the Brabant Parautochthon, between Couthuin and the Mehaigne River valley, north of the Landenne Fault. It passes laterally to the Franc-Waret Formation.

Age. The base of the Famelette Formation might still be late Frasnian in age but guide taxa are lacking. The age of oolitic ironstone may be early Famennian (Dreesen, 1982b). In the Java gallery (Couthuin mine), the shale directly resting on top of the oolitic ironstone horizon would have yielded a diverse Strunian fauna, including trilobites and *Prospira struniana* (Ancion et al., 1956; Vandercammen, 1956). Nevertheless, the material has not been traced in the RBINS and ULiège collections; therefore, the material remains unrevised pending further research. The top of the formation would be Hastarian in age based on the spores according to Streel (1977), but it is highly improbable; confusion with the Hastarian shaly Pont d'Arcole Formation cannot be ruled out. Therefore, according to the literature data, it seems that only the basal and topmost Famennian are recorded with a relative certainty, the rest of the stage being in hiatus.

Franc-Waret Formation – FRW

Origin of name. From the village of Franc-Waret, *Schistes de Franc-Waret* in Stainier (1892, p. 99).

Remarks. In the Brabant Parautochthon and in the Haine–Sambre–Meuse Overturned Thrust sheets, the argillaceous deposits, which are comprised between the last Frasnian carbonates (Aisemont and Rhisnes formations) and the Famennian sandstones, have been placed in the Franc-Waret or in the Falisolle (*Formation de Falisolle* in Delcambre & Pingot, 2000a, p. 23) formations (see references below). After completion of the geological mapping of these tectonic units, it now appears that the similar lithologies encountered do not justify the coexistence of two distinct units. Priority has been given to the Franc-Waret Formation in order to preserve the continuity with the former lithostratigraphic framework.

Description. The Franc-Waret Formation essentially consists of greenish or purple shale that is frequently finely micaceous and sometimes becomes yellowish when altered; calcareous coquinoid layers (brachiopods), sometimes partly decalcified, occur sporadically whereas sandstone and siltstone intercalations become more abundant and thicker within the upper part of the formation. In the Brabant Parautochthon, an oolitic ironstone horizon (up to 1.5 m thick) is developed several metres (8 to 20 m) above the base of the formation and is subdivided into two or three layers of sandy shale or even brownish red sandstone rich in haematitic oolites (Delmer, 1912; Denayer et al., 2011b; Delcambre & Pingot, 2015). In more eastern localities from the Haine–Sambre–Meuse Overturned Thrust sheets, its upper part may include a few beds of oolitic ironstone (Delcambre & Pingot, 2017, 2018b).

The Franc-Waret Formation overlies the limestones of the top of the Rhisnes Formation or those of the Aisemont Formation when the latter is developed (Lacroix, 1999c). However, Delcambre & Pingot (2015) noted that it is possible that the base of the shales included in the Franc-Waret Formation passes to the Aisemont Formation between Marchovelette and the Orneau River valley where the latter is not developed.

Stratotype and sections. The historical type section of the Franc-Waret Formations was a small excavation located in the park of the eponymous castle, but it does not exist anymore. No stratotype has been selected so far due to the paucity of outcrops around Franc-Waret. Delcambre & Pingot (2015) have observed the Franc-Waret Formation in the bed of the eponymous creek, close to the castle of Franc-Waret, and in another nearby section north of

Marche-les-Dames, along the N992 road, in front of the Notre-Dame du Vivier abbey. Moreover, this lithostratigraphic unit can be observed in the railway trench in front of the Falnuée castle, between Mazy and Onoz (Delcambre & Pingot, 2008). The original section of the Falisolle formation at the entry of the former Moreau quarry at Aisemont, to the south of Falisolle (Delcambre & Pingot, 2014, fig. 11I), has almost disappeared. Although tectonically disturbed, the section of Huy-Nord (e.g. Coen-Aubert & Lacroix, 1979; Vanguestaine et al., 1983) could be selected as the parastratotype of the Franc-Waret Formation.

Area and lateral variations. The Franc-Waret Formation is recognised in surface in the central part of the Brabant Parautochthon, from the Orneau River valley to Vezin (Delcambre & Pingot, 2008). Westwards it fades away and re-appears in the Ligne River valley. In the Dendre River valley, it is only known from boreholes: Mévergnies (Chabot & Laurent, 1973; Doremus & Hennebert, 1995b), former *Tannerie Gérard* at Soignies (Hennebert & Eggermont, 2002), and Feluy (Lacroix, 1999c). It was also reported in the Leuze borehole by Coen-Aubert et al. (1981) between the Rhisnes and Samme formations, but the encountered lithologies (dolostone, limestone; 14 m thick) are markedly different from those known to the east (Hennebert & Doremus, 1997; Lacroix, 1999c). North of the Landenne Fault and to the Mehaigne River valley, the remains of the Franc-Waret Formation is included in the Famelette Formation (Delcambre, 2023). It was recognised in the Haine–Sambre–Meuse Overturned Thrust sheets (see references below) and in the Campine Basin (Lagrou & Coen-Aubert, 2017) as the Falisolle formation.

Thickness. Quite variable, from 20 m to 40 m in the type area (Delcambre & Pingot, 2015), decreasing westwards where its thickness is estimated at 15–25 m in the Soignies area (Hennebert & Eggermont, 2002), c. 10 m in the Feluy boreholes (Lacroix, 1999c), and c. 4 m in the Mévergnies borehole (Chabot & Laurent, 1973), and reaches c. 50 m to the east of the type area (Mourlon, 1875b; Delcambre, 2023), before disappearing north-east of Vezin.

In the Haine-Sambre-Meuse Overturned Thrust sheets, its thickness is highly variable (c. 30 m up to 90 m). Indeed, Delcambre & Pingot (2000b) suggested a thickness of 80–90 m in the la Tombe Massif. Eastwards, its thickness varies: 50 m at Aisemont (Delcambre & Pingot, 2014), < 45 m in the Wépion borehole (Delcambre & Pingot, 2017), between 40–65 m (Delcambre & Pingot, 2018b) and c. 30–40 m (Delcambre, 2023) south of the Meuse River valley (e.g. Haltinne, Ahin), c. 30 m at Huy (Mottequin et al., 2021), < 50 m at Streupas and Vaulx-sous-Chèvremont (Delcambre et al., in press). In the Booischot and Heibaart boreholes (Campine Basin), the thickness of the Franc-Waret Formation varies between c. 61–65 m (Lagrou & Coen-Aubert, 2017).

Age. Late Frasnian–early Famennian based on rhynchonellide brachiopods reported notably by Beugnies (1973) (‘*Porthmorhynchus ferquensis*’) and Sartenaer (in Coen-Aubert & Lacroix, 1979) (*Ptychomaletoechia omaliusi* (Pl. 4.L), *P. gonthieri* (Pl. 4.M), and *P. dumonti* (Pl. 4.N)) at Huy-Nord, below and above the first occurrence of oolitic ironstone (level I of Dreesen 1981, 1982a; see also Vanguestaine et al., 1983). The presence of *Basilicorhynchus basilicus gerardimontis* (Pl. 4.Q) was documented at Ahin, Ben Ahin, and Vezin by Sartenaer (1986) within the oolitic ironstone.

Use. The oolitic ironstone horizon was intensively exploited in mine galleries during the 19th century and the first half of the 20th century, mostly between Les Isnes and Vezin, and in the Couthuin area (e.g. Denayer et al., 2011b).

Main contributions. Gonthier (1867), Stainier (1892), Delmer (1912), Asselberghs (1936), Van Leckwijck & Ancion (1956), Beugnies (1973), Coen-Aubert & Lacroix (1979), Vanguestaine et al. (1983), Lacroix (1999c), Delcambre & Pingot (2000a, 2000b, 2008, 2015), Delcambre (2023).

Verviers Member – VER (Lambermont Formation)

Description. The Lambermont Formation starts with 6 m of green and grey shale with scarce carbonate nodules, but rich in atrypide and spiriferide brachiopods and fenestellid bryozoans. Then follows a mixed argillaceous–carbonate, red to green unit, known as the *facies de Verviers* (Dubrul in Dumont et al., 1954, p. 174), referred to here as the Verviers Member. This c. 12 m thick unit starts with a biostromal limestone bed rich in massive rugose corals (*Frechastraea*, *Potyphyllum* and *Iowaphyllum*) known as the third *troisième biostrome à Phillipsastrea* of Coen et al. (1976), overlain by red to green argillaceous, nodular limestone and nodular shale enclosing fragments of massive rugose corals.

Stratotype and sections. Western access road to the motorway Verviers–Prüm (A27, exit no. 4) at Lambermont (Laloux et al., 1996a). This is likewise the type section selected here for the Verviers Member. It can be complemented by a series of sections listed by Laloux et al. (1996a, 1996b) and Delcambre et al. (in press) in the Vesdre area, notably that located along the right bank of the Vesdre River, below the rue des Récollets at Renoupré and that situated immediately to the northwest of the confluence between that river and the Fond des Cris Creek, east of Chaudfontaine.

Area and lateral variations. The Verviers Member is especially developed between Pepinster and Les Surdents (Dubrul in Dumon et al., 1954); it can be traced from Chaudfontaine to the west up to Membach to the east, where it passes laterally to nodular shale with corals (*facies d'Eupen ou oriental* of Dubrul in Dumon et al., 1954, p. 175). In the Fond des Cris quarries at Chaudfontaine, the 5 m thick Verviers Member lies directly on the limestone of the Aisemont

Formation (Dubrul, 1931; Coen-Aubert, 1974a). Nevertheless, it displays strong and fast lateral variations as it reaches c. 22 m in the Chaudfontaine school borehole (Graulich & Vandenven, 1978; Dejonghe, 1987a). At Hony, the Verviers Member is lacking. The Verviers Member is also known from the Theux Tectonic Window (Coen-Aubert, 1974a; Graulich, 1979) and the Bolland and Soumagne boreholes (Coen-Aubert, 1974a; Dejonghe, 1987a).

Lustin Formation – LUS

Origin of name. From the village of Lustin, *Formation de Lustin* in Coen-Aubert & Coen (1975, p. 512).

Remarks. Although Lacroix (1974a), Coen-Aubert & Lacroix (1979) and Coen-Aubert (1982) recognised a lower coralliferous member (*calcaire récifal*) and an upper lagoonal member (*calcaire à faciès lagunaire*) within the Lustin Formation (Marlagne Formation in Lacroix, 1974a, see this term), the latter have never been formally named as reminded by Bellière (2015), although several names were proposed in the literature. For Coen-Aubert (1999a), this is due to the fact that this distinction cannot be applied everywhere, especially in eastern Belgium, where Coen-Aubert & Coen's (1975) unit e, which corresponds to the boundary between both informal members, is generally poorly individualised. However, this is not a valid argument for maintaining the status quo, which is why these separate members are formally referred to here (see below). In fact, they should have called this member the 'member rich in corals and stromatoporoids' because, strictly speaking, there is no 'reefal member'. Moreover, the distinction between the 'reefal member' and the 'lagoonal member' is based primarily on colour: very dark for the former and light for the latter. Note that there are also corals and stromatoporoids in the upper member, but to a much lesser extent.

Description. Coen-Aubert & Coen (1975) and Coen-Aubert (1999a) described in detail its content in the Meuse River valley (see also Coen-Aubert & Lacroix, 1979).

The Gougnies Member – GOU (*Assise de Bovesse et de Gougnies* in Conseil de Direction de la Carte, 1896, p. 54) begins with a first unit (a in Coen-Aubert & Coen, 1975) enclosing few beds of crinoidal limestone preceding the first massive 9 m thick package of beds rich in stromatoporoids and corals – i.e. the 'biostromes' of the literature corresponds to the *Marbre Sainte-Anne*, here designated as Sainte-Anne Facies. This limestone is often dark in colour and contains lots of lamellar and ramose stromatoporoids (e.g. *Stachyodes*), solitary and fasciculate (*Disphyllum*) rugose corals and branched and lamellar (*Alveolites*) tabulate corals. This thick unit is sometimes partly or entirely dolomitised and is capped by several usually light-coloured limestone beds rich in massive stromatoporoids. The 7 m thick unit b corresponds to light-coloured limestones with a thin shaly horizon, overlaid by argillaceous limestone with brachiopods (e.g. orthides, atrypides and spiriferides) and especially a level rich in very large colonies of *Disphyllum*. The unit c (c. 10 m thick) comprises dark, stratified limestone (sometimes laminar in the basalmost part) with occurrence of levels with massive stromatoporoids, *Alveolites*, branched tabulate corals and massive and solitary rugose corals. It is followed by light-coloured, massive limestone (c. 17 m thick) that is variably rich in stromatoporoids and corals (unit d). The Gougnies Member ends with a remarkable stratified unit (c. 4.5 m thick; unit e) in which lamellar stromatoporoids are predominant over *Alveolites*, branched tabulate corals, solitary rugose corals and fragments of *Hexagonaria.*

The Rochers de Frênes Member – RFR (after the eponymous rocks overlooking the Meuse River at Lustin; unit f of Coen-Aubert & Coen, 1975) includes c. 48 m of thinly and well-bedded limestone with, near the top of the succession, some beds rich in massive stromatoporoids and rugose corals. Three thick argillaceous horizons interpreted as paedogenetised cinerites are developed in this member and display thin brecciated level at their base (Da Silva, 2004; Rensonnet, 2005). In the bottom of the Wépion borehole (between 2019 m and 2069.2 m), Graulich (1961, p. 39) introduced the *Assise de La Marlagne* to designate the c. 50 m thick package of grey to black dolostone situated below the Aisemont Formation. This dolostone includes locally intraclasts and ghosts of dendroid stromatoporoids associated at the base with ramose tabulate corals and some fragments of colonial and solitary rugose corals (Coen-Aubert, 1988). The Marlagne Formation was used by Tsien et al. (1973) and Lacroix (1974a, 1974b) for designating the Rocher de Frênes Member, whereas Delcambre & Pingot (2017) considered the Marlagne formation (sensu Coen-Aubert, 1988) as part of the Lustin Formation. Although only known from the Wépion borehole, it could be regarded as a local dolomitic facies of the Lustin Formation (Marlagne Dolomitic Facies). In the Visé area, the Rocher de Frênes Member is probably represented by a local facies designed herein as the Richelle Facies (after the village of Richelle in the Meuse River valley, south of Visé) that consists of massive light grey fine-grained limestone (mudstone to wackestone), sometimes slightly dolomitic, with fossils restricted to some beds (Gumusboga, 1989). These are notably tubular (amphiporids), massive and lamellar stromatoporoids, colonial (*Hexagonaria*) and solitary rugose corals, massive (*Alveolites*) and ramose (*Thamnopora*) tabulate corals, and brachiopods (Coen-Aubert in Graulich, 1975b; Lorenzi, 1981). The massive limestone of the Richelle Facies is generally brecciated (collapse breccia to megabreccia) as observed in boreholes in the disused La Folie quarry at the locality Brichtembeau (Lorenzi, 1981; Poty, 1982), at Hermalle-sous-Argenteau (Graulich, 1975b) and Visé (Goemaere & Vandenven, 1989), as resulting of a solution collapse process (Poty 1981, 1982; Poty & Delculée, 2011). In the Hermalle-sous-Argenteau borehole, the Richelle Facies overlies coarse-grained sandstone and black dolomitic shale (Graulich, 1975b) that are assigned here to the Alvaux Formation (see Denayer et al., 2024). It is overlain by the Frasnian Aisemont Formation or by Carboniferous deposits, depending on different tectonic blocks of the Visé area (Poty & Delculée, 2011).

Stratotype and sections. The section of the Rochers de Frênes, both along the railway cut and the road from Dinant to Namur (N947), corresponds to the stratotype of the Lustin Formation. However, it is incomplete, but the contacts with the underlying and overlying formations are exposed in the woody hillside that dominates the section (Coen-Aubert & Coen, 1975; Coen-Aubert, 1999a). This is also the stratotype of the Rochers de Frênes Member. The historical type section of the Gougnies Member corresponds to the disused quarries located south of the eponymous village; nevertheless, they are partly flooded and therefore difficult to access (Delcambre & Pingot, 2004). It is complemented by the disused railway section between Biesme and Gougnies. The Richelle Facies is well exposed in the M quarry (following Horion & Gosselet's (1892) lettering) at Richelle (e.g. Pirlet, 1967; Poty, 1982), although it has been transformed into a landfill with rather difficult access (Poty, 1982).

Area and lateral variations. The Lustin Formation is known from the Haine–Sambre–Meuse Overturned Thrust sheets, from Landelies to the west (Delcambre & Pingot, 2000a) up to Engis to the east (Delcambre, in press, a). In the bottom of the Wépion borehole (between 2069.2 m and 2139.1 m; Brabant Parautochthon), above the Nismes Formation (Presles Facies), Coen-Aubert (1988) introduced the Su Wary formation to designate alternations of shale and limestone, often argillaceous, that contain occasionally stromatoporoids. This informal unit was implicitly placed in the Lustin Formation by Delcambre & Pingot (2017). These rocks are only known from the Wépion borehole and may represent a local mixed argillaceous–calcareous facies of the Lustin Formation, reminiscent of the Machenées

Member of the Pont de la Folle Formation. The Lustin Formation is largely developed on the northern limb of the Dinant Synclinorium, from Gerpinnes (Delcambre & Pingot, 2000b) up to Louveigné (Marion et al., in press). South of Gerpinnes, it laterally passes to the Pont de la Folle and Philippeville formations. On the south-eastern limb of the Dinant Synclinorium, it passes, near My, to the Moulin Liénaux and Grands Breux formations, which are characteristic for the southern limb of the Dinant Synclinorium, and to the Pont de la Folle and Philippeville formations near Tohogne and Sy (Marion & Barchy, in press, a). The latter lithostratigraphic units represents the typical succession of the Durbuy–Philippeville Anticlinorium. The Lustin Formation is well developed in the Vesdre area, up to the German border (e.g. Coen-Aubert, 1974a; Laloux et al., 1996a, 1996b, 2000), as well as in the Theux Window (Coen-Aubert, 1974a), but the distinction of the two members is less obvious. In these areas, the shaly Nismes Formation, hardly reaching 2 m in thickness, was mapped together with the Lustin Formation. Eastwards, in Germany, the Formation passes laterally to the *Walheim-Formation* (Deutsche Stratigraphische Kommission, 2016; Schindler et al., 2018) (ex *Frasnium-Riffkalksteine* or *Obere Massenkalk* sensu Kasig, 1967 and Kasig & Reissner, 2008). The Richelle Facies is only known from the Visé area and is brecciated everywhere, except on the Souvré block (e.g. Hermalle-sous-Argenteau and Visé boreholes, Graulich, 1975b; Lorenzi, 1981; Poty, 1982).

Coen-Aubert (1999a) provided a thorough survey of the lateral variations observed within the Lustin Formation with the exception of the Visé area.

Thickness. The Lustin Formation is generally thick on the northern limb of the Dinant Synclinorium, but thins out from west to east: c. 160 m at Gerpinnes (Lecompte, 1960, 1963; Coen-Aubert, 1982), 104 m in the stratotype at Lustin (Coen-Aubert & Coen, 1975), 125 m at Hun, c. 80 m at Vierset-Barse (Coen-Aubert, 1974a), 62 m at Hony (Coen-Aubert, 1974a), and

c. 45 m in Tilff (Delcambre et al., in press). In the Haine–Sambre–Meuse Overturned Thrust sheets, its thickness does not exceed 80 m: 78 m at Presles, 75 m at Aisemont (Lacroix, 1974a, 1974b; Coen, 1976; Coen-Aubert, 1977), 56 m at Dave (Lacroix, 1974b), and c. 50 m at Huy (Coen-Aubert & Lacroix, 1979). In the Vesdre area, the Lustin Formation becomes thicker eastwards: c. 35–40 m at Chaudfontaine, c. 45–50 m at Prayon, 80 m at Les Surdents, and up to 150 m (including some metres of the Nismes Formation) towards the German border (Coen-Aubert, 1974a; Laloux et al., 1996a, 1996b, 2000). In the Theux Window, it does not exceed 60 m in thickness (Coen-Aubert, 1974a). The Richelle Facies is 80 m thick in the Hermalle-sous-Argenteau borehole, south of Visé (Graulich, 1975b; Poty, 1982; Barchy & Marion, 2000, 2017). It is also brecciated and about 100 m thick in the boreholes of the 'K' quarry south of Visé (Goemaere & Vandenven, 1989; Poty & Delculée, 2011).

Age. Middle Frasnian. Although poor in conodonts (Groessens, 1971; Coen-Aubert & Coen, 1975), the range of the Lustin Formation most probably spans the interval of the *punctata* to the lower *rhenana* conodont zones according to Gouwy & Bultynck (2000). The rugose corals *Macgeea rozkowskae, Disphyllum hilli* and *Hexagonaria mirabilis* are abundant respectively in the lower and upper parts of the Gougnies Member whereas *Argustrastrea konincki* and *A. lecomptei* are typically found in the Rochers de Frênes Member, with *Wapitiphyllum vesiculosum.*

Marche-en-Famenne Formation – MEF

Origin of the name. From the town of Marche-en-Famenne (term introduced herein).

Remarks. In the Dinant Synclinorium, the mostly shaly succession comprised between the upper Frasnian carbonate units (Aisemont and Neuville formations) and the Esneux Formation has been the subject of debate over its most appropriate subdivision due to the complex intertwining of facies and usually poor outcropping conditions. In the last comprehensive lithostratigraphic overviews (Boulvain et al., 1999a; Bultynck & Dejonghe, 2002; Thorez et al., 2006), several formations were proposed to subdivide the set: the Barvaux, Matagne, Valisettes, Senzeille, Mariembourg and Aye formations, with the Famenne group including the Senzeille and Mariembourg formations (see below). In order to make a parallel with the lithostratigraphic divisions of the Frasnian of the southern limb of the Dinant Synclinorium, which are characterised by a lower carbonate sole, a middle 'reefal' and an upper shaly units (see Moulin Liénaux and Grands Breux formations), Coen-Aubert (2015) introduced the Champ Broquet formation by retrograding to the member status the Neuville and Valisettes formations, complemented with the mud mounds ascribed to the Petit-Mont Member, notwithstanding the age of the latter. However, the revision of the geological map of Wallonia demonstrated the difficulties to find clear boundaries in the field between most of the previously introduced units and many of them were mapped together. Moreover, the Senzeille and Mariembourg formations (*schistes de Senzeilles à Rh. Omaliusi* and *schistes de Marienbourg à Rh. Dumonti* in Gosselet, 1879b, p. 389) were abandoned, and replaced by the imprecisely delineated Famenne formation, because the distinction between the two former units were based on rhynchonellide brachiopods and on an elusive oolitic ironstone marker (level I of Dreesen, 1982). Consequently, in order to solve the lithostratigraphic issues that arose during the geological mapping of the Dinant Synclinorium, the Marche-en-Famenne Formation is introduced herein.

Description. The Marche-en-Famenne Formation is predominantly shaly, but it also incorporates carbonate bodies. It is characterised at its base by the Neuville Member, overlaid by the Valisettes Member (enclosing the Barvaux and Matagne facies) that is capped by the

Famenne Member (with the Aye Facies at its top); the mud mounds are included in a distinct member (Petit-Mont Member).

The lower **Neuville Member – NEU** (Neuville Formation (pars) in Tsien, 1974, p. 4, 6, 31) consists of nodular limestones with intercalations of nodular shale in its type locality (western part of the Durbuy–Philippeville Anticlinorium) (Boulvain et al., 1993b, 1999b), but the latter lithology is dominant on the southern and southeastern limbs of the Dinant Synclinorium. Brachiopods and corals can be abundant, particularly at the base.

The **Petit-Mont Member – PTM** (*Membre du Petit-Mont* in Boulvain et al., 1999b, p. 74; MM for *monticule micritique* on the geological maps) corresponds to the reddish to grey carbonate mounds that develop at different stratigraphic horizons laterally to the Neuville Member (Les Bulants type in Boulvain, 1993b) and the Valisettes Member (Les Wayons–Haumont type in Boulvain, 1993b). In the type section (Petit-Mont quarry at Vodelée), the mound is 60 m thick in its central part and composed of massive limestone into which three successive lithofacies are recognised (Boulvain, 1993b), from base to top: (1) red limestone with stromatactis, (2) pink limestone with rugose and tabulate corals, incertae sedis (*Receptaculites*, Pl. 3.M), crinoids, brachiopods and bryozoans, and (3) grey limestone with diverse rugose and tabulate corals, brachiopods, and a lot of calcimicrobial structures. Some mounds display in their upper parts a fourth unit of recurrent red mudstone with stromatactoid cavities, with on the top a sharp surface interpreted as an emersion surface by Sandberg et al. (1992) and Muchez et al. (1996) and correlated with the top of the Fond des Cris Member of the Aisemont Formation by Denayer & Poty (2010) and Mottequin & Poty (2016). It should also be noted that the geometrical relationships between the carbonate mounds and the surrounding shale are variable. In the Les Bulants type of mounds, the red limestone forms a low tabular lens with its margins interdigitated within the lateral nodular limestone and displays only a vertical variation of facies. In the Les Wayons–Haumont type of mounds, the red limestone forms an elevated lens with margins inclined at c. 30 degrees, with few interdigitations into the lateral shale and displays both vertical and lateral facies differentiation (Boulvain, 1993b).

The Valisettes Member – VAL (*Formation des Valisettes* (pars) in Boulvain et al., 1993c, p. 27) is essentially shaly but, in the vicinity of the mud mounds of the Petit-Mont Member, as is the case in its stratotype (Neuville railway section), nodular limestone can have a consequent development. There, contrasting with the more carbonated Neuville Member, it starts with about 50 m of dark grey to green shale with four thin beds of limestone at its base and a scarce fauna, followed by 34 m of red or green nodular limestone and shale with carbonate nodules (Boulvain et al., 1993c, 1999c). The macrofauna is abundant and include brachiopods (e.g. athyridides, atrypides, spiriferides), massive rugose corals (*Frechastraea*, *Iowaphyllum*, *Tabulophyllum*; *faune 3* of Coen et al., 1976), lamellar tabulate corals (*Alveolites*, *Senceliaepora*), crinoids and locally abundant sponges (Termier et al., 1981). Above this thick carbonate interval, there is green to purplish shale (c. 13 m thick) with few nodular levels that includes very small reddish mud mounds, reaching 1–2 m in width and 0.2–0.4 m in thickness (Mottequin et al., 2015; Mottequin & Poty, 2016). The usual shaly facies of the Valisettes Member passes laterally to the singular Matagne and Barvaux facies or is overlain by them (see below). On the southern and southeastern flanks of the Dinant Synclinorium, the dark grey to green shale of the base of the Valisettes Member, yields abundant brachiopods (e.g. athyridides, spiriferides) (Mottequin, 2004a, 2005a), are less thick (Bultynck et al., 1998; Coen, 1999) and generally passes to the Matagne or Barvaux facies. The Matagne Facies (*Schistes de Matagne* and *Schistes de Matagne à Cardium palmatum* in Gosselet, 1871, p. 296, 298) consists of a monotonous series of fine dark greenish-brown to black shales that include few flattened nodules and rare thin sandstone lenses. One or several beds of limestone with ammonoid cephalopods and bivalves is/are encountered at the base of this facies. Although poorly diverse, the fauna is highly characteristic and includes buchiolid bivalves (e.g. *Buchiola*, *Glyptohallicardia*) (e.g. Maillieux, 1936; Grimm, 1998), smooth thin-shelled rhynchonellide brachiopods (Sartenaer, 1974a), ammonoids, comprising large gephuroceratids (e.g. Matern, 1931; House & Kirchgasser, 1993; Goolaerts et al., 2018), and even dendroid graptolites (e.g. Maletz et al., 2020; Mottequin et al., 2023). The particular lithology and faunal assemblages reflect a dysoxic environment (Mottequin & Poty, 2016). Similar facies is also known from the Lambermont Formation. The Barvaux Facies (*schistes de Barvaux* in Gosselet, 1880b, p. 199) is predominantly composed of purplish shale, but also greenish locally (Coen, 1999). The lower and upper parts of the Barvaux Facies include some nodules whereas the middle part contains many coquina beds, which are composed essentially of large, transverse cyrtospiriferid brachiopods and smaller strophomenides and thin sandstone lenses. The residual macrofauna includes notably scarce bivalves, solitary (*Macgeea*) and massive (*Frechastraea*) rugose corals (e.g. Maillieux, 1939; Coen, 1999). The uppermost part of the Valisettes Member is marked by the Hony Horizon (see Lambermont Formation) of which thickness reaches 0.2 m at Neuville and 0.3 m at Deulin, respectively, and this singular horizon is overlain by the ultimate occurrence of the Matagne Facies corresponding to the Upper Kelwasser Event and to the top of the Valisettes Member.

The Famenne Member – FAM (s*chistes, qui se développent principalement dans les deux petites contrées nommées Famenne et Fagne* in d'Omalius d'Halloy, 1839, p. 448; *schiste de Famenne* in d'Omalius d'Halloy, 1853, p. 553, p. 555, both in footnotes) consists of shales that are primarily olive green to greyish green in the lower part and grey to purplish in the upper part. Thin beds of siltstone and sandstone increase in frequency towards the top of the unit; carbonate nodules can be locally abundant as is the case of the coquina beds, largely dominated by rhynchonellide, athyridide and spiriferide brachiopods. Outside the tempestites coquina beds, brachiopods, which never reach the size of the large ones encountered in the Barvaux Facies even if they become larger in the upper part of the Famenne Member, are associated with bivalves and orthoconic cephalopods. Oolitic ironstone level(s) is (are) developed in the middle of the formation (Dreesen, 1982). The Aye Facies (*Formation des Schistes d'Aye* in Thorez et al., 1977, p. 26) is locally developed and characterised by the alternation of greenish shales/platy argillaceous siltstone beds and lenticular, usually centimetric to pluricentimetric (more rarely thicker) beds of fine-grained siltstone and sandstone. However, the transition between both lithotypes is generally gradual. The sandstone can display cross laminations. According to Boulvain et al. (1995), the bioturbation can be so important that it gives rise to quite poorly sorted 'mixed' sediments. Carbonate nodules and pluricentimetric lenses of limestone with brachiopods and crinoids are also present (Dreesen, 1978). Note that Dusar & Dreesen (1984) reported up to 3 m thick domal shaped accumulations of large crinoidal debris in shales, just above Dreesen's (1982a) oolitic ironstone level IIIb in the Ourthe River valley (Hamoir area; Marion & Barchy, in press Hamoir); they could correspond to aborted Baelen-type mounds.

Stratotype and sections. Characterisation of the Marche-en-Famenne Formation is based on type sections of the former units that make it up. However, the area around the town of Marche-en-Famenne offers good outcrops exposing the main facies (Barchy & Marion, 2014; Denayer & Mottequin, 2023).

The stratotype of the Neuville Member is composed by the northern and southern railway trench sections (Couvin–Charleroi railway line), also known as the old and new Neuville trenches of the literature, whereas that of the Valisettes Member corresponds to the southern section and the disused Petit-Mont quarry at Vodelée is the type section of the eponymous member (Boulvain et al., 1993b, 1993c, 1999b, 1999c). The latter is not accessible nowadays, but the neighbouring Haumont quarry (Vodelée) as well the Beauchâteau quarry at Senzeille serve as good parastratotypes (e.g. Boulvain, 1993b; Boulvain & Coen-Aubert, 1991, 1992).

As reminded by Sartenaer (1974c), Gosselet (1871) did not mention a particular section in the vicinity of the villages of Gimnée, Matagne-la-Grande and Matagne-la-Petite for the Matagne Facies. Coen et al. (1999) selected the Nismes railway section, on the left bank of the Eau Blanche River valley southwest of the Tienne aux Pauquis, as the stratotype of the Matagne formation due to its historical value because it was firstly sketched by Gosselet (1888), although they considered other outcrops as more characteristic of this lithostratigraphic unit: Charleroi–Couvin (N5–E420) road section at Frasnes-lez-Couvin (Sartenaer, 1974a; Bultynck et al., 1998), protected outcrop behind the Saint-Sulpice church of Boussu-en-Fagne (Casier, 1975), Lessive section (Coen, 1977a; Bultynck et al., 1998).

Although Coen (1974, 1999) referred to the Liège–Marloie railway section located in the trench on both sides of the disused halt of Biron as the type section of the Barvaux Facies, it appears that Gosselet (1880b) has never cited this outcrop, but he mentioned the section located to the southwest of the Barvaux station, as noted by Sartenaer (1974d). Moreover, this author clearly demonstrated that Gosselet (1880b, p. 195–198) designated the Brussels–Luxembourg railway trench to the north of the halt of Aye as the type section of the *Schistes brunâtres et violacés (...) de Barvaux* (see also Gosselet, 1882, 1888).

The Famenne Member is well exposed in the Brussels–Luxembourg railway trench at Hogne (Gosselet, 1888; Mottequin, 2005), north of the halt of Aye, at least its contact with the Valisettes Member. In the same area, the Aye Facies is visible in the section located in the railway trench located southeast of the hamlet of Les Basses, near Haversin, and described by Dreesen & Dusar (1975).

Area and lateral variations. The Marche-en-Famenne Formation is recognised throughout the Dinant Synclinorium. The Neuville Member is recognised on the southern and southeastern margins of the Dinant Synclinorium, from the French border (Marion & Barchy, 2001) up to the lower Ourthe River valley, where it passes laterally to the Aisemont Formation between Xhignesse and Awan (Bellière, 2015; Marion & Barchy, in press, a). In the northwestern part of the Dinant Synclinorium, the transition with the Aisemont Formation is unclear in the absence of outcrops and the thinning out of the Neuville Member, notably between Thuillies and Villers-Poterie, and up to Maison (Delcambre & Pingot, 2000b, 2004; Hennebert, 2008).

In the Durbuy–Philippeville Anticlinorium, the Valisettes Member was invariably grouped with the Neuville Member (e.g. Dumoulin & Marion, 1997) and also with the Matagne Facies (Lemonne & Dumoulin, 1998). In the Famenne depression, it was grouped with the Barvaux Facies as the facies are intricately intertwined. The Matagne Facies occurs on the southern limb of the Dinant Synclinorium and in the western part of the Durbuy–Philippeville Anticlinorium. A study of the distribution of brachiopods within the Valisettes Member in the Neuville railway section (Mottequin, 2005a) did not confirm the existence of two Matagne Facies occurrences as hypothesised by Bultynck et al. (1998, fig. 11). Coen & Coen-Aubert (1974) and Godefroid & Helsen (1998) had already indicated a repetition by fault of the Valisettes Member in this section. The Barvaux Facies is known from the southeastern flank of the Dinant Synclinorium; the lateral transition with the Matagne Facies and Valisettes Member, occurs in the Ciergnon–Lessive area (Sartenaer, 1970; Coen, 1999; Dumoulin & Blockmans, in press). It was recognised up to the Ourthe River valley where it disappears east of Comblain-la-Tour (Marion & Barchy, in press, a).

Along the northern limb of the Dinant Synclinorium, the distinction between the Valisettes and Famenne members is elusive, tough reddish facies are occasionally developed (e.g. Hoyoux River valley, Mottequin et al., 2021), and the former Neuville and Famenne formations were grouped for mapping purposes (Hennebert, 2008). Eastwards, the Valisettes Member passes in the Vesdre area to the Lambermont Formation whereas the Famenne Member passes to the Hodimont Formation (Laloux et al., 1996a). The Aye Facies is recognised in the central and southern parts of the Dinant Synclinorium, from the French border (Dumoulin, 2001; Marion & Barchy, 2004; Hennebert, 2008) to the west, up to Borlon (Barchy & Marion, 2018) and Comblain-Fairon (Marion & Barchy, in press, a) to the east. As pointed out by Donnay & Ramelot (1948) and Bouckaert et al. (1968), the Esneux Formation passes laterally to the more argillaceous Aye Facies in the central part of the Dinant Synclinorium (i.e. in a more offshore position).

Thickness. On the the southeasterm limb of the Dinant Synclinorium, the Marche-en-Famenne Formation could be estimated at c. 450 m thick in the eponymous area (Barchy & Marion, 2014), but the thickness of its constitutive members shows great variations. The Neuville Member is rather thin in the Philippeville Anticlinorium with a relatively constant thickness: 16–24 m in the stratotype sections (e.g. Boulvain et al., 1993b, 1999b). Its thickness increases up to c. 40 m on the southern margin of the Dinant Synclinorium (e.g. Marion & Barchy, 1999; Dumoulin & Marion, 1997 Sautour), c. 25 m at Olloy-sur-Viroin (Dumoulin & Coen, 2008), 40 m at Givet (Lemonne & Dumoulin, 1998), 110 m at Han-sur-Lesse (Coen, 1977a; Boulvain et al., 1999b), 35–100 m (Barchy & Marion, 2014). On the southeastern limb of the Dinant Synclinorium, the Neuville Member is still 50 m thick at Sy (Boulvain et al., 1999b; Marion & Barchy, in press, a). Along the northern limb of the Dinant Synclinorium, the Neuville Member reaches 20 m at Merbes-le-Château (Hennebert, 2008) up to Hymiée (a tens of meters according to Delcambre & Pingot, 2000b). In their type section, the Valisettes and Petit-Mont members are about 90 m and 60 m, respectively (Boulvain et al., 1993b, 1993c, 1999b, 1999c). The maximal thickness of the Matagne Facies, i.e. about 50 m, is recorded on the southern limb of the Dinant Synclinorium. In the Philippeville Anticlinorium, it decreases to c. 10 m. That of the Barvaux Facies varies from a few dozen metres to over 90 m (Coen, 1999; Barchy & Marion, 2014).

The Famenne Member varies in thickness from 50 to 60 m along the northern limb of the Dinant Synclinorium, 260 m in the Silenrieux-Walcourt area and 400 m in the Achêne-Leignon area located in the central part of the Dinant Synclinorium, and reaches its maximum development along the southern side of the Dinant Synclinorium between the Meuse River valley and the Lesse River valley (> 400 m in the Han-sur-Lesse area, Dumoulin & Blockmans, in press Han). Nevertheless, such thicknesses are probably overestimated due to the presence of numerous faults; indeed, 400 m would correspond to the deposition of 1000 m of clay before compaction and diagenesis. The thickness of the Aye Facies is quite variable locally; the maximal thickness (c. 220 m) is encountered in the Hermeton River valley (Boulvain & Marion, 1994), but it tends to decrease progressively westwards (e.g. 100–150 m on the Grandrieu–Beaumont map, Dumoulin, 2001) and eastwards (e.g. 50–100 m on the Natoye–Ciney map, Barchy & Marion, 2018; 0–100 m on that of Hamoir–Ferrières; Marion & Barchy, in press).

Age. Late Frasnian to early middle Famennian. The Neuville Member is assigned to the Lower *rhenana* conodont Zone (Bultynck et al., 1998; Boulvain et al., 1999b), but its base is diachronous and youngers northwards (Poty & Chevalier, 2007). The base of the Upper *rhenana* conodont Zone is close of that of the Valisettes Member (Bultynck et al., 1998). Characteristic brachiopods of the Neuville Member are notably *Navalicria compacta*, *Calvinaria megistana*, *Pseudoatrypa godefroidi*, *Warrenella* (*W.*) *aquaealbae* and *Tyorcyrspis bironensis*. Several of these species are also known from the Aisemont Formation (Tchafornis Member).

The conodonts from the carbonate mounds of the Petit-Mont Member developed in the Philippeville Anticlinorium were discussed by Coen et al. (1977), Tourneur (1982), Bultynck et al. (1988), Boulvain et al. (1988), and Boulvain et al. (1992). Along the southern limb of the Dinant Synclinorium, the carbonate mounds are restricted to the Lower *rhenana* conodont Zone and yield the rugose corals typical of the *faune 1* of Coen et al. (1976). Some small mounds developed precociously, i.e. almost at the base of the Neuville Member, notably in Frasnes-lez-Couvin, the Ternias (north of Nismes), Fort Condé (Givet), and Saint-Rémy mounds (Rochefort). In the Philippeville Anticlinorium, the carbonate mounds extend from the Lower to Upper *rhenana* conodont Zones and yield the rugose corals typical of both the *faune 1* (in red limestone) and *faune 2* (in pink and grey limestone). Within the brachiopod fauna, *Neometabolipa duponti*, *Parallelepipedorhynchus trapezoides* and *Iowatrypa rotundicollis* rank among the most characteristic taxa of the Petit-Mont Member.

In matter of conodont zonation, the base of the Valisettes Member is almost coincident with the boundary between the Lower and Upper *rhenana* zones whereas its top is placed at the transition between the *linguiformis* and *triangularis* zones (Bultynck et al., 1998; see remarks concerning the lower Famennian conodont zonation in section 3). The Valisettes Member yields a characteristic late Frasnian atrypide assemblage including *Spinatrypina* (*Exatrypa*) *marmoris*, *Iowatrypa philippevillensis*, *I. ultima* and *Waiotrypa*? sp. (Mottequin, 2003, 2004b, 2008b). The early development of the Matagne Facies is recorded at the base of the Upper *rhenana* conodont Zone (Frasnes, Nismes) or is just below (Lower *rhenana* conodont Zone, Lessive) on the southern limb of the Dinant Synclinorium (Bultynck et al., 1998); in the Philippeville Anticlinorium, this facies is included in the *linguiformis* conodont Zone (Bultynck et al., 1998). The Hony Horizon argillaceous limestone are in fact the only carbonate unit that yields conodonts from the *linguiformis* Zone (Gouwy & Bultynck, 2000). The leiorhynchid brachiopod *Ryocarhynchus tumidus* is present throughout the Matagne Facies (Sartenaer, 1968a, 1974a). The Barvaux Facies belongs to the Upper *rhenana* conodont Zone (Coen, 1999; Gouwy & Bultynck, 2000; Bultynck & Dejonghe, 2002). *Douvillina area* and *Retrorstrophia retrorsa*, *Cleiothyridina* sp. A, *Cyrtospirifer ambosulcata* and *Iowatrypa ultima* are key brachiopod species of this shaly facies (Mottequin, 2003, 2008a, 2008b, 2008c, 2019).

The Famenne Member is usually early Famennian to early middle Famennian in age (*triangularis–marginifera* conodont zones) and is marked by a renewal of the brachiopod fauna following the late Frasnian biological Crisis. Nonetheless, its base could be also late Frasnian in age where the Valisettes Member is not developed. Sartenaer (e.g. 1968b, 1972, 1983, 2001) established a detailed rhynchonellide zonation for this member confirming the biostratigraphic value of these brachiopods already pointed out by Gosselet (1877a, 1879b, 1887). Furthermore, orthotetides (*Floweria pseudoelegans*), athyridides (*Crinisarina angelicoides*, *C. stainbrooki*, *C. reticulata*, and spiriferides (e.g. *Sinospirifer stolbergensis*, *S. subextensus*, '*Pseudocyrtiopsis' senceliae*, *Dmitria* cf. *angustirostris* are also particularly helpful in the field to recognise the lower Famennian. The Aye Facies yields conodont of the *rhomboidea* Zone to transition between the Lower and Upper *marginifera* zones (Dreesen, 1982a; Thorez et al., 2006).

Nismes Formation – NIS

Origin of name. From the village of Nismes in the Eau Noire River valley, *Formation de Nismes* in Coen-Aubert et al. (1985, p. 7), who cited an unpublished document by Bultynck et al. (1983), and Nismes Formation in Sartenaer (in Bultynck et al., 1988a, p. 253).

Remarks. On the geological maps of Wallonia, two different names were applied to the mixed argillaceous–carbonate deposits that overly the last Givetian limestones, namely the Nismes and Presles formations (e.g. Bultynck & Coen, 1999; Coen-Aubert, 1999b). According to Coen-Aubert (1999b), the Presles Formation would be distinguished from the Nismes Formation by the development of argillaceous limestones and dolomites frequently enclosing haematitic oolites whereas the latter unit is essentially shaly. However, the criteria used to distinguish both former units are quite tenuous as ferruginous oolites are also present locally within the Nismes Formation (e.g. Marche-en-Famenne, Ny), and it is more logical to consider herein the Presles Formation as a facies of the Nismes Formation.

Description. The Nismes Formation is essentially shaly and the passage between the underlying Givetian Fromelennes Formation is progressive (e.g. Nismes) or abrupt (e.g. Sourd d'Ave). It was subdivided into three members by Godefroid & Jacobs (1986, p. 69), who mentioned Bultynck et al.'s (1983) unpublished document, as the *Membre du Pont d'Avignon*, *Membre du Sourd d'Ave* and *Membre de La Prée* that are developed on the southern and southeastern limbs of the Dinant Synclinorium, to which it is added here the Presles Facies, which is known from the northern and eastern areas (see below).

The former basal member is regarded herein as a horizon (Pont d'Avignon Horizon) due to its insignificant thickness (1.15 m thick). It includes pluridecimetric beds of argillaceous, bioclastic and greyish limestone with somewhat nodular to sub-nodular aspect. It is rich in large-sized atrypide and spiriferide brachiopods (*niveau des monstres* (pars) in Gosselet, 1871, p. 296; see also Sartenaer, 1974e, 1982; Sartenaer in Bultynck et al., 1983, 1988a; Godefroid & Jacobs, 1986). The basal bed of the Pont d'Avignon Horizon is marked by a reddish-brown alteration colour due to a relatively high content in limonite (Bultynck & Jacobs, 1982; Godefroid & Jacobs, 1986).

The **Sourd d'Ave Member – SAV** (16.3 m thick) can be subdivided into a lower part consisting of greenish, very nodular shale with some thin sub-nodular limestone lenses and an upper part composed of shale with less carbonate nodules, but with thicker sub-nodular limestone beds. The aforementioned brachiopods are less abundant than in the Pont d'Avignon Horizon, but the lower half of this member was also included in the *niveau des monstres*. Between Ny and Humain, a decimetre-thick limestone bed full of chamositic oolites occurs near the base of the member (de Magnée, 1933; Coen,1973, 1974).

The **Prée Member – PEE** (c. 20–22 m thick) starts above the last conspicuous limestone bed of the Sourd d'Ave Member and is essentially shaly. The greenish to brownish shale includes few nodules of greyish, very argillaceous limestone and, very rarely, thin limestone lenses. Brachiopods are generally less abundant than in the Pont d'Avignon Horizon and Sourd d'Ave Member (Sartenaer, 1982; Bultynck & Jacobs, 1982; Mottequin et al., 2016).

The **Presles Facies** (*Formation de Presles* in Coen-Aubert et al., 1985, p. 8, 25) is predominantly argillaceous and sandwiched between two carbonate lithostratigraphic units, i.e. the Le Roux and Lustin formations (Coen-Aubert, 1999b). It often incorporates thin dolomite beds at its base as well as several horizons of haematitic or chamositic oolites. Thanks to these characteristics, it is a good marker in the field to recognise the onset of the Frasnian transgression. According to Coen-Aubert (1988, 1999b), the Presles Facies, in its type section, starts with 3.4 m thick argillaceous, bioclastic, dark limestones with crinoids and brachiopods that overlie the fine-grained limestone, sometimes rich in rugose and tabulate corals, of the Givetian Le Roux Formation (see Denayer et al., 2024). One or several beds of argillaceous limestone with haematitic oolites are present in the middle part. The argillaceous limestone is overlain by green to brownish shale (6.3 m thick) that comprises some beds of argillaceous limestone and some haematitic oolite horizons near the top of this facies. Locally (Ourthe River valley), a level rich in *Disphyllum* is developed below the contact with the overlying Lustin

The boundary with the overlying Moulin Liénaux (Chalon Member), Pont de la Folle (Fontaine Samart Member) and Lustin (Gougnies Member) formations is placed at the top of the last shale bed situated below the first limestone bed.

Stratotype and sections. A composite stratotype, including four sections located on the northern margin of the Bois de Mousti at Nismes, was proposed by Bultynck et al. (1988a) (see Bultynck & Coen, 1999) for the Nismes Formation and the Sourd d'Ave and Prée members. The stratotype can be complemented, among the outcrops described by Bultynck & Jacobs (1982) and Godefroid & Jacobs (1986), by the easily accessible Sourd d'Ave section at Wellin (Bultynck & Jacobs, 1982) and the railway trench at the Fond des Vaulx at Marche-en-Famenne (Barchy & Marion, 2014). However, in both latter sections, the contact with the overlying Moulin Liénaux Formation is not exposed. Coen-Aubert et al. (1985) and Coen-Aubert (1999) proposed the section mentioned by Lacroix (1974a, 'Presles' without any information) and Coen (1976), along the Namur–Charleroi road (N922) in the by-pass of Presles, as the stratotype of the Presles Facies. This outcrop is very overgrown nowadays).

The Nismes composite section was selected by the Subcommission on Devonian Stratigraphy of the IUGS (Prague, August 1986) as an auxiliary stratotype (parastratotype) for the Givetian–Frasnian boundary in neritic facies (Bultynck et al., 1988a, 1988b).

Area and lateral variations. The Nismes Formation has a widespread distribution in southern Belgium. It is observed along the southern and eastern margins of the Dinant Synclinorium, from the French border to the west (Marion & Barchy, 2001) up to Deigné (Coen, 1974; Marion et al., in press) to the east. Though discontinuous laterally, the chamositic horizon is developed between the Wamme River and Ourthe River valleys.

The Nismes Formation is recognised in the Durbuy–Philippeville Anticlinorium (e.g. Coen, 1977b; Boulvain & Marion, 1994; Dumoulin & Marion, 1997b), but is essentially shaly with no clear distinction into members (Bultynck & Coen, 1999) as is the case on the northern limb of the Dinant Synclinorium. In the latter Variscan unit, the Nismes Formation is recognised in northern France, south of Honnelles (Hennebert & Delaby, in press), and south of Solre-sur-Sambre (Hennebert, 2008; Pas et al., 2015), Gerpinnes (Delcambre & Pingot, 2000b), between Biesme and Gougnies (Delcambre & Pingot, 2004) up to the Meuse River valley where the Presles Facies begins to develop north of the Rivière Syncline (Coen-Aubert & Coen, 1975; Delcambre & Pingot, 2018a).

In the Vesdre area, the Nismes Formation was recognised within the Membach boreholes by Coen-Aubert et al. (1985) where it is made up of shale with thin calcareous levels at its base and top. To the west, the Presles Facies stands out from the rest of the formation.

The Presles Facies is recognised in the Haine–Sambre–Meuse Overturned Thrust sheets (e.g. Lacroix, 1974a, 1974b; Coen-Aubert, 1988), in the Brabant Parautochthon (Wépion borehole; see Coen-Aubert, 1988; Delcambre & Pingot, 2017), in the northern and eastern parts of the Dinant Synclinorium (e.g. Coen-Aubert, 1973; Marion et al., in press), the western part of the Vesdre area (e.g. Coen-Aubert, 1974; Laloux et al., 1996a) and in the Theux Tectonic Window (Graulich, 1979).

Thickness. The Nismes Formation is c. 39 m thick in its stratotype (Bultynck & Coen, 1999). Eastwards, its thickness varies between 20 and 35 m on the southern and southeastern limbs of the Dinant Synclinorium (e.g. Dumoulin & Blockmans, 2013; Barchy & Marion, 2014; Barchy et al., 2024; Marion & Barchy, in press, b). On the eastern flank of the latter tectonic unit, the Nismes Formation is 13 m thick at Aywaille (Fourmarier, 1900; Coen, 1974) and drastically thins northwards. Comparable thicknesses are observed in the western part of the Durbuy–Philippeville Anticlinorium (e.g. Boulvain & Marion, 1994; Dumoulin & Marion, 1997b). In the northern part of the Dinant Synclinorium, Hennebert (2008) cited an average thickness of 35 m (20–50 m thick) in the Sambre River valley, c. 20 m at Hymiée (Delcambre & Pingot, 2000b), 15–20 m between Biesme and Gougnies (Delcambre & Pingot, 2004), c. 10 m at the maximum in the Rivière Syncline (Coen-Aubert & Coen, 1975; Delcambre & Pingot, 2018a). In the Membach boreholes, its thickness does not exceed 7 m (Coen-Aubert et al., 1985).

The Presles Facies is c. 10 m thick in its type section and 16.6 m thick in the bottom of the Wépion borehole (Coen-Aubert, 1988), which corresponds to its maximal thickness. Usually, it is around 5 m thick in the Dinant Synclinorium and in the Haine–Sambre–Meuse Overturned Thrust sheets (Lacroix, 1974b; Coen-Aubert & Lacroix, 1979). In the western extremity of the Vesdre area, at Colonster in the Ourthe River valley, the Presles Facies consists of few metres of of argillaceous limestone rich in spiriferide brachiopods. Due to its thinness in the Vesdre area (only 2 m thick at the maximum; Coen-Aubert, 1974a), it was mapped together with the overlying Lustin Formation (Laloux et al., 1996a; Delcambre et al., in press). In the Theux Tectonic Window (Polleur viaduct boreholes), it reaches 6 m in thickness (Graulich, 1979).

Age. Latest Givetian–early Frasnian (Lower *falsiovalis–transitans* conodont zones) (Bultynck & Coen, 1999; Bultynck et al., 1999). The Pont d'Avignon Horizon is of latest Givetian age at Nismes and Wellin whereas the first occurrence of the conodont *Ancyrodella rotundiloba* is recorded in the basalmost part of the Sourd d'Ave Member in both sections (Bultynck &

Jacobs, 1982). The top of the Prée Member yielded a few specimens of *Palmatolepis transitans* (Vandelaer et al., 1989). *Ancyrodella rotundiloba* occurs at the base of the Presles Facies in several sections located on the northern limb of the Dinant Synclinorium and in the Haine–Sambre–Meuse Overturned Thrust sheets, between Aisemont and Vierset-Barse (Coen-Aubert, 1973; Mouravieff in Lacroix, 1974a; Coen-Aubert & Coen, 1975). The atrypide brachiopod succession, including in ascending order, the *Desquamatia* (*Seratrypa*?) *suppinguis*, *D.* (*Neatrypa*) *gosselet*) and *D.* (*N.*) *europaea* zones, observed within the Pont d'Avignon Horizon and the Sourd d'Ave Member on the southern and southeastern margins of the Dinant Synclinorium confirms the diachronism documented by the conodonts in these areas (Godefroid & Jacobs, 1986, fig. 25); indeed, the base of the Nismes Formation becomes younger from the south (Nismes, Martouzin) to the northeast (Sy). Besides *D.* (*S.*) *pectinata* and *Anathyris* (*A.*) *calestiennensis* (Godefroid & Jacobs, 1986; Mottequin et al., 2016), on the southern (S) and southeastern (SE) margins of the Dinant Synclinorium, the Nismes Formation yields a succession of spiriferide species that has yet to be further documented: *Uchtospirifer*? *fraiponti* (the so-called *Spirifer orbelianus* in the Franco-Belgian literature; see Mottequin, 2019 and Serobyan et al., 2022) (S, SE; *Eodmitria oblivialis oblivialis*, *E. oblivialis grandis* (SE), *Geminisulcispirifer bisinus* (S, SE) and *Subquadriangulispirifer malaisi* (S, SE). In the Presles Facies, only the presence of *Eodmitria oblivialis oblivialis* and *Eodmitria oblivialis grandis* is well documented (Sartenaer, 1982; Delcambre et al., in press). Both *Eodmitria* subspecies are also known from the Bovesse Formation (Sartenaer, 1982). Although they need to be revised, representatives of the genus *Apousiella* can be frequent in the Presles Facies.

Philippeville Formation – PHV

Origin of name. From the town of Philippeville, *Formation de Philippeville* (Boulvain et al., 1993d, p. 14).

Description. The carbonate Philippeville Formation abruptly overlies the shaly upper part of the Pont de la Folle Formation (Machenées Member). It is frequently, but irregularly affected by dolomitisation (Coen & Coen-Aubert, 1976; Boulvain et al., 1993d, 1999d). This thick unit deserves to be subdivided into three members based on distinct lithologies firstly recognised in the Entre-Sambre-et-Meuse area (e.g. Beugnies et al., 1963). The description hereafter is based on the succession observed in its type section at Philippeville (Coen, 1977b; Boulvain et al., 1993d, 1999d).

The Cousolre Member – COU (*marbre de Cousolre* in Gosselet, 1877b, p. 253–254; *Assise F5 (marbre de Cousolre ou dolomie de Renlies)* in Beugnies et al., 1963, p. 220) is essentially made up of light-coloured limestone. It starts with such limestone yielding lamellar tabulate corals and pentameride brachiopods (3–4 m), followed by 7 m of argillaceous limestone with brachiopods, and ends with 5 m of fairly massive, light-coloured limestone with lamellar tabulate corals (*Alveolites*), fenestellid bryozoans and fenestrae. The argillaceous limestone is sometimes absent (Neuville railway section). This member should not be confused with the *schistes de Cousolre*, a disused Famennian unit proposed by Gosselet (1880a, p. 112, 1888, p. 562).

The Reugnies Member – REU (*Assise F6 (Calcaire noir lité de Reugnies)* in Beugnies et al., 1963, p. 223; *Membre de Reugnies* in Delcambre & Pingot, 2000b, p. 39) starts with 16 m of decimetre-thick beds of black limestone with small bioclasts (brachiopods, solitary rugose and ramose tabulate corals are abundant locally) corresponding to the *marbre noir de Reugnies* (Beugnies et al., 1963, p. 223), then followed by 3 m of black shale and argillodolomitic limestones, and ends with 7–8 m of black limestone with ramose tabulate corals, less abundant solitary rugose corals and rare lamellar stromatoporoids.

The Thy-le-Bauduin Member – THY (*Assise de Rhisnes et de Thy-le-Baudouin* in Conseil de Direction de la Carte, 1896, p. 54) consists of alternations of decimetre-thick beds of frequently laminar limestone and of metric-bedded limestone rich in massive and branched stromatoporoids (60 m thick); massive rugose corals become frequent at the top of this second unit, which is also known as the *complexe biostromal* (Cornet, 1978). Its top is placed just below the first bed of nodular limestone characteristic of the Marche-en-Famenne Formation (Neuville Member).

Locally, the dolomitisation can affect large parts of the Philippeville Formation and forms dolomitic masses reaching 70 m in thickness and several kilometres in lateral extension (Dejonghe et al., 1989), notably in the western part of the Durbuy–Philippeville Anticlinorium, around the villages of Merlemont and Sautour. These masses are here named the Merlemont Dolomitic Facies. Four types of dolostone were distinguished by Dejonghe et al. (1989): (1) greyish, finely to moderately grained (with fossil phantoms), (2) whitish to yellowish (no fossils, and frequently with numerous vacuoles), (3) banded (or zebra) with rhythmic, plurimillimetric to pluricentimetric alternations of greyish to whitish dolostone), and (4) greyish, coarsely grained (no fossils). Cherts and diffused silicifications occur in the dolostone.

Stratotype and sections. Trench of the Charleroi–Couvin road (N5–E420) south of Philippeville, north of Km-stone 79 (Boulvain et al., 1993e, fig. 2). The stratotype can be complemented by the Neuville railway section where the upper part of the Philippeville Formation is better exposed (Boulvain et al., 1993d, fig. 4, section 2). The historical type section of the Cousolre Member corresponds to the quarries mostly located on the right bank of the La Thure River at Cousolre in Avesnois (France) (Gosselet, 1877b) whereas that of the

Reugnies Member comprises the quarries situated on the hillside of the French eponymous village (e.g. Gosselet, 1888). The Thy-le-Bauduin Member was originally based on the sections located around this village (Delcambre & Pingot, 2000b).

Area and lateral variations. On the northern margin of the Dinant Synclinorium, the Philippeville Formation is known from the Avesnois and the French border (Beugnies et al., 1963; Hennebert, 2008) up to Hymiée (Delcambre & Pingot, 2000b, 2004) where it laterally passes to the Lustin Formation. It is known from the anticlines in the central western part of the Dinant Synclinorium (Entre-Sambre-et-Meuse) up to Rance (Marion & Barchy, 2004) and in the western part of the Durbuy–Philippeville Anticlinorium. In this latter tectonic unit, the Philippeville Formation laterally and progressively passes to the Grands Breux Formation southeast of a virtual line linking Sautour and Omezée (Dumoulin & Marion, 1997b). East of the Meuse River valley, this lithostratigraphic unit is recognised in the Durbuy–Philippeville Anticlinorium, from Sinsin to Nettine (Coen, 1974; Barchy & Marion, 2008, 2014) and from Petite-Somme to Tohogne where it passes laterally, towards the northeast, to the Lustin Formation (Marion & Barchy, in press, a). The southeastern lateral passage to the Grands Breux Formation takes place between Bohon and Barvaux-sur-Ourthe (Marion & Barchy, in press, b). The Reugnies Member is only recognised in the Entre-Sambre-et-Meuse area and tends to disappear northwards (Delcambre & Pingot, 2004).

Thickness. The Philippeville Formation is quite thick in the western part of the Durbuy–Philippeville Anticlinorium, i.e. 103 m in the stratotype and 113 m in the Neuville railway section according to Coen (1977b) and Boulvain et al. (1993d, 1999d), as is the case in its eastern part where similar thicknesses were reported (Barchy & Marion, 2008; Marion & Barchy, in press, a, b). In the anticlines of the western central part of the Dinant Synclinorium (e.g. Beaumont, Renlies), it varies between 70–100 m (Préat & Lapierre, 1986; Dumoulin &

Marion, 1997a; Dumoulin, 2001; Marion & Barchy, 2004). On the northwestern margin of the Dinant Synclinorium, its thickness reaches c. 85 m in the Labuissière area (Hennebert, 2008) and 100 m south of Gerpinnes and in the Hanzinne area (Delcambre & Pingot, 2000b, 2004).

Age. Middle Frasnian. Although poorly constrained due to the conodont rarity (Coen, 1977b), Gouwy & Bultynck (2000) and Bultynck & Dejonghe (2002) suggested an interval comprised between the lower part of the *hassi* s.l. conodont Zone and the lower part of the Lower *rhenana* conodont Zone. The rugose corals *Hexagonaria mirabilis* and *Peneckiella fascicularis* are typically found in the Cousolre Member whereas *Argutastraea koninckí* and *A. lecomptei* are abundant in the Thy-le-Bauduin Member (Coen-Aubert, 2009), allowing the correlation of these units with the upper member of the Lustin Formation and with the Grands Breux Formation.

Pont de la Folle Formation – PFL

Description. The Pont de la Folle Formation rests on the shaly Nismes Formation. In the western part of the Durbuy–Philippeville Anticlinorium, where it was originally defined, it was subdivided, in ascending order, into the Fontaine Samart and Machenées members (Boulvain et al., 1993e). Later, the Brayelles member was proposed by Dumoulin & Marion (1997a), but overlooked by Boulvain et al. (1999e). The Hymiée Member, originally presented as a local member of the Lustin Formation (Delcambre & Pingot, 2000b), has all the characteristics of the Pont de la Folle Formation with a few peculiarities due to its northern position in the Dinant Synclinorium, close to the transition with the Lustin Formation.

In its type section, the **Fontaine Samart Member – FSA** (*Membre de la Fontaine Samart* in Boulvain et al., 1993e, p. 9; units b–b’ in Coen, 1977b, p. 26) is c. 35 m thick (including an 8 m exposure gap) and starts with about ten of metres of light grey limestone with small stromatactis, brachiopods and crinoids of which the upper 5 m are massive and rich in stromatactis, lamellar and bulbous stromatoporoids, crinoids, lamellar tabulate corals (*Alveolites*) and pentameride brachiopods, with an abundant sparitic cement. This massive black-and-white-coloured limestone corresponds to the Sainte-Anne Facies or *Marbre Sainte-Anne* of the authors (Groessens, 1981), or *niveau R1* in Delcambre & Pingot (2000b). The top of the Member corresponds to 14 m of well-bedded, black and bioclastic limestone becoming gradually more argillaceous upwards (calcshale according to Coen, 1977b) and yielding some solitary rugose corals, brachiopods and crinoids. In the western central part of the Dinant Synclinorium (Barbençon–Boussu-lez-Walcourt, Solre-Saint-Géry and Grandrieu anticlines), the lower part of the Fontaine-Samart Member, which includes light-coloured and massive limestone corresponding to the *Marbre Sainte-Anne* of the authors, is dolomitised. This dolostone is named Brayelles Dolomitic Facies (*Membre de Brayelles* in Dumoulin & Marion, 1997a, p. 17). It corresponds to a thick package of black, beige or grey-beige saccharoidal and/or pulverulent dolostone with a few ghosts of reef-building organisms which have escaped the dolomitisation process (Dumoulin, 2001). This unit, overlying the Nismes Formation, is developed laterally to the *Marbre Sainte-Anne* (see above). It is capped by stromatoporoid-rich bedded limestone belonging to the top of the Fontaine Samart Member.

The **Machenées Member** – **MAC** (Membre des Machenées in Boulvain et al., 1993e, p. 9; unit c in Coen, 1977b, p. 26) is composed of shale more or less nodular that incorporates some beds of nodular limestone with crinoids and, sometimes, stromatoporoids and lamellar tabulate corals.

On the north-western limb of the Dinant Synclinorium, between Hymiée and Gerpinnes, the Pont de la Folle Formation is represented by the Hymiée Member – HYM (*Membre d'Hymiée* in Delcambre & Pingot, 2000b, p. 40) that essentially consists of a succession of two or three reefal carbonate units with metre-thick beds rich in fasciculate rugose corals (*Disphyllum*) at their base; bedded limestone is also present. At Hymiée, the first reefal unit is dolomitised and the top of the Member corresponds to several metre-thick shale beds (< 10 m), whereas the latter progressively thins to attain only 1 m north of the Gerpinnes Anticline, before disappearing northwards.

Stratotype and sections. The stratotype of both the Pont de la Folle Formation and the Fontaine Samart and Machenées members is located south-west of Philippeville and corresponds to the eastern trench of the Charleroi–Couvin road (N5–E420), on both sides of the railway bridge, but is largely overgrown nowadays. Other sections have been proposed in the western part of the Durbuy–Philippeville Anticlinorium notably by Dumoulin & Marion (1997b). In the western central part of the Dinant Synclinorium (Barbençon–Boussu-lez-Walcourt and Solre-Saint-Géry anticlines), Dumoulin & Marion (1997a) and Dumoulin (2001) listed a series of important outcrops. The Brayelles Facies has been intersected in two boreholes in Brayelles, 3.5 km north-east of Barbençon (Dumoulin, 2001). The stratotype of the Hymiée Member corresponds to the section along the road from Gerpinnes to Hanzinne (N975), 400 m to the north of the bifurcation leading to the village of Hymiée (Delcambre & Pingot, 2000b); it is complemented by the Evrard quarry (also known as the société wallonne des eaux quarry) to the south of Gerpinnes (Coen-Aubert, 2009).

Area and lateral variations. The Pont de la Folle Formation is recognised in the north-western part of the Durbuy–Philippeville Anticlinorium (e.g. Boulvain et al., 1993e, 1999e) and, to the south-east of this tectonic structure, it passes laterally to the Moulin Liénaux Formation (Dumoulin & Marion, 1997b). In the eastern part of the Durbuy–Philippeville Anticlinorium, the Pont de la Folle Formation (and its classic members) crops out from the Heure Creek valley, south of Nettine (Barchy & Marion, 2008), up to Tohogne (Coen, 1974; Marion &

Barchy, in press, a) where it passes laterally to the base of the Lustin Formation. In the transitional zone between the Durbuy–Philippeville Anticlinorium and the south-eastern limb of the Dinant Synclinorium, the Pont de la Folle Formation passes laterally to the Moulin Liénaux Formation in the Bomal-sur-Ourthe area (Marion & Barchy, in press, a). In this region, the Brayelles Facies is recognised within the Herbet Creek valley (Marion & Barchy, in press, a; Boulvain et al., 2022). It is also reported in different anticlines from the western central part of the Dinant Synclinorium (see above). The Hymiée Member is only known around Gerpinnes; it marks the transition between both usual members of the Pont de la Folle Formation to the south and the basal part of the Lustin Formation to the north.

Thickness. In the type section (Philippeville), the whole formation is c. 90 m thick, with 35 m and 55 m for the Fontaine Samart and Machenées members, respectively (Boulvain et al., 1993e, 1999e); eastwards, it is c. 70 m thick in the Durbuy area with about 20 m for the Machenées Member (Coen, 1974; Marion & Barchy, in press, b). The thickness of the Brayelles Facies varies from 55 m to 75 m between Barbençon and Boussu-lez-Walcourt (Dumoulin, 2001; Dumoulin & Marion, 1997a) and reaches 48 m at Bomal-sur-Ourthe (Boulvain et al., 2022). Delcambre & Pingot (2000b, 2004) estimated the thickness of the Hymiée Member at around one hundred metres.

Age. Early to middle Frasnian. The Pont de la Folle Formation spans the interval of the upper part of the *transitans* up to the lower part of the *hassi* s.l. conodont zones (Coen, 1977b; Bultynck & Dejonghe, 2002). The Machenées Member yielded a characteristic association of rugose corals, namely *Hexagonaria mirabilis, Scruttonia focantensis*, *S. balconi*, *Mansuyphyllum elongatum*, and *Tabulophyllum mcconelli* (Boulvain et al., 1999e). At Gerpinnes, the rugose coral fauna recognised within the shaly upper part of the Hymiée Member includes *Sinodisphyllum kielcense*, *T. mcconnelli* and *H. mirabilis* (Coen-Aubert, 2009). The presence of *Metabolipa greindli* in the Fontaine Samart Member (Godefroid in Dumoulin, 2001) has to be noted as this pentameride also occurs in the Moulin Liénaux Formation (Arche Member).

Samme Group – SAM

Origin of name. From the Samme River, *Formation de la Samme* in Doremus & Hennebert (1995a, p. 11).

Content. This unit was introduced by Doremus & Hennebert (1995a), as a formation composed of three members, in ascending order: the Bois de la Rocq, Feluy and Mévergnies members. Delcambre & Pingot (2008) have promoted the Bois de la Rocq to the formation status, as it can be traced all along the Brabant Parautochthon, whereas the other two are restricted to the Dendre River and Senette River valleys; consequently, the other two members, characterised by distinct lithologies, are also considered as formations within the Samme Group.

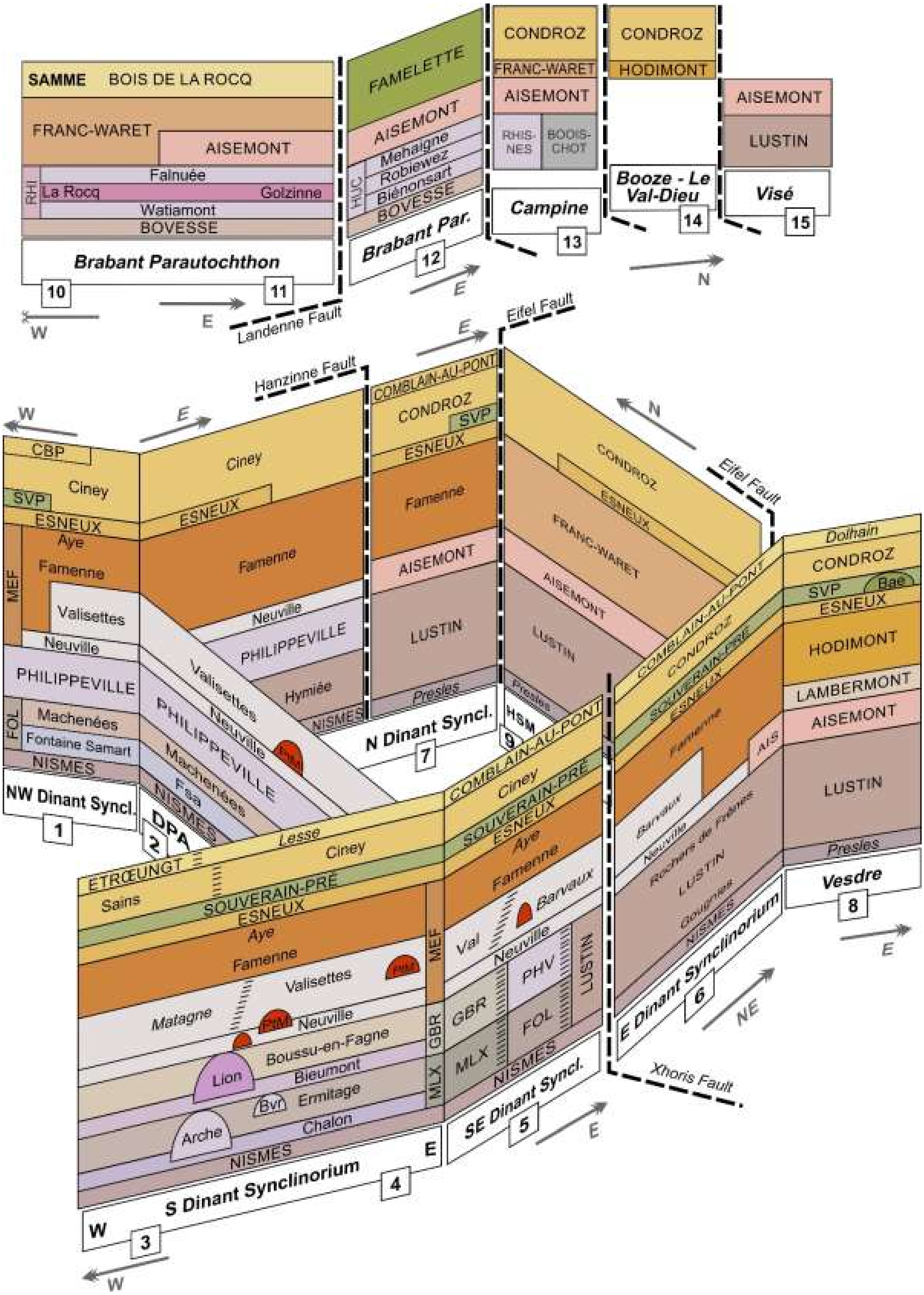

Figure 8. Schematic vertical and lateral relationships of the Upper Devonian units of Belgium. Formations in capital letters, Members in regular letters, Facies in italics. 1: NW limb of the

Dinant Synclinorium, 2: Philippeville-Durbuy Anticlinorium, 3: western part of S limb of the Dinant Synclinorium, 4: eastern part of S limb of the Dinant Synclinorium, 5: SE limb of the Dinant Synclinorium, 6: eastern limb of the Dinant Synclinorium, 7: northern limb of the Dinant Synclinorium, 8: Vesdre area, 9: Haine-Sambre-Meuse overturned thrust sheets, 10: western part of the Brabant Parauthochthon, 11: central part of the Brabant Parauthochthon, 12-13: eastern part of the Brabant Parauthochthon, 14: Booze – Le Val-Dieu Ridge, 15: Visé area, 16: Campine Basin.

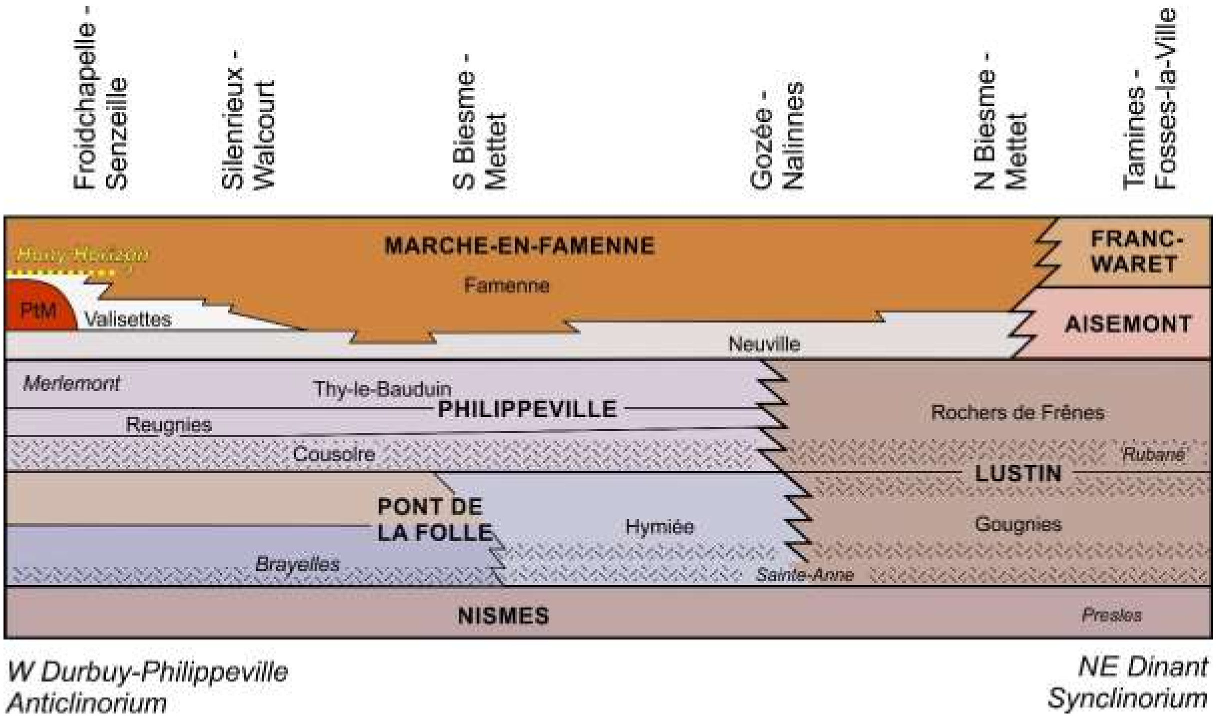

Figure 2. Lateral variations observed in Frasnian formations within the Dinant Synclinorium and Philippeville Anticlinorium (origin of data: see main text). Formations in capital letters, members in regular letters, facies in italics. Shaded areas are biostromal or coralliferous beds.

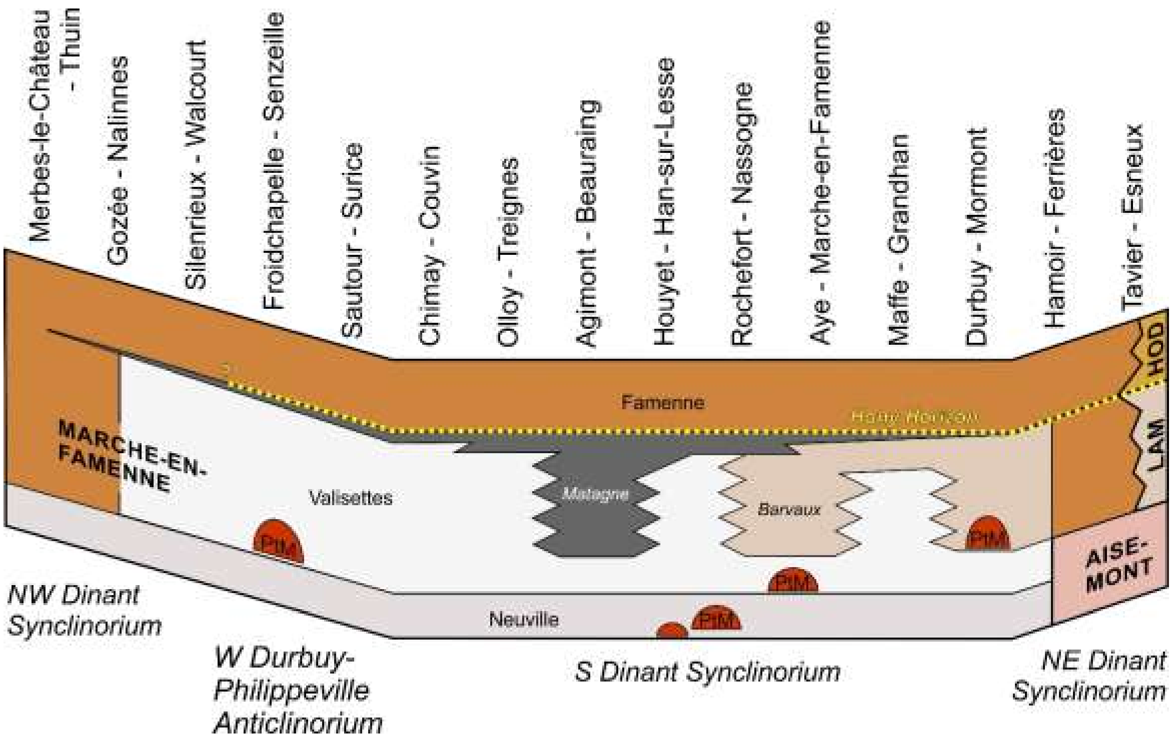

Figure 4. Lateral variations of the members and facies recognised within the Marche-en-Famenne Formation (late Frasnian–early Famennian) in the Dinant Synclinorium. Formations in capital letters, Members in regular letters, Facies in italics

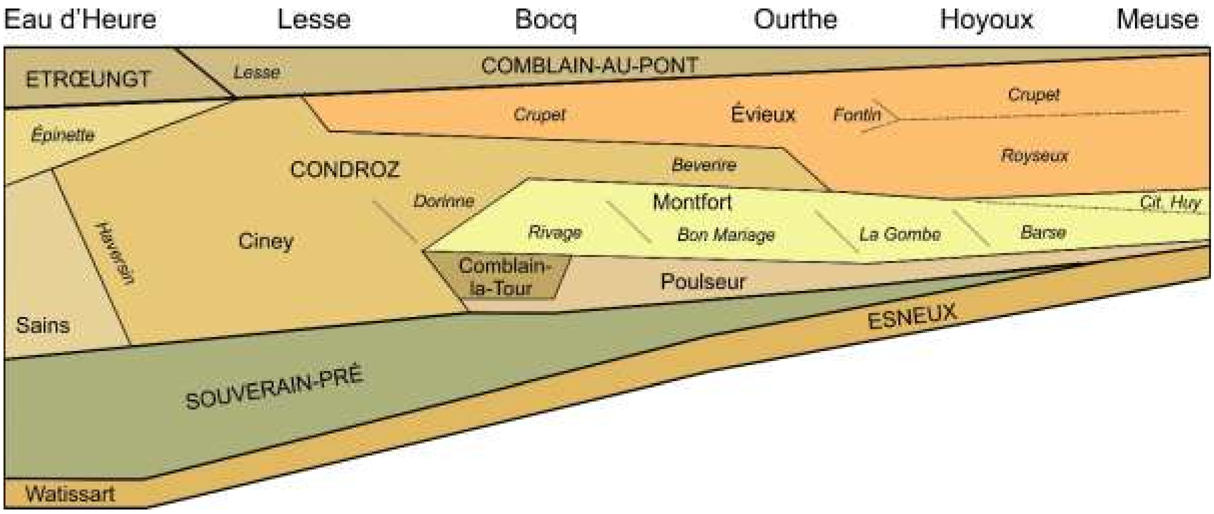

Figure 4. Middle–uppermost Famennian formations within the Dinant Synclinorium and the Haine–Sambre–Meuse Overturned Thrust sheets (origin of data: see main text). Formations in capital letters, members in regular letters, facies in italics.

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