GEOLOGICA BELGICA (2008) 11 : 93-121

LES MONTS DE BAILEUX SECTION: DETAILED SEDIMENTOLOGY AND MAGNETIC SUSCEPTIBILITY OF HANONET, TROIS-FONTAINES AND TERRES D'HAURS FORMATIONS (EIFELIAN/GIVETIAN BOUNDARY AND LOWER GIVETIAN, SW BELGIUM)

Cédric MABILLE & Frédéric BOULVAIN

(10 figures, 2 tables and 3 plates)

Pétrologie sédimentaire, B20, Université de Liège, Sart-Tilman B-4000 Liège; e-mails: cmabille@ulg.ac.be, fboulvain@ulg.ac.be

ABSTRACT. This work details for the first time the sedimentology of Les Monts de Baileux section. This section, located in a quarry between Chimay and Couvin, exposes a remarkable succession of strata from the top of the Jemelle Formation to the base of the Mont d'Haurs Formation. It therefore offers the opportunity to investigate the entire Hanonet, Trois-Fontaines and Terres d'Haurs formations, biostratigraphically from *Polygnathus ensensis* to *P. timorensis* conodont zones. This large lithostratigraphic thickness of clayley and argillaceous, and also pure limestones encompasses the Eifelian/Givetian boundary in the lower part of Hanonet Formation, allowing a better understanding of the transition between the Eifelian which corresponds to a mixed siliciclastic-carbonate detrital ramp and the lower Givetian dominated by a carbonate rimmed shelf-related sedimentation.

Petrographic study leads to the definition of 21 microfacies integrated into two palaeogeographical models. The first model (13 microfacies) is proposed for the Jemelle, Hanonet and Trois-Fontaines formations, i.e. *P. ensensis* Zone and almost entire *P. hemiansatus* Zone. In this platform model, the fore-reef environment is characterized by a high influence of storm events and carbonate input coming from proximal settings. The reef is mainly composed of an accumulation of stromatoporoids, crinoids, tabulate corals and rugose corals with a peloidal matrix. The back-reef area is dominated by agitated environments and calmer lagoons. Locally, less agitated conditions allow growth of massive and laminar organisms. The second model (6 microfacies) concerns the Terres d'Haurs Formation with the end of *P. hemianstus* Zone and significant part of the *P. timorensis* Zone. This ramp model is divided into a mid-ramp characterized by open-marine sedimentation interrupted by storm-related events and an inner ramp composed of ooidal shoals, back-shoal sedimentation and storm related deposits. Two other microfacies are fragmentarily defined for the Mont d'Haurs Formation, within the main *P. varcus* / *P. rhenanus* intervals. This unit was affected by strong dolomitization processes, where scarcity of well preserved, primary sedimentary fabrics is not favourable for designing of a microfacies-based model at all.

The last part of the work concerns stratigraphic variations of magnetic susceptibility (MS). Values of mass MS of rocks were plotted and juxtaposed with semi-quantitative variation curves of microfacies. According to the prevailing magnitudes of MS, the relationships with two controlling parameters are evaluated: terrigenous influence (using the thin-section data on detrital quartz contents as proxies) and wave agitation (based on microfacies interpretation). The transgressive-regressive evolution of microfacies characteristics are compared with the juxtaposed trends in decreasing-increasing MS magnitudes. Approximately two thirds of this section suggests a good matching of the trends on generalized lithological and magnetic data. It is explained by common presence of clayey/silty impurities of slightly to moderately varying compositions which are greatly evidenced by means of thin-section studies and represent a principal and abundant paramagnetic component. The overall MS magnitudes actually show decreasing trends together with vigorous, eustatically driven sealevel rises. However, the remaining third of intervals in this section shows the rather complex than simple, equivocally or negatively arranged sequence/lithologic and MS stratigraphic trends.

KEYWORDS. Eifelian, Givetian, sedimentology, magnetic susceptibility, platform, ramp

1. Introduction

The Baileux section covers the Eifelian-Givetian boundary. At this time, a large carbonate platform developed throughout northern Europe (Fig. 1a) and overcame the mixed siliciclastic-carbonate ramp characterizing most of the Eifelian. One of the main aims of this study is to highlight this important palaeoenvironmental and ecological event.

The studied section is located along the southern flank of the Dinant Synclinorium (Fig. 1b), and more precisely along the N66 road between Chimay and Couvin, to the North of Boutonville locality (Fig. 2).

The Baileux section (Pl. 1A) provides a continuous succession of strata encompassing the top of the Jemelle Formation, the entire Hanonet, Trois-Fontaines and Terres d'Haurs formations and the base of the Mont d'Haurs

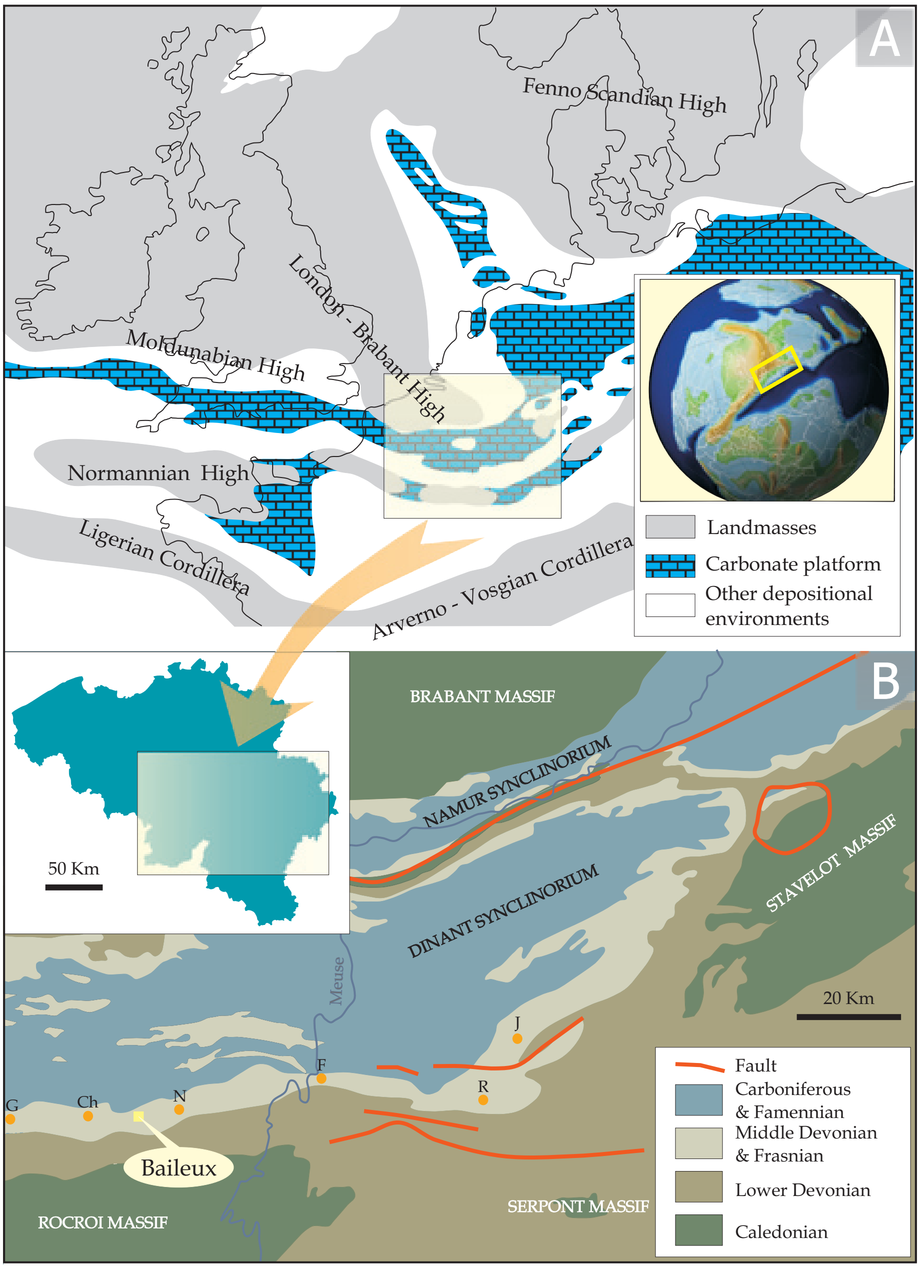

Figure 1. A: Palaeogeographical setting during the Eifelian (390 Ma), after Ziegler (1982) and McKerrow & Scotese (1990) showing the large carbonate platform which develops throughout northern Europe and overcomes the mixed siliciclastic-carbonate ramp. B: Geological setting and location of Les Monts de Baileux section at the southern flank of the Dinant Synclinorium. G: Glageon, Ch: Chimay, C: Couvin, F: Fromelennes (Givet), R: Resteigne, J: Jemelle.

Formation (Fig. 3). Points of interest of this outcrop are multiple. (1) It provides an outstanding section in order to investigate the Eifelian-Givetian boundary and the lower Givetian; only three other comparable sections in terms of lithostratigraphic interval are known at the southern border of the Dinant Synclinorium: Resteigne, Glageon and Fromelennes. (2) The Hanonet Formation corresponds here to uncommon lithologies. (3) The Terres d'Haurs Formation is generally not well exposed due to more argillaceous succession than the surrounding formations (Bultynck & Dejonghe, 2001) and complete sections are particularly rare. (4) The entire section was never studied in detail, so that this paper may substantially complete the development of regional and international palaeoenvironmental data in this stratigraphic window.

1.1. Previous work

The Baileux section was first studied by Szalai (1982). This was a sedimentological approach and the data were then incorporated into the PhD thesis by Préat (1984) and subsequent publications (e.g. Mamet & Préat, 1986). However, the section studied in years '80 (Trois-Fontaines Formation) does not exist anymore because of an important progression of the quarry to the East. Comparison with these works is therefore highly problematic. In 1986, the first twelve metres of the present day section were investigated for conodont biostratigraphy by Meurrens (1986) but results were not published. Recently, the 113 first meters of outcrop were the subject of a detailed sedimentological study (Mabille & Boulvain, 2007a) in order to investigate the lateral variation within the Hanonet Formation.

A synthetic description of the stratotypes of each formation studied here is available in Bultynck *et al.* (1991). Concerning the Jemelle Formation, the stratotype corresponds to two sections located in Jemelle: the first

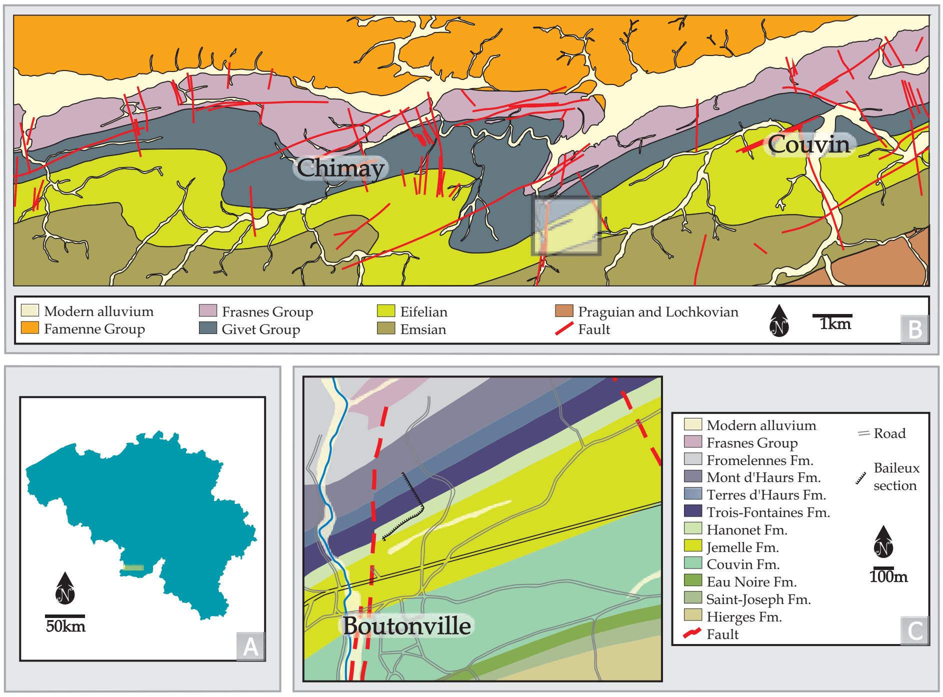

Figure 2. Location of studied section: A. Location of the Chimay-Couvin area. B. Geological map of the Chimay-Couvin area. The Baileux section is located by black box. C. Close up of the studied section.

one along the road to Forrières on both sides of the railway station and the second one along the disused railway Jemelle-Rochefort, immediately west of the bridge over the Lomme river. The Hanonet Formation stratotype is located in Couvin (La Couvinoise quarry). The three remaining stratotypes are located in Givet: in Les Trois Fontaines quarry (Trois-Fontaines Formation) and along south-eastern walls of Mont d'Haurs fortress (Terres d'Haurs and Mont d'Haurs formations). Except for the Hanonet Formation stratotype (Mabille & Boulvain, 2007a), the sedimentology of these stratotype sections is poorly known. Comparison are then generally limited to the field scale.

Concerning the time-equivalent sections mentioned in the introduction (see Fig. 1b for location and Fig. 3 for lithostratigraphic interval), the Resteigne section (description and sedimentological study in Casier & Préat, 1991) covers a stratigraphic interval between the top of the Hanonet Formation and the base of the Mont d'Haurs Formation. The Glageon section was the subject of a detailed sedimentological and palaeontological (corals) study (Boulvain *et al.,* 1995). It encompasses 63 metres of

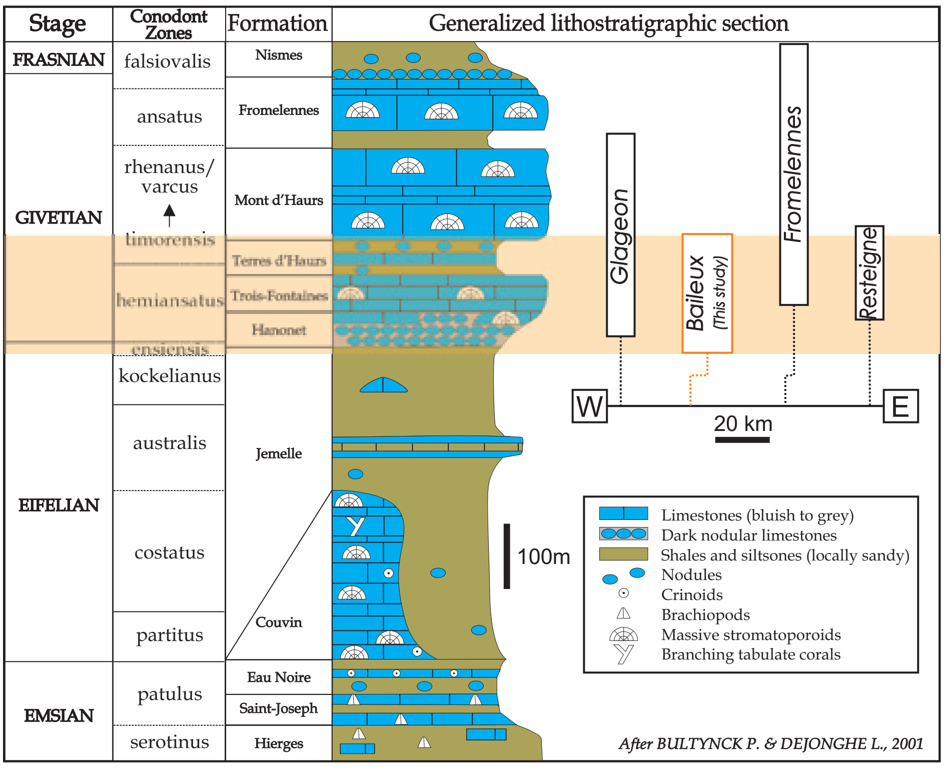

Figure 3. Generalized lithostratigraphic section of Middle Devonian formations at the southern border of the Dinant Synclinorium, after Bultynck & Dejonghe (2001). The studied interval is located at the boundary between the Eifelian (ramp-related sedimentation) and the Givetian (carbonate platform-related sedimentation). The lithostratigraphic interval covered by the Glageon, Baileux, Fromelennes and Resteigne sections are represented by boxes.

the Hanonet Formation, the entire Trois-Fontaines, Terres d'Haurs and Mont d'Haurs formations and the 25 first metres of the Fromelennes Formation. The Fromelennes section (Coen-Aubert, 1991) begins near the base of the Trois-Fontaines Formation and ends in the Nismes Formation (Frasnian). None detailed sedimentological study was ever performed on this last section.

At regional scale, detailed study of the Eifelian-Givetian transition along the southern border of the Dinant synclinorium led to the definition of ten major microfacies and several sub-microfacies deposited on a mixed siliciclastic-carbonate detrital ramp (Préat & Kasimi, 1995; Kasimi & Préat, 1996).

1.2. Methods

Bed-by-bed description and sampling were carried out between 2004 and 2006. From the samples, 580 thin sections were prepared. The textural classification used to characterize the microfacies follows Dunham (1962) and Embry & Klovan (1972).

The description of stromatoporoids is based on morphological classification by Kershaw (1998). The terms used are branching, laminar, domical, bulbous and encrusting. The term massive (Tucker & Wright, 1990) is used for both domical and bulbous forms when the difference cannot be made (fragments or thin sections). The term "coverstone" characterises facies where laminar organisms cover mud and bioclastic debris (Tsien, 1984).

Thin section analyses led to the definition of 13 microfacies for the Jemelle, Hanonet and Trois-Fontaines formations and six microfacies for the Terres d'Haurs Formation.

These microfacies are compared to those defined in Resteigne (Casier & Préat, 1990; Casier & Préat, 1991) and in Glageon (Boulvain *et al.*, 1995), and also with the microfacies defined for the Eifelian-Givetian boundary interval (Préat & Kasimi, 1995) and for the Eifelian Couvin Formation (Mabille & Boulvain, 2007b). References are also made to the standard microfacies of Wilson (1975) and to the standard ramp microfacies of Flügel (2004).

Samples were also submitted to magnetic susceptibility (abbrev. MS) measurements with a KLY-3 (Kappabridge) device. Each sample was measured three times and weighed with a precision of 0.01g. These operations allow the definition of the mass-calibrated magnetic susceptibility of each sample and the drawing of magnetic susceptibility curves.

2. Description of section

In order to clarify the description of the 267 metres of section, 19 lithological units (A to S) are defined. These units are described formation by formation. For the Hanonet, Trois-Fontaines and Terres d'Haurs formations, a rapid comparison with stratotype, Glageon and Resteigne sections follows the detailed description. Note that units A to H were already defined by Mabille & Boulvain (2007a).

2.1. Jemelle Formation

The top of the Jemelle Formation corresponds to the lowest lithological unit (see Fig. 4 for legend; A in Fig. 5). This unit is 6 m thick and composed of very argillaceous limestone with a sparse fauna of crinoids and brachiopods. At the top of the unit, some lenticular decimetre-thick

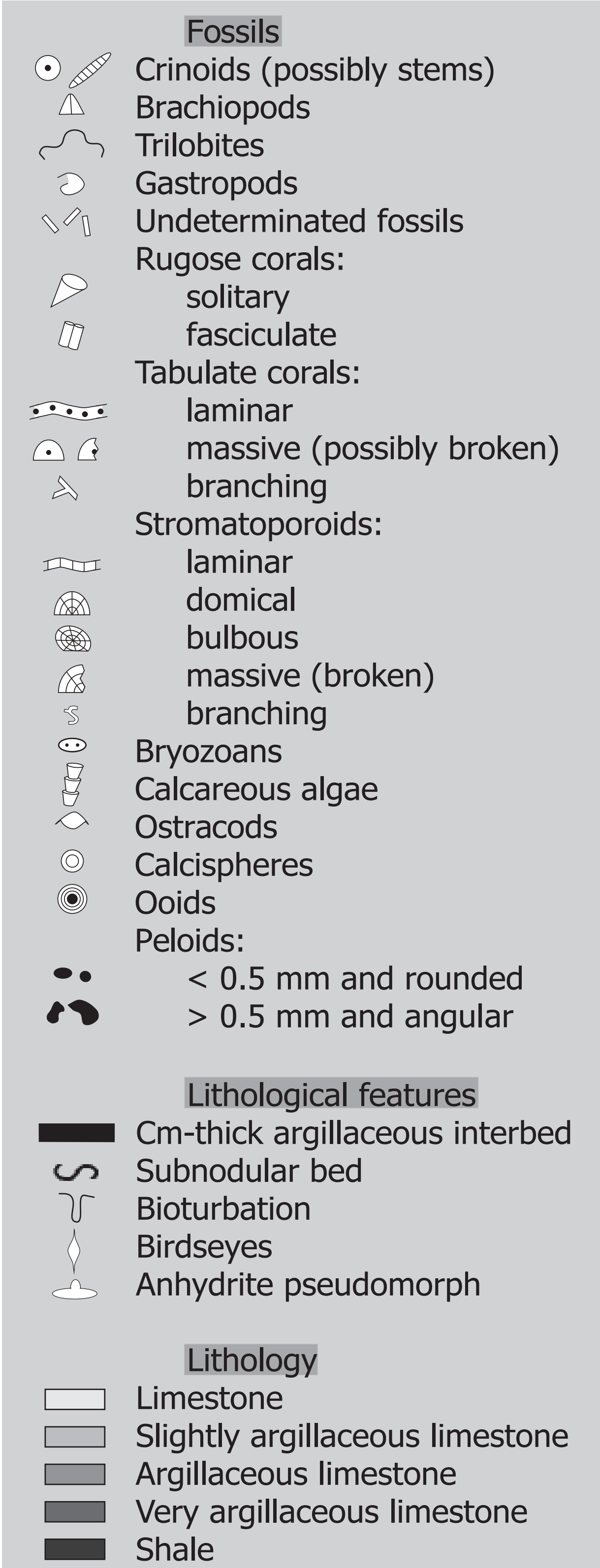

Figure 4. Legend for symbols used in figures.

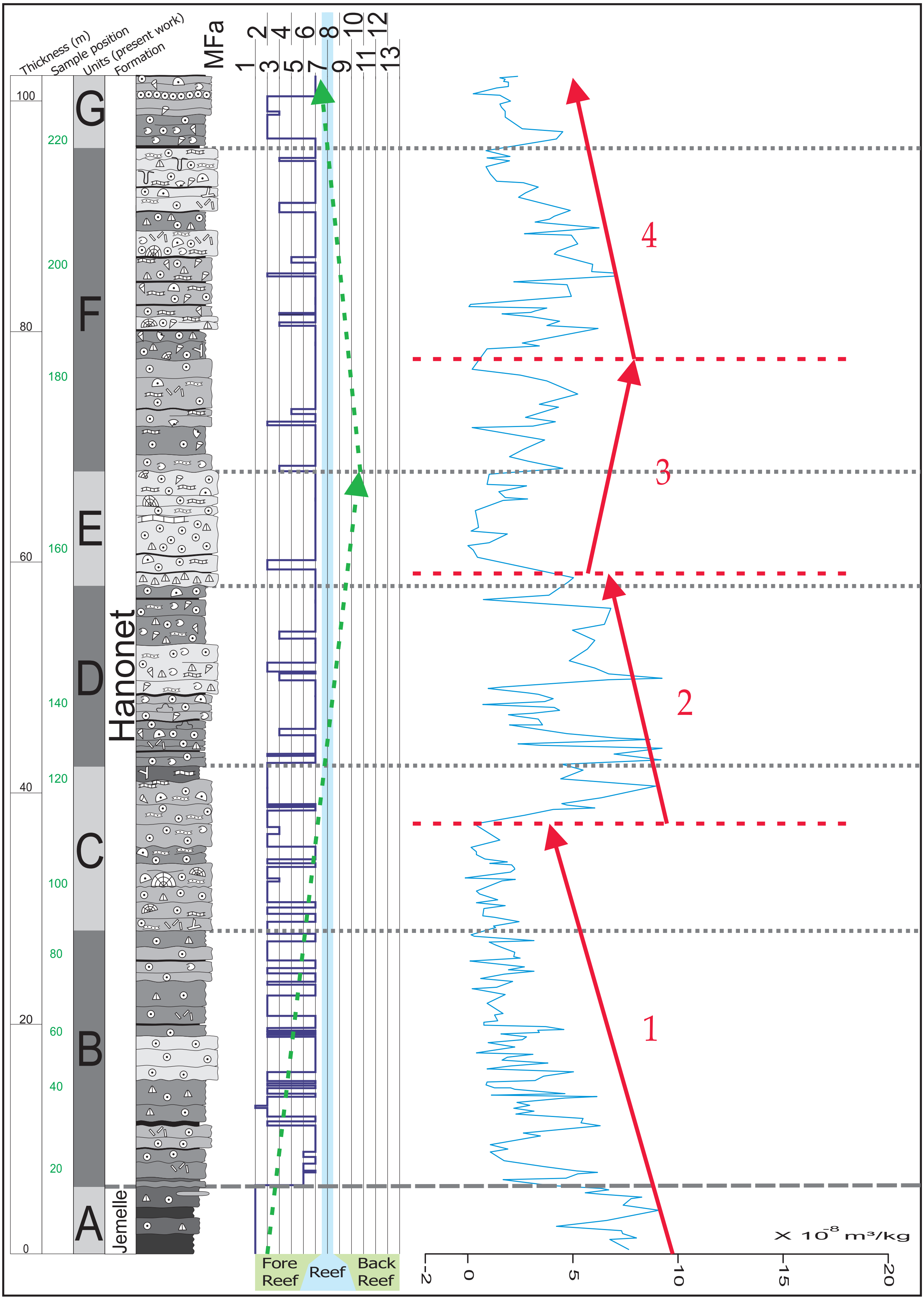

Figure 5. Schematic sedimentological log (see Fig. 4 for legend), lithological units, microfacies curves and magnetic susceptibility curves of the top of Jemelle Formation (A unit) and the entire Hanonet Formation (Units B to G). Arrows represent trends in curves and dashed lines magnetic susceptibility events.

beds of slightly argillaceous limestone are present. Boundary between Jemelle and Hanonet formations is illustrated on Pl. 1B.

2.2. Hanonet Formation

The Hanonet Formation is 95 metres thick and 6 lithological units (B to G on Fig. 5, see Fig. 4 for legend) are defined.

B unit (from 6 to 26 metres) consists of an interbedding of several metres thick sets of beds of pure limestone with more argillaceous limestone. Shaly interbeds are common. In comparison with A unit, a more abundant fauna with an enrichment in gastropods characterizes B unit.

In C unit (from 26 to 41 m) fauna becomes more diverse with the first development of domical stromatoporoids (up to 50 cm in diameter), laminar stromatoporoids and branching, domical and laminar tabulate corals. Crinoids are present whereas brachiopods and gastropods are less abundant. This unit is composed of variably argillaceous limestone.

At the beginning of D unit (from 41 to 57 m) an important faunal change occurs. Although crinoids and domical tabulate corals are still present, domical stromatoporoids and branching tabulate corals disappear. As laminar skeletons of stromatoporoids and tabulate corals become less common, brachiopods and gastropods are more abundant. Finally, the first appearance of rugose corals and trilobites is observed. Lithologically, the limestone is less argillaceous even though some argillaceous interbeds are still present.

E unit (from 57 to 67 m) starts with a distinctive metre-thick coquina with brachiopods, crinoids and gastropods. The unit is composed of slightly argillaceous limestone. The fauna includes crinoids, rugose corals, laminar and domical stromatoporoids and tabulate corals.

F unit (from 67 to 95 m) is characterized by argillaceous limestone becoming less argillaceous upward. This unit resembles C unit, but some differences can be noted: rugose corals and some bioclastic decimetre-thick lenses are present.

Finally, the beginning of G unit (from 95 to 101 m) is marked by a 5 cm thick shale bed followed by limestones. The lower half of this unit is more argillaceous than the upper half. The fauna consists of gastropods, crinoids, brachiopods, rugose corals and domical tabulate corals. Two decimetre-thick crinoidal grainstone beds are present; the first one is characterized by an erosive base and the second is lenticular.

<u>Comparison with other sections:</u> The Hanonet Formation is generally regarded as composed of argillaceous and locally nodular limestone interbedded with calcareous shale, passing vertically to biostromal limestone near the top (Bultynck & Dejonghe, 2001). In Glageon, it corresponds to argillaceous limestone interbedded with coverstone beds (Boulvain *et al.*, 1995) and in Resteigne to poorly bedded, locally nodular, argillaceous limestone interbedded with less argillaceous crinoidal limestone (Casier & Préat, 1990). The lithological succession observed in Baileux is therefore unique because it is dominated by pure to slightly argillaceous limestone. Note also that the thickness observed in Baileux (92 metres) is higher than the generally admitted maximum one (70 metres after Bultynck & Dejonghe, 2001). A detailed sedimentological comparison with the stratotype of the Formation located in La Couvinoise quarry in Couvin was already proposed (Mabille & Boulvain, 2007a). It demonstrates important sedimentological differences within the formation with an environmental model depicting the lateral transition from a multiclinal carbonate ramp (in the stratotype located in Couvin) to a fore-reef setting (in Baileux).

2.3. Trois-Fontaines Formation

The Trois-Fontaines Formation is 91 metres thick and 6 lithological units are defined. These units are numbered H to M on Fig. 6.

H unit (from 101 to 125 m) consists of bioturbated, slightly argillaceous limestone. Crinoids dominate the fauna but some tabulate corals (laminar, domical and branching), rugose corals, stromatoporoids (laminar and domical) and gastropods are also present. This unit corresponds to the base of the Trois-Fontaines Formation defined previously as locally coral-rich crinoidal limestone (Préat & Tourneur, 1991a).

The following I unit (from 125 to 137 m) is composed of thick bedded limestone (Pl. 1C). The fauna is diverse with dominance of crinoids and massive stromatoporoids (possibly broken or in living position). Accessory fossils are tabulate corals (branching, massive and laminar), rugose corals (solitary and fasciculate) and uncommon gastropods and brachiopods. This unit corresponds to the biostromal unit of the Trois-Fontaines Formation (Bultynck & Dejonghe, 2001).

A less diversified fauna characterises J unit (from 137 to 145 m). It corresponds to crinoidal limestone. Some broken massive stromatoporoids and tabulate corals, solitary rugose corals and brachiopods are locally present.

Despite a succession of ten beds corresponding to crinoidal grainstone observed in the top of K unit, this unit (from 145 to 164 m) is marked by a turn back to slightly argillaceous limestone. Fauna is represented by crinoids, brachiopods, gastropods, solitary rugose corals, massive stromatoporoids and broken shells. A remarkable thick bed is observed at the half of the unit. It corresponds to an accumulation of reworked fasciculate rugose corals associated with branching tabulate corals, laminar and massive stromatoporoids and crinoids.

The base of L unit (from 164 to 182 m) is underlined by a two meter-thick bed corresponding to an accumulation of broken gastropods and recrystallised shells. They are associated with some crinoids, brachiopods and uncommon branching tabulate corals. Then, the lower half of the unit is mainly characterized by limestone rich in ostracods whereas the upper half is composed by beds dominated by crinoids or barren of fauna. This limestone is locally slightly argillaceous and several argillaceous interbeds are

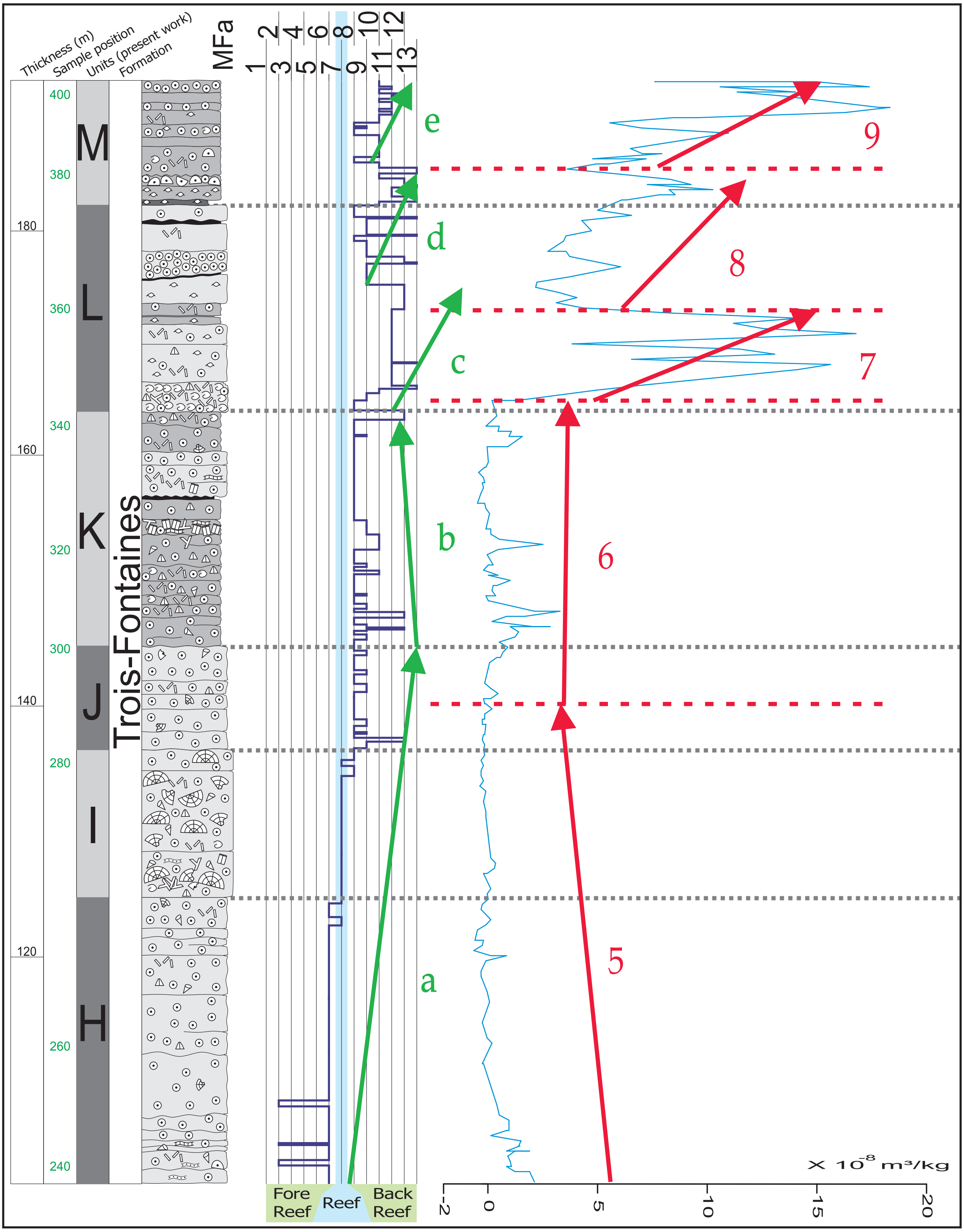

Figure 6. Schematic sedimentological log (see Fig. 4 for legend), lithological units, microfacies curves and magnetic susceptibility curves of the Trois-Fontaines Formation. Arrows represent trends in curves and dashed lines magnetic susceptibility events.

observed. Uncommon brachiopods and undeterminable broken shells are locally present. The two first meters of the M unit (from 182 to 192 m) are composed of diversely argillaceous limestone particularly rich in ostracods. The rest of the unit corresponds to slightly argillaceous limestone. Barren beds are alternating with crinoidal rich ones. These beds also contain some ostracods, undeterminable shells and gastropods. A remarkable bed is observed at the first quarter of the unit. It corresponds to an accumulation of reworked and in situ massive tabulate corals.

Comparison with other sections: The Trois-Fontaines Formation is traditionally divided into 3 parts: a crinoidal sole, a biostromal unit and a lagoonal unit (Bultynck & Dejonghe, 2001). (1) The crinoidal sole, represented by our H unit, is described as crinoidal limestone locally enriched in corals in the stratotype (Préat & Tourneur, 1991a). Some exceptions are noted, as in La Couvinoise, where it corresponds to 8 meters of more argillaceous crinoidal limestone (Bultynck & Dejonghe, 2001; Mabille & Boulvain, 2007a). (2) The biostromal unit was studied in detail in Resteigne (see, e.g., Préat *et al.*, 1984), pointing out the lateral variations (thickness and facies) within this unit. In Glageon, the biostrome thickness (14 metres after Boulvain *et al.*, 1995) is comparable with our I unit (12 metres). Note that a layer particularly rich in stringocephalids is often observed at the top of the biostromal unit (Préat & Tourneur, 1991a), but was not observed in Baileux. (3) The last unit is generally composed of micritic and locally laminated limestone (Bultynck & Dejonghe, 2001). In Resteigne, this third

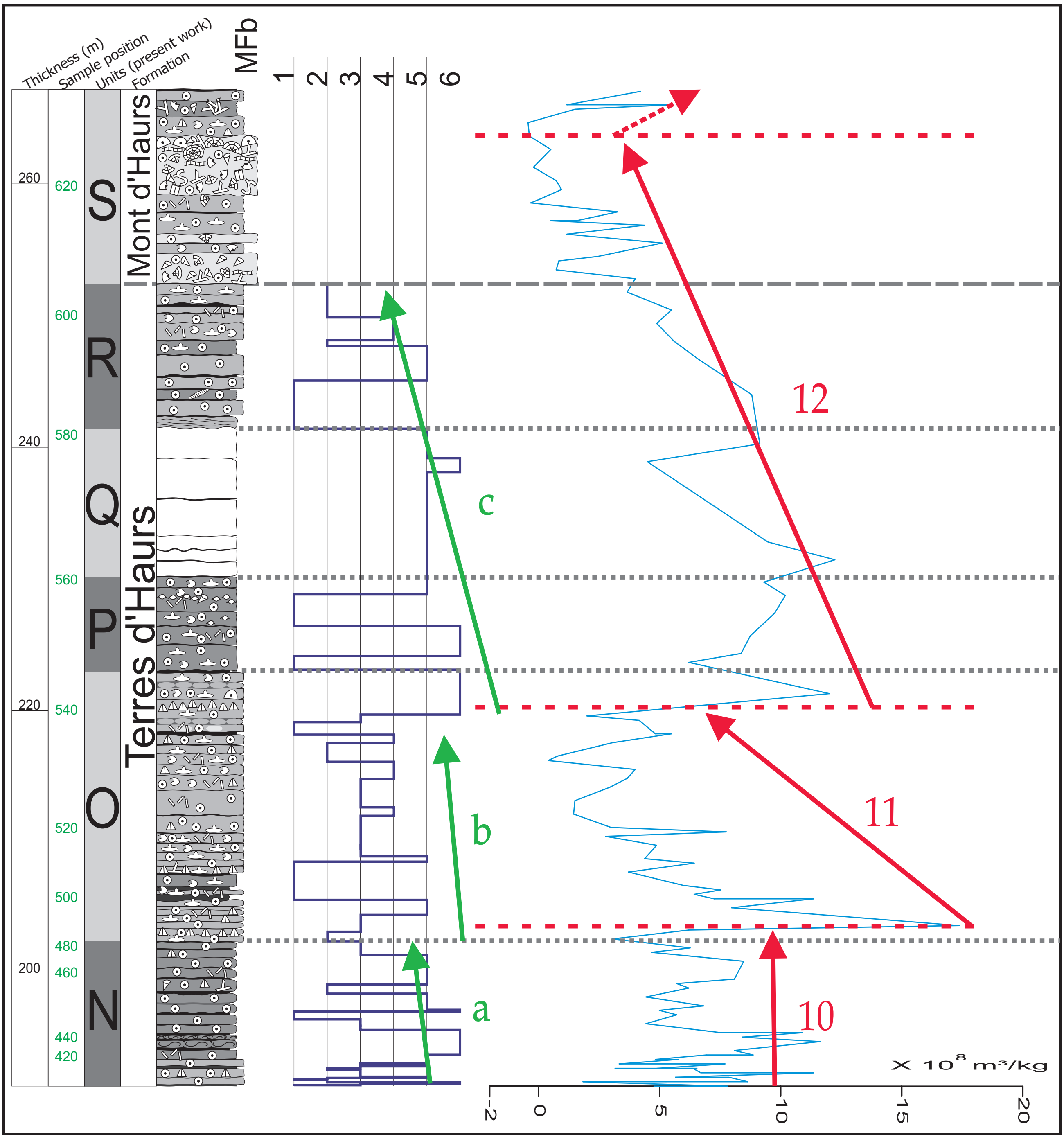

Figure 7. Schematic sedimentological log (see Fig. 4 for legend), lithological units, microfacies curves and magnetic susceptibility curves of the entire Terres d'Haurs Formation (Units N to R) and the base of the Mont d'Haurs Formation (S unit). Arrows represent trends in curves and dashed lines magnetic susceptibility events.

part is mainly characterized by fenestral and burrowed mudstone or wackestone and ends with a thick succession (≈ 10 meters) of laminites (Préat & Boulvain, 1987). The succession observed in Baileux (units J to M) differs drastically from this classical lagoonal unit with a more diversified fauna and important lithological variations. Similar differences were also noted in Glageon (Boulvain *et al.*, 1995).

2.4. Terres d'Haurs Formation

The Terres d'Haurs Formation is 60 metres thick and 5 lithological units are defined. These units are numbered N to R on Fig. 7. The boundary between the Trois-Fontaines and Terres d'Haurs Formations is illustrated on Pl. 1D.

The first N unit (from 192 to 203 m) is composed of slightly argillaceous limestone (first two meters) passing vertically to argillaceous limestone. This unit is thin-bedded and numerous cm- to dm-thick argillaceous interbeds are observed. Some subnodular beds are present within the first quarter of the unit. Fauna is poorly diversified and dominated by crinoids. Other fossils are uncommon: brachiopods, undeterminable broken shells, branching tabulate corals and solitary rugose corals.

The following O unit (from 203 to 224 m) corresponds to slightly argillaceous limestone with several cm- to dm-thick argillaceous interbeds. Some nodular beds are observed at the top. Crinoids still dominate the fauna but numerous brachiopods and gastropods are present. Accessory fossils include undeterminable broken shells, branching and massive tabulate corals. An important feature of this unit is the first occurrence of centimetric calcitic nodules probably corresponding to anhydrite pseudomorphs.

P unit (from 224 to 230 m) is similar to N unit with argillaceous limestone alternating with cm- to dm-thick argillaceous interbeds. Despite abundance of crinoids, the fauna is quite different and locally dominated by ostracods or gastropods. Undeterminable broken shells and solitary rugose corals are, however, scarcely present in this sediment. Anhydrite pseudomorphs are regularly observed.

Q unit (from 230 to 242 m) corresponds to an

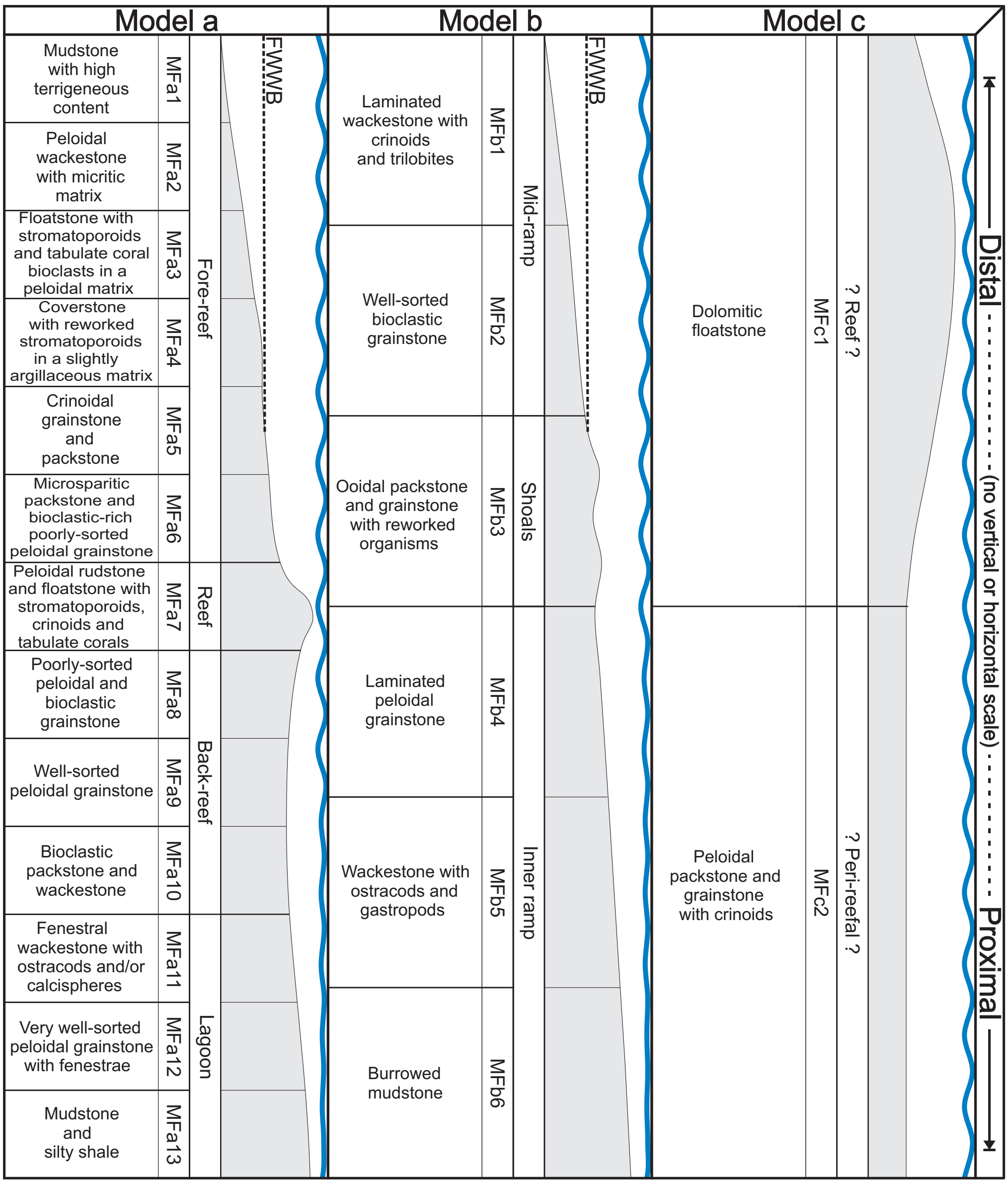

Figure 8. Compilation of microfacies described in text with their general palaeoecological setting into the three defined models. Model a corresponds to a platform geometry and groups 13 microfacies (MFa1 to MFa13). Model b consists of a ramp profile with 6 microfacies (MFb1 to MFb6). The last model c is not well constrained and corresponds to MFc1 and MFc2.

observation gap due to mud covering the beds. The observations are then limited to bed thickness and the sampling rate is relatively low when compared to other units. Argillaceous interbeds are observed in the first half of the unit.

The last R unit of the Terres d'Haurs Formation (from 242 to 252 m) consists of slightly argillaceous limestone alternating with argillaceous limestone. Here again, numerous cm- to dm-thick argillaceous interbeds and some anhydrite pseudomorphs are present. Fauna is poorly diversified with crinoids associated with some gastropods and few broken shells, solitary rugose corals and brachiopods.

Comparison with other sections: This formation is described as alternating argillaceous limestone and calcareous shales. Locally, its base is underlined by the development of patch-reefs with massive rugose corals (Bultynck & Dejonghe, 2001); notably in the stratotype (Préat & Tourneur, 1991b), in Glageon (Boulvain *et al.*, 1995) and in Resteigne (Casier & Préat, 1991). However, these patches are not recorded in Baileux. The thickness observed in Baileux (60 metres) is higher than in Glageon (46 metres after Boulvain *et al.*, 1995) and lower than in Resteigne (71 metres after Casier & Préat, 1991) and in the stratotype (65-70 metres after Bultynck & Dejonghe, 2001).

2.5. Mont d'Haurs Formation

The Baileux section ends with S unit (from 252 to 267 metres) composed of metre-thick biostromal beds interbedded with thinner slightly argillaceous limestone beds. Fauna of biostromal beds consists of stromatoporoids (domical, bulbous, massive, laminar and branching), massive and branching tabulate corals, solitary rugose corals and uncommon fasciculate rugose corals. These fossils are found in living position or overturned and are locally broken. Crinoids, brachiopods and anhydrite pseudomorphs are also present. In the more argillaceous beds, fauna is dominated by crinoids but some brachiopods, gastropods and undeterminable broken shells are present. Locally, branching tabulate corals, solitary rugose corals and broken massive tabulate corals and stromatoporoids occur. The regular presence of cm-thick argillaceous interbeds and anhydrite pseudomorphs is noted.

This unit begins with a first biostromal bed and corresponds to the base of the Mont d'Haurs Formation *sensu* Préat & Tourneur (1991c).

3. Description of microfacies and sedimentological interpretation

Petrographic study leads to the definition of 21 microfacies which are integrated into two sedimentological models. The first model (13 microfacies) is proposed for the Jemelle, Hanonet and Trois-Fontaines formations (Model a - Summary on Table 1). The second model (6 microfacies - Summary on Table 2) corresponds to ramp geometry and concerns the Terres d'Haurs Formation (Model b). The two last microfacies are not integrated into a well-constrained model (Model c). These 21 microfacies with their general palaeoecological setting into the three defined models are compiled into Fig. 8.

3.1. Model a: Microfacies of the Jemelle, Hanonet and Trois-Fontaines formations (Tab. 1 – Pl. 2)

3.1.1. MFa1: Mudstone with high terrigeneous content

Fauna is rare (Pl. 2A) and poorly diversified (crinoids and brachiopods). Locally, it is accompanied by broken bryozoans, ostracods, tabulate corals, palaeosiphonocladaceae, trilobites and echinoid spines. Small ovoidal peloids (< 0.1 mm) are rare to abundant. These debris range from 0.2 to 3 mm. They are well preserved, except for crinoids which are frequently micritised and pitted.

These mudstones are particularly rich in detrital quartz (from 10 to 40%) with local presence of micas flakes (up to 2.5%). Hematite and goethite are often abundant, giving a yellowish to reddish colour to the rock.

The matrix is micritic and highly argillaceous. Horizontal burrows, filled with a darker micrite, are developed but the lamination is locally preserved. Millimetre-thick wackestone or packstone lenses are also present.

Interpretation: MFa1 represents the deepest microfacies of the Baileux section. The primary sedimentation mechanism process was slow accumulation of suspended mud and minute debris, but small wackestone and packstone lenses likely represent distal storm deposits. This suggests that this microfacies formed just above the SWB (Préat & Kasimi 1995). Anyway, the absence of hummocky cross-stratification or grainstone texture rules out a more proximal interpretation (compare Wright & Burchette, 1996).

This microfacies is the same as MFB1 in Mabille & Boulvain (2007a) and similar to MFi defined in Resteigne (Casier & Préat, 1990) and to MF1 defined in Glageon (Boulvain *et al.*, 1995).

3.1.2. MFa2: Peloidal wackestone with micritic matrix

Bioclasts of trilobites, brachiopods, crinoids, ostracods and bryozoans dominate the fauna. Small ovoidal peloids (from less than 0.1 to 0.3 mm) are also present (Pl. 2B). Green algae are locally present (palaeosiphonocladaceae and dasycladaceae). A few rounded lithoclasts were observed (up to 2 mm). The majority of debris ranges from 0.2 to 1 mm and is poorly preserved (breakage and micritisation of grains). However, better preserved skeletal fossil remains (between 2 mm and 1 cm) occur in packstone lenses.

Detrital quartz reaches concentrations between 1 and 5%. Micas flakes are rare but occur disseminated throughout the sample. Here again, hematite is often abundant and provides a reddish colour to some thin-sections.

MF	Name	Assemblage	Setting	Previously defined MF
Fore-Reef				
MFa1	Mudstone with high terrigeneous content	Open-marine	Just above SWB	MFB1[a] / MF1[c] / MFi[d]
MFa2	Peloidal wackestone with micritic matrix	Open-marine >> Proximal influence	Above SWB	MFB2[a] / MF5[c]
MFa3	Floatstone with stromatoporoids and tabulate coral bioclasts in peloidal matrix	Open-marine > Proximal influence	Close to FWWB	MFB3[a] / MFiv[d]
MFa4	Coverstone with reworked stromatoporoids in a slightly argillaceous matrix	Laminar stromatoporoids > Open-marine	Close to FWWB	MFC5a[a] / MF3[c]
MFa5	Crinoidal grainstone and packstone	Crinoidal meadows	Around FWWB	MFB4[a] / MFv[d]
MFa6	Microsparitic packstone and bioclastic-rich poorly-sorted peloidal grainstone	Proximal > Open-marine influence	Mixing by normal waves	MFC6a & MFC6b[a] / MF6[c]
Reef				
MFa7	Peloidal rudstone and floatstone with stromatoporoids, crinoids and tabulate corals	«reef-building»	In-situ accumulation	MF8 & MF9[c] / MFvi[d]
Back-reef				
MFa8	Poorly-sorted peloidal and bioclastic grainstone	Proximal > Reef-building > Open-marine influence	Poorly-protected	MF9[b] / MF7[e]
MFa9	Well-sorted peloidal grainstone	Proximal >> Open-marine influence	Poorly-protected	MF7[e]
MFa10	Bioclastic packstone and wackestone	Patch reef-derived	Semi-protected	
Lagoon				
MFa11	Fenestral wackestone with ostracods and/or calcispheres	Restricted	Intertidal lagoon	MF13[b] / MF14 & MF15[d] / MF9[e]
MFa12	Very well-sorted peloidal grainstone with fenestrae	Algal mats	Intertidal lagoon	SMF19[f]
MFa13	Mudstone and silty shale	Restricted	Mud decantation	MF16[c]

Table 1. Microfacies defined for Jemelle, Hanonet and Trois-Fontaines formations with their assemblage and setting features. Previously defined microfacies from: Mabille & Boulvain, 2007a (a); Mabille & Boulvain, 2007b (b); Boulvain *et al.,* 1995 (c); Casier & Préat, 1990 (d); Casier & Préat, 1991 (e); Wilson, 1975 (f).

The matrix is a clay-free micrite and can be locally dolomitized by euhedral dolomite crystals.

Interpretation: Two sources of debris must be considered to explain the nature of MFa2 assemblage: an open-marine one (trilobites, bryozoans, crinoids, brachiopods and ostracods) and a transported proximal one (peloids and calcareous algae and possibly micrite). Peloids probably have shallow water, low-energy origin like a lagoon or a back-reef area (see, e.g., Tucker & Wright, 1990). Moreover, in other Eifelian sections studied in Belgium, the presence of peloids is also linked to the development of reefal settings (Mamet & Préat, 2005; Préat & Kasimi, 1995). This proximal environment supplies also calcareous algal debris and possibly micrite but proximal origin of mud is uncertain and a local production could not be excluded. It is noticeable that there is a mixing between the two kinds of sediment (open-marine bioclasts and peloids + calcareous algae). This suggests that the proximal material (supplied by storm deposits or debris flows) and the open-marine bioclasts (supplied by storm deposits) are deposited in the same environment and then mixed e.g. by burrowing. MFB2 was situated above the SWB, the packstone lenses representing storm deposits.

This microfacies is the same as MFB2 in Mabille & Boulvain (2007a) and similar to MF5 defined in Glageon (Boulvain *et al.*, 1995).

3.1.3. MFa3: Floatstone with stromatoporoids and tabulate coral bioclasts in peloidal matrix

Between domical tabulate corals (Pl. 2C), solitary rugose corals, laminar stromatoporoids and laminar tabulate corals, matrix is rich in peloids (from less than 0.1 to 0.2 mm), gastropods and calcareous algae: dasycladaceae, palaeosiphonocladaceae, udoteaceae and *Girvanella*. Larger organisms range between 2 and 8 cm, moreover, they are not broken nor bioeroded. At the opposite, bioclasts which are part of the matrix are smaller (from 0.1 to 1 mm) and generally less well preserved, with the exception of gastropods.

Detrital quartz is locally present and can reach 10%. Micas flakes are absent.

The matrix is a clay-free microspar.

Interpretation: MFa3 is situated under the influence of a proximal source supplying peloids and calcareous algae and perhaps micrite (see MFa2), but open-marine conditions still prevailed. The floatstone texture points to a relatively agitated environment, located close to the FWWB.

The same interpretation was made for similar microfacies (Préat 1989; Préat & Kasimi, 1995). This microfacies is the same as MFB3 in Mabille & Boulvain (2007a) and similar to MFiv defined in Resteigne (Casier & Préat, 1990).

3.1.4. MFa4: Coverstone with reworked stromatoporoids in a slightly argillaceous matrix

This microfacies is dominated by laminar stromatoporoids (Pl. 2D). They are well preserved but some are overturned. Their dimensions reach more than 1 m in diameter and 20 cm in thickness. These stromatoporoids cover a sediment ranging from packstone to mudstone. Crinoids, ostracods and brachiopods dominate the fauna. However, other organisms like domical tabulate corals and stromatoporoids, branching tabulate corals and algae are locally present. Peloids (spherical or ovoidal and from 0.2 to 0.5 mm in diameter) are also observed. Except for laminar stromatoporoids, skeletons of organisms are diversely preserved and range from 0.2 mm to 1.5 cm.

Detrital quartz is present in low amounts and hardly reaches concentrations of 1%.

The matrix is micritic to microsparitic and slightly argillaceous. The predominant textures in the matrix are wackestone, then packstone and finally mudstone, in descending order.

Interpretation: The colonization of seafloor by laminar stromatoporoids is characterizing MFa4. It corresponds to favourable conditions in terms of bathymetry, substrate and sufficiently low detrital input (see, e.g., Kershaw, 1998). Moreover, some stromatoporoids are overturned, suggesting an important influence of storms and a location near the FWWB (Kershaw, 1980).

This microfacies is the same as MFC5a in Mabille & Boulvain (2007a) and similar to MF3 defined in Glageon (Boulvain *et al.*, 1995).

3.1.5. MFa5: Crinoidal grainstone and packstone

Well-sorted crinoidal debris dominate the fauna (Pl. 2E), whereas ovoidal to spherical peloids (from 0.2 to 0.5 mm) and bioclasts, such as trilobites, ostracods, bryozoans, brachiopods and some calcareous algae (palaeosiphonocladaceae and dasycladaceae) are less common. This debris ranges between 0.1 and 1 mm.

Detrital quartz is locally observed (up to 2.5%). Hematite is locally concentrated in reddish millimetre-sized patches.

The matrix of packstones is microsparitic and frequently dolomitized. In grainstones, equigranular sparite cement prevails, and some crinoids are rimmed by syntaxial cement.

Interpretation: MFa5 is characterized by well-sorted crinoidal grainstone and packstone. Such an accumulation of crinoids corresponds to storms deposits around the FWWB, close to crinoidal meadows (Préat & Kasimi, 1995). The environment is largely influenced by an open-marine source while material originating from proximal areas is less abundant.

This microfacies is the same as MFB4 in Mabille & Boulvain (2007a) and similar to MFv defined in Resteigne (Casier & Préat, 1990).

3.1.6. MFa6: Microsparitic packstone and bioclastic-rich poorly-sorted peloidal grainstone

MFa6 corresponds to packstone interbedded with lenses or layers of grainstone. These occurrences of grainstone show thickness ranging from few millimetres to entire bed. Concerning the assemblage, peloids represent 20 to 30% of the thin section surfaces (Pl. 2F). Two types of peloids were observed: some are similar to those described in MFa5; some are larger (0.5 to 1 mm) and irregular. They can be related to the micritisation of bioclasts and lithoclasts as suggested by local relics of the original particles. This microfacies is rich in bioclasts: crinoids, brachiopods, bryozoans, ostracods, trilobites, algae (*Girvanella*, dasycladaceae, udoteaceae and palaeosiphonocladaceae) and gastropods in order of decreasing abundance. These fossils are variously broken and preserved. They range from 0.2 mm to 2 cm, with more frequent sizes around 1mm.

Detrital quartz can reach up to 2.5%. Accessory pyrite cubes are disseminated in limestone.

The matrix of packstone is microsparitic and grainstone cement is an equigranular sparite.

Interpretation: The main characteristic of MFa6 is the abundance of peloids. As they are similar to those from MFa2, they probably also have a shallow-water, low-energy origin. Here again, this proximal environment supplied calcareous algal debris and possibly micrite, but, according to the fauna, an open-marine influence was still present. The mixing between open-marine bioclasts and peloids + calcareous algae is also noted. This suggests that the proximal material (supplied by storm deposits or gravitational flow of suspended debris) and the open-marine bioclasts (supplied by storm deposits) deposited in the same environment and then mixed by wave agitation. The grainstone texture suggests a location above the FWWB (Wright & Burchette, 1996).

This microfacies corresponds to MFC6a and MFC6b in Mabille & Boulvain (2007a) and is similar to MF6 as defined in Glageon (Boulvain *et al.*, 1995).

3.1.7. MFa7: Peloidal rudstone and floatstone with stromatoporoids, crinoids and tabulate corals

Fossils constituting the rudstone and floatstone (Pl. 2G) are, ranked by decreasing abundance, stromatoporoids (massive and branching), crinoids, tabulate corals (massive and branching) and rugose corals (fasciculate and solitary). These organisms are slightly broken (usually larger than 1cm, with some stromatoporoids reaching pluridecimetrical sizes). Between them, the matrix is a peloidal grainstone (or locally packstone). These peloids are various in form (spherical, ovoidal, irregular) and size (0.1 to 1mm). Part of them corresponds to the micritisation of bioclasts as suggested by local relics of the original fossils. Fragments of secondary importance are crinoids, ostracods, gastropods, brachiopods and calcareous algae (paleosiphonocladaceae and dasycladaceae). They generally range between 0.5 and 2 mm. Some rounded lithoclasts (from 2 to 4 mm) with a mudstone texture are present. Symmetrical algal coatings are frequently observed; encrustations by stromatoporoids are less common.

Disseminated hematite is contained.

Cement is an equigranular sparite; locally a microsparitic matrix is observed.

Interpretation: This microfacies is characterized by the dominance of "reef-building organisms": stromatoporoids, crinoids, tabulate and rugose corals. This dominance is marked in thin-section but also at the field scale where it is related to the biostromal unit (unit I). Moreover, the rudstone texture implies a location above the FWWB. MFa7 is here regarded as a reefal microfacies corresponding to an in situ accumulation of reef-building organisms (parabiostrome *sensu* Kershaw, 1994).

This microfacies is similar to MF8 and MF9 defined in Glageon (Boulvain *et al.*, 1995) and can be compared to MFvi defined in Resteigne (Casier & Préat, 1990).

3.1.8. MFa8: Poorly-sorted peloidal and bioclastic grainstone

Despite ovoidal or spherical peloids (0.1 to 0.3 mm) are still dominating the assemblage (Pl. 2H), many crinoids, brachiopods, lithoclasts (with a wackestone or peloidal grainstone texture) and broken stromatoporoids, rugose and tabulate corals are observed (Pl. 2I). They are generally well preserved and range from 0.5 mm to 2 cm. Smaller poorly-preserved bioclasts such as gastropods, dasycladaceae, paleosiphonocladaceae and not very common gastropods, trilobites, bryozoans and foraminifera are also present. They usually show micritised rims.

Detrital quartz is present in low amounts and hardly reaches 1%. Disseminated hematite and pyrite are both present.

Cement is mainly an equigranular sparite but some crinoid columnals have syntaxial rims. These cements are locally affected by dolomitization. Some cm-thick planar laminations were observed. They consist of bioclastic layers interbedded with a more peloidal sediment.

Interpretation: MFa8 is characterized by an assemblage dominated by peloids with a significant presence of broken "reef-building organisms": crinoids, stromatoporoids, rugose and tabulate corals. This suggests the close proximity of the bioconstructed unit, corresponding here to MFa7. Moreover, the poor sorting, the grainstone texture and the local preservation of lamination lead us to consider an intermittent agitation. This implies a relatively protected setting. MFa8 thus corresponds to a back-reef microfacies highly influenced by inputs coming from the biostromal unit.

This microfacies can be compared to MF9 defined for the Couvin Formation (Mabille & Boulvain, 2007b) and to MF7 defined in Resteigne (Casier & Préat, 1991).

3.1.9. MFa9: Well-sorted peloidal grainstone

Ovoidal to spherical peloids (≈ 0.1 mm) represent more than 95% of the assemblage of grains (Pl. 2J). Fragments of crinoids, ostracods, brachiopods, trilobites and palaeosiphonoclaceae are rare. These bioclasts were intensely broken (< 0.5 mm) and well sorted, larger bioclasts are typically absent in this sediment.

The cement is an equigranular sparite. Planar lamination (1 to 5 mm thick) is locally observed.

Interpretation: In comparison with MFa8, the sorting is very good and the faunal assemblage is poor. This could indicate a more effective agitation in a zone less influenced by the bioconstructed units than it was in MFa8 conditions.

This microfacies is also comparable to MF7 defined in Resteigne (Casier & Préat, 1991).

3.1.10. MFa10: Bioclastic packstone and wackestone

Fauna is generally poorly diversified: crinoids, ostracods, brachiopods and gastropods are dominant. These fossils are generally broken and never exceed 1.5 mm. However, some tabulate corals (massive and branching), rugose corals (massive and branching) and stromatoporoids (laminar and encrusting) are locally abundant (Pl. 2K). They are better preserved (up to 5 cm in diametre) and some of them are found in living position. Uncommon and poorly-preserved palaeosiphonocladaceae, dasycladaceae and calcispheres are present.

Detrital quartz is present (up to 1%). Pyrite is found in cubes or disseminated in the sediment.

Matrix is a brownish micrite, which is locally affected by dolomitization. This microfacies is found in close association with well-sorted peloidal grainstone (related to MFa9). This is marked by the occurrence of lenses or layers (mm- to cm-thick) or by burrows infilling.

Interpretation: This microfacies corresponds to low agitation as shown by the presence of matrix. This relatively quiet environment allows the local development of tabulate corals, rugose corals and stromatoporoids. However, the occurrence of peloidal grainstone gives evidence of intermittent agitation. This is confirmed by the fact that corals and stromatoporoids growth forms are massive or laminar and adapted to relatively high wave energy (James, 1984). MFa10 is then interpreted as a microfacies of back-reef characteristics submitted to a relatively limited wave agitation but regularly affected by more energetic events.

3.1.11. MFa11: Fenestral wackestone with ostracods and/or calcispheres

The microfossil assemblage is poor and dominated by calcispheres (Pl. 2L) and/or ostracods. The firsts are locally so abundant that the rock corresponds to a "calcispherite" (Préat & Kasimi, 1995). The seconds are particularly well preserved and reach up to 5 mm. Accessory bioclasts (< 1 mm) are paleosiphonocladaceae, crinoids, brachiopods, *Girvanella* (aggregates), gastropods, dasycladaceans and trilobites.

Detrital quartz (1 to 2.5%) and micas flakes (up to 1%) are present. Lots of pyrite and hematite are disseminated into the sediment or concentrated within fenestrae.

The matrix is a fine and dark micrite. Birdseyes are present in every thin-section. They are ranging from 0.5 and 3 mm and are filled by equigranular sparite. Vertical burrows are present in some thin sections and are filled by microsparitic mudstone, equigranular sparite or well-sorted peloidal grainstone.

Interpretation: MFa11 is characterized by the presence of fenestrae (and notably birdseyes) and by an assemblage consisting essentially of calcispheres and ostracods. This indicates an intertidal and restricted lagoon.

This is also the interpretation made for similar microfacies described in the Eifelian and Givetian in the Dinant Synclinorium (MF13 in Mabille & Boulvain, 2007b; MF10a in Préat & Kasimi, 1995). MFa11 is similar to MF9 defined in Resteigne (Casier & Préat, 1991) and can be compared to MF14 and MF15 defined in Glageon (Boulvain *et al.*, 1995).

3.1.12. MFa12: Very well-sorted peloidal grainstone with fenestrae

Ovoidal to spherical peloids (< 0.1 mm) dominate. Bioclasts like ostracods, brachiopods, crinoids, *Girvanella* (aggregates), paleosiphonocladaceae and calcispheres are present in very low amounts. These bioclasts are intensively broken (< 0.3 mm) and altered. The sorting is particularly good.

The quartz is rare and disseminated pyrite is abundant.

The cement is an equigranular sparite. Lamination, corresponding to bright layers (related to MFa12) alternating with dark ones (related to MFa13), is locally observed. These laminations never exceed 2 mm in thickness. Fenestrae filled with large crystals of calcite are regularly observed and consists in two types. The first type corresponds to small angular fenestrae (< 1 mm), whereas the second underlines the lamination (Pl. 2M). It corresponds to elongated fenestrae ranging between 1 and 6 mm in lenght but never exceeding 0.5 mm in height. Vertical burrows are marked by the perturbation of the lamination or by the presence of open cavities filled by large crystals of sparite.

Interpretation: MFa12 is often observed interbedded with MFa11. This observation combined to the fact that Wilson (1975) groups two microfacies similar to MFa11 and MF12 in his SMF19 leads to consider an intertidal and restricted lagoonal environment for MFa12. Moreover, the presence of elongated fenestrae within the peloidal grainstone suggests that MFa12 may correspond to algal mats (Flügel, 2004).

3.1.13. MFa13: Mudstone and silty shale

Bioclasts are notably scarce in this sediment (Pl. 2N), poorly-preserved, hardly reaching 0.5 mm. They derived from crinoids and dismembered ostracod shells. Calcispheres are also present.

Detrital quartz locally reaches concentrations up to 10% and micas flakes are present (up to 5%). Iron oxides are abundant, giving a yellowish to reddish colour to some thin-sections.

Planar lamination and vertical burrows are locally observed.

Interpretation: This particularly fine-grained microfacies indicates a low energy setting where the main sedimentary process is slow accumulation of mud. Such environments are found in open-marine locations below the SWB or in internal protected settings (Préat & Kasimi, 1995). The second hypothesis is preferred because of the presence of calcispheres and ostracods.

This microfacies is similar to MF16 defined in Glageon (Boulvain *et al.*, 1995).

3.2. Palaeoenvironmental model a

To summarize and illustrate the interpretation made for each microfacies, a palaeoenvironmental model is proposed (Fig. 9). The platform profile was preferred because of (1) the presence of a reef barrier related to I unit and MFa7, (2) important exportation of carbonate material from proximal areas to fore-reef settings, and (3) the presence of a protected lagoon associated with calcispheres and algal mats.

In details, the model corresponds to a platform where the reef is mainly composed of an accumulation of stromatoporoids, crinoids, tabulate corals and rugose corals with a peloidal matrix (MFa7). The fore-reef environment is characterized by a high influence of storm events with the deepest microfacies (MFa1) located just above the SWB. Local development of laminar stromatoporoids (MFa4) and crinoidal meadows (MFa5) is also noted. Then, the influence of back-reefal and reefal environments is marked by a large input in peloids, reworked reef-building organisms and possibly micrite (MFa2, MFa3, MFa6). The back-reef environment is mainly dominated by agitated settings (MFa8, MFa9) and lagoons (MFa11, MFa12, MFa13). MFa10 corresponds to less agitated conditions where massive and laminar organisms were able to grow.

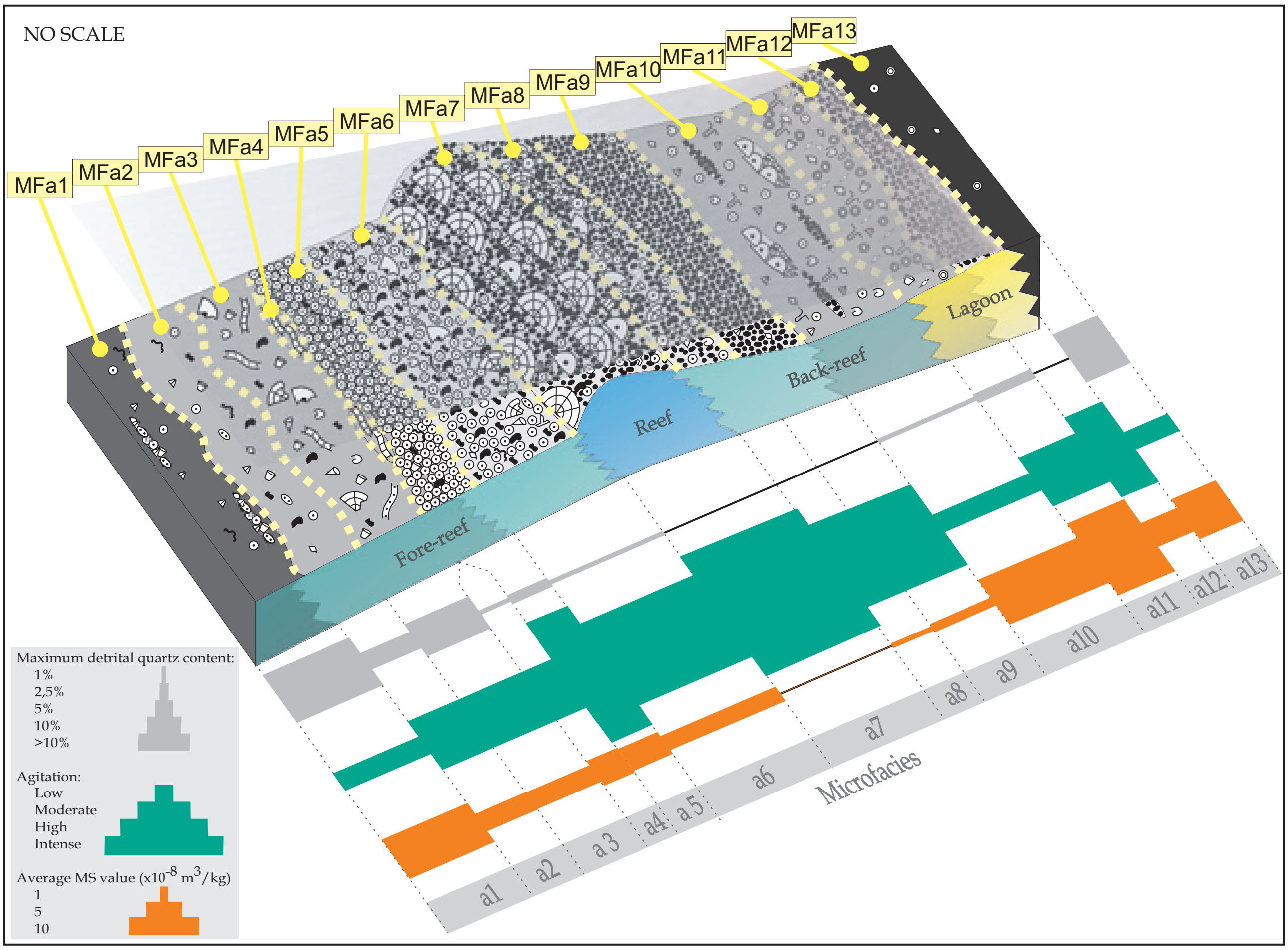

Figure 9. Proposed palaeoenvironmental model a for the top of the Jemelle Formation and the entire Hanonet and Trois-Fontaines formations (see Fig. 4 for legend). It corresponds to a platform model where the fore-reef environment is characterized by high influence of storms and carbonate input coming from proximal settings. The reef is mainly composed of an accumulation of stromatoporoids, crinoids, tabulate corals and rugose corals with a peloidal matrix. Finally, the back-reef environment is dominated by agitated settings and lagoons. Locally, quiet and non-restricted conditions allow the development of massive and laminar organisms. For each microfacies, maximal abundance of detrital quartz, agitation and average magnetic susceptibility values are given.

3.3. Model b: Microfacies of the Terres d'Haurs Formation (Tab. 2 – Pl. 3)

3.3.1. MFb1: Laminated wackestone with crinoids and trilobites

Even if bioclasts are mainly represented by crinoids and trilobites (Pl. 3A), ostracods and brachiopods, a few paleosiphonocladaceae, dasycladaceae, foraminifera and calcispheres are also present. These fossils are generally smaller than 1mm with few centimetric exceptions. Their microstructures are generally well preserved but the presence of some symmetrical algal encrustings and mud coated grains has to be noted. Some irregular peloids (from 0.1 to 0.4 mm) are locally observed.

Detrital quartz is present with concentrations up to 5%. Micas flakes, pyrite and hematite are regularly observed.

Planar lamination results from two structures: the first one is a preferential shell orientation parallel to the bedding (mainly with their convex side up); the second one are regularly spaced mm- to cm-thick packstone layers. The brownish micrite in matrix is locally argillaceous, silty or dolomitized. Horizontal burrows are present and underlined by a brighter and microsparitic infilling.

Interpretation: The assemblage is dominated by crinoidal and trilobite remains, pointing to an open-marine setting. The combined presence of mud and more bioclastic lenses and layers corresponds to slow accumulation of suspended mud and minute debris interbedded with distal storm deposits. This suggests that this microfacies was located above the SWB (Préat & Kasimi, 1995).

This microfacies is comparable with RMF13 (Flügel, 2004).

3.3.2. MFb2: Well-sorted bioclastic grainstone

The assemblage of allochems is generally dominated by broken shells (Pl. 3B) of brachiopods and ostracods. They are poorly preserved and range between 0.5 and 5 mm. These shells are oriented parallel to the bedding with the concavity pointing to the bottom (presence of shelter porosity). Locally, peloids are dominant (Pl. 3C). These peloids range from 0.1 and 0.4 mm and show various

MF	Name	Assemblage	Setting	Previously defined MF
Mid ramp				
MFb1	Laminated wackestone with crinoids and trilobites	Open-marine	Just above SWB	RMF13 [a]
MFb2	Well-sorted bioclastic grainstone	Open-marine > Proximal influence	Close to FWWB	
Shoal				
MFb3	Ooidal packstone and grainstone with reworked organisms	Ooids > Open-marine & proximal influences	Around FWWB	RMF29 [a] / MF12 [b]
Inner ramp				
MFb4	Laminated peloidal grainstone	Proximal & ooids > Open-marine influence	Poorly-protected	MF13 [b]
MFb5	Wackestone with ostracods and gastropods	Proximal > Open-marine influence	Protected	RMF18 [a]
MFb6	Burrowed mudstone	Proximal >> Open-marine influence	Mud decantation	

Table 2. Microfacies defined for Terres d'Haurs Formation with their assemblage and setting features. Previously defined microfacies from: Flügel, 2004 (a); Boulvain et al., 1995 (b).

morphologies: spherical, ovoidal, irregular. Many of them correspond to totally micritised shells. Crinoids, trilobites, ostracods and brachiopods are less common. Uncommon foraminifera, bryozoans, tabulate corals, gastropods, palaeosiphonocladaceae, calcispheres and dasycladaceae are observed. These fossils (0.5 to 5 mm) are partly recrystallised. Symmetrical and asymmetrical algal encrustings as well as mud coated grains are common. The sorting is good.

Detrital quartz is generally absent but locally reaches 5%. Disseminated pyrite is present.

Planar lamination corresponds to fining-upward mm to cm-thick layers. Some erosive layers related to MFb2 occur within MFb1. The cement is an equigranular sparite but ghosts of a fibrous primary cement are locally evident.

Interpretation: MFb2 corresponds to amalgamated storm deposits. This is proven by the presence of erosive layers, fining-upward sequences, preferential orientation of shells and sorting (Wright & Burchette, 1996). The faunal assemblage is dominated by open-marine organisms (e.g. trilobites) but an important proximal influence is noted (e.g. calcispheres). MFb2 is located in an intermediate position, just under the FWWB.

3.3.3. MFb3: Ooidal packstone and grainstone with reworked organisms

The main characteristic of these packstone and grainstone is the abundance of ooids and cortoids (30 to 80%). They range between 0.1 and 3 mm but their size is relatively homogeneous in each sample (Pl. 3D, E and F). Here, the typical nucleus of an ooid is quite large and amounts to 20-70% of the entire ooid volume; its shape is rounded but primary microstructures are usually too micritized to be determined. Locally, micritized shell fragments were coated by peels of precipitated carbonate and formed elongated, ovoidal variations of ooids. The cortex is diversely recrystallized. Some other types of bahamites grains are observed as well. The second feature is the presence of 10 to 40% of ostracods and gastropods (0.5 to 3 mm) filled with dark micrite. Some micritic lithoclasts are observed, some of them corresponding to dissolved shells filled by micrite (mold peloids *sensu* Flügel, 2004). Lumps (0.5 to 5 mm) and mud coated grains (≈ 1 mm) are also present. The remaining assemblage is mainly composed of dismantled valves of ostracods and brachiopods ranging between 0.3 mm to 1.5 mm. Crinoids, trilobites, foraminifera, calcispheres, paleosiphonocladaceae, dasycladaceae and debris of tabulate corals and stromatoporoids are less common. Symmetrical algal encrusting are locally present and the sorting is good to moderate.

Detrital quartz (up to 2.5% in packstone) and disseminated pyrite are observed. Ooids, lithoclasts and matrix are locally slightly dolomitized.

The matrix is generally microsparitic but dark micrite also occurs (Pl. 3D). Grainstone cement is an equigranular sparite (Pl. 3E and F). Lamination is locally observed and consists of preferential bioclasts orientation parallel to the bedding.

Interpretation: The presence of ooids implies an important agitation typical of inner ramp shoals settings (Flügel, 2004). This high agitation rate is confirmed by reworked organisms and mold peloids (Flügel, 2004). This would lead to consider a location above FWWB but the presence of matrix suggests intermittent agitation. MFb3 is considered as being located around the FWWB and corresponding to ooidal shoals.

This microfacies is similar to MF12 defined in Glageon (Boulvain *et al.*, 1995) and can be compared to RMF29 (Flügel, 2004).

3.3.4. MFb4: Laminated peloidal grainstone

Peloids represent 70 to 90% of the assemblage. They range between 0.1 and 0.3 mm. Ostracods, trilobites, crinoids, brachiopods, bryozoans and paleosiphonocladaceae are uncommon. They are intensively broken (<0.5 mm) and altered. Part of them is encrusted by algae. Lithoclasts and ooids similar to those described for MFb3 are locally present. The sorting is generally good.

Detrital quartz (<1%) and disseminated pyrite are present.

Lamination consists of a mm-thick alternation of more bioclastic, bright levels interbedded with more peloidal and darker layers (Pl. 3G). This alternation occurs both in planar-laminated and cross-bedded sets. The cement in the grainstone is an equigranular sparite.

Interpretation: This microfacies is related to shallow-water settings by the abundance of peloids (compare Tucker & Wright, 1990) and the presence of horizontal planar and cross-laminations (Johnson & Baldwin, 1996). Moreover, the intense breakage of fossils indicates a significant reworking of grains. Even if it is less well marked in comparison with MFb3, the influence of ooidal shoals is also marked by regular occurrence of ooids and cortoids.

This microfacies is similar to MF13 defined in Glageon (Boulvain *et al.*, 1995).

3.3.5. MFb5: Wackestone with ostracods and gastropods

Despite ostracods and gastropods dominate the fauna, the assemblage is diversified with trilobites, crinoids and less abundant brachiopods, foraminifera, bryozoans, tabulate and rugose corals (Pl. 3H). Palaeosiphonocladaceae, calcispheres and dasycladaceae algae are present. Fossils are well-preserved and range between 0.5 mm and 1 cm. Some symmetrical algal encrusting and mm-sized irregular lithoclasts are observed.

Detrital quartz reaches concentrations up to 5%. Some micas flakes and disseminated pyrite or hematite are also present.

An important feature of MFb5 is its systematic association with MFb4. This is marked in two ways. The first one and the more frequent, is the presence of burrows filled by peloidal grainstone (related to MFb4). These burrows are vertical or horizontal and have diameters between 2 mm and 1 cm. Their borders are never well defined (Note, for some less common cases, that there are also inverse relationships, specifically with burrows filled with wackestone related to MFb5 in a peloidal grainstone). The second association is the presence of mm- to cm-thick layers of MFb4 interbedded within MFb5 (Pl. 3I). Part of these layers shows an erosive base. The matrix is generally a pure and dark micrite but is locally argillaceous to silty.

Interpretation: MFb5 characteristics suggest less agitated settings, allowing mud deposition. However, the regular association with MFb4 demonstrates episodic increase of wave energy. This corresponds to a protected location within the inner ramp with a possible reworking under storm action. This is confirmed by fauna which indicates relatively protected settings (dominance of ostracods and gastropods with the occurrence of calcispheres) together with an open-marine influence (trilobites, brachiopods and crinoids).

This microfacies can be compared to RMF18 (Flügel, 2004).

3.3.6. MFb6: Burrowed mudstone

Occurrence of fauna is sporadic, only with low amounts of some ostracod, crinoid and trilobite bioclasts. Rare paleosiphonocladaceae are also present. Also these fossils are highly broken (<0.3 mm).

Detrital quartz (up to 5%), disseminated pyrite and some micas flakes were observed.

Matrix is a dark micrite. Horizontal burrows are recognized by their microsparitic infilling (Pl. 3J). They generally reach 0.2 mm in diameter. The locally-visible lamination developed with mm- (Pl. 3K) to cm-thicknesses (Pl. 3L). It is marked by the occurrence of peloidal grainstone layers. These grainstones also contain ostracods and lithoclasts. The sediment is locally enriched in small fragments of trilobites, crinoids, foraminifera, brachiopods, calcispheres and dasycladaceae. Ooids and cortoids are also present.

Interpretation: MFb6 corresponds to a particularly quiet depositional environment allowing mud deposition. Such environments are found in open-marine locations, even above the SWB or in proximal protected settings (Préat & Kasimi, 1995). The second hypothesis is preferred because of the presence of calcispheres and ooids or cortoids. As explained for MFb5, these quiet periods are interrupted by storm events recorded by grainstone levels.

3.4. Palaeoenvironmental model b

A palaeoenvironmental model, corresponding to a ramp profile, is proposed for the Terres d'Haurs Formation (Fig. 10). The ramp geometry was preferred because of (1) the development of ooidal shoals related to MFb3, (2) the poor development of restricted lagoonal environment, and (3) the presence of storm-related deposits in proximal settings associated to MFb5 and MFb6.

This model can be subdivided into a mid-ramp and an inner ramp following definitions introduced by Burchette & Wright (1992). The mid-ramp is characterized by a background sedimentation corresponding to packstones with open-marine fauna (MFb1) interrupted by storm-related events (packstone layers and MFb2). The inner ramp is characterized by the development of ooidal shoals (MFb3). These shoals did not protect the back-shoal area from important storm influence (MFb4). This back-shoal area is characterized by wackestone with ostracods and gastropods (MFb5) and by more protected facies (MFb6).

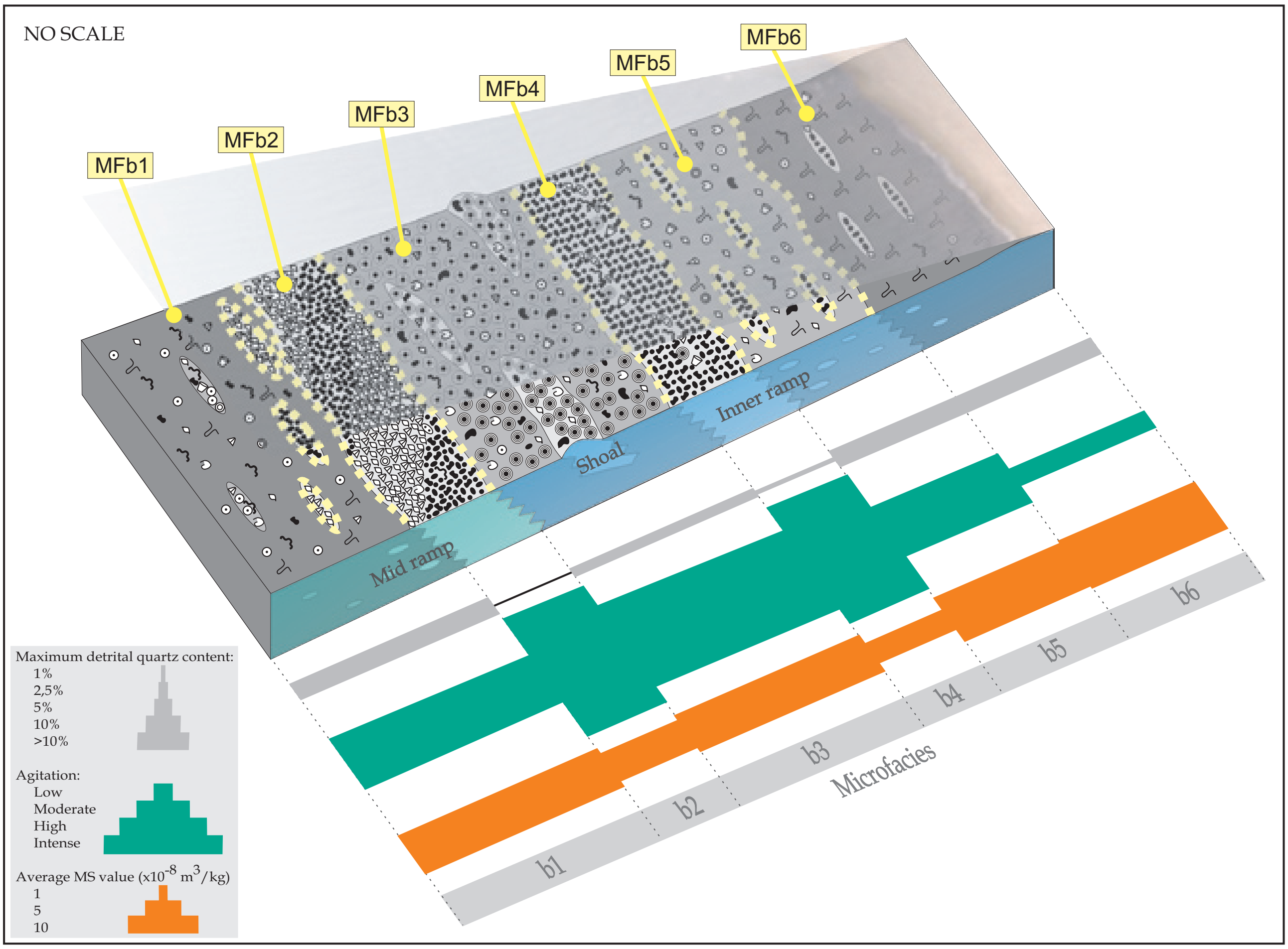

Figure 10. Proposed palaeoenvironmental model b for the Terres d'Haurs Formation (see Fig. 4 for legend). It corresponds to a ramp model where the mid-ramp is characterized by an open-marine sedimentation interrupted by storm events. The inner ramp setting is characterized by the development of ooidal shoals, back-shoal sedimentation and storm related deposits. For each microfacies, maximal abundance of detrital quartz, agitation and average magnetic susceptibility values are given.

3.5. Model c: Microfacies of the Mont d'Haurs Formation (Pl. 3)

Because of intense dolomitization and low number of samples, microfacies defined below are problematic for accurate description and interpretation. MFc1 and MFc2 are given for information and are not integrated into a palaeoenvironmental model.

3.5.1. MFc1: Dolomitic floatstone

Fauna is diverse and abundant: stromatoporoids (laminar, massive, branching and encrusting), tabulate corals (massive, branching, laminar and encrusting), rugose corals (solitary and fasciculate) (Pl. 3M). These fossils are cm-sized and locally broken. However, part of them is found in living position (presence of shelter porosity under laminar organisms; Pl. 3N). Crinoids but also brachiopods, gastropods, ostracods, gastropods and *Girvanella* are present. Their remains are poorly-preserved, with sizes that range between 0.5 and 5 mm.

Detrital quartz (<1%), authigenic quartz (<5%) and disseminated pyrite or hematite are regularly observed.

Microsparitic matrix is locally preserved and generally intensely dolomitized. Dolomite crystals (<0.05 mm) are euhedral to xenomorphic.

Interpretation: MFc1 is mainly related to the biostromal beds of the Mont d'Haurs Formation but is also associated with more argillaceous beds interbedded between the biostromes.

3.5.2. MFc2: Peloidal packstone and grainstone with crinoids

Crinoids (from 0.5 to 3 mm) and irregular peloids (from 0.3 to 0.7 mm) dominate the assemblage (Pl. 3O). Bioclasts (≈1 mm; derived mostly from shells of brachiopods, ostracods, gastropods and also *Girvanella* algae) are less common. Broken stromatoporoids and tabulate corals (cm-sized) are locally observed. Symmetrical algal encrusting is abundant.

Detrital and authigenic quartz are locally present (<2.5% together). Disseminated pyrite is observed.

The matrix is micritic to microsparitic and is locally dolomitized. The cement is an equigranular sparite.

Interpretation: MFc2 is found both in the biostromal beds and in more argillaceous ones. The presence of broken stromatoporoids and tabulate corals suggests a close proximity of MFc1.

4. Microfacies evolution

The palaeoenvironmental evolution, highlighted by the microfacies curves, is described formation by formation.

4.1. Jemelle and Hanonet Formations

This part of the section was already described and discussed in Mabille & Boulvain (2007a). The microfacies curve oscillates between two "groups" of microfacies. The first group (MFa2, MFa3, MFa4 and MFa5) represents the background sedimentation with a limited but real proximal influence, whereas the second "group" (MFa6) corresponds to higher proximal inputs in carbonate (peloids and calcareous algae and possibly micrite).

The major process that controls the microfacies curve is the pulses in the carbonate influx, which were independent of bathymetry (Mabille & Boulvain, 2007a). This makes bathymetrical evolution trends more difficult to identify. However, it is possible to define two hypothetical trends by considering the relative importance of MFa6 in comparison with the "background microfacies" (Fig. 5). They correspond to a shallowing-upward trend (units A to E) followed by a deepening-upward trend (units F and G).

4.2. Trois-Fontaines Formation

This formation shows a shallowing upward succession: fore-reef (unit H), biostrome (I) and finally back-reef (J to M). In details, 5 successive trends, corresponding to four regressive and one transgressive, are defined (Fig. 6).

(a) The first shallowing-upward trend encompasses units H, I and J. H unit corresponds to fore-reef settings where influence of proximal carbonate inputs (MFa6) is dominant. Few occurrences of pure background sedimentation are observed at the base of the unit. Then the biostromal unit (unit I) makes the transition to the back-reef (unit J). Despite one small lagoonal occurrence (MFa12) at the base of J unit, this unit mainly corresponds to agitated settings (MFa8 and MFa9)

(b) The deepening-upward trend concerns K unit which is still dominated by MFa8 and MFa10 but interbedded with more protected deposits (MFa12 next to base then MFa10).

(c-d-e) The upper part of the Trois-Fontaines Formation (units L and M) is characterized by three successive shallowing-upward trends. They are similar with a base dominated by agitated settings (MFa8 and MFa9) and a top characterized by more protected to lagoonal settings (MFa10 to MFa13).

4.3. Terres d'Haurs Formation

The Terres d'Haurs Formation comprises three successive slightly deepening upward trends (Fig. 7). They all show important oscillations between microfacies. These rapid environment changes could indicate an important slope angle of the ramp, frequent re-opening of the environment or important sea level variations. It is particularly interesting to note that the transition between the platform and the ramp models is notably sharp and that none transition or turn-back to microfacies characterising the platform is observed.

(a) The first trend is observed within unit N. It is poorly marked because of high amplitude and rapid oscillations. All microfacies, except MFb4, are represented. It suggests that ooidal shoals are present since the base of the Terres d'Haurs Formation.

(b) The second deepening upward trend is more marked and concerns the main part of O unit. Oscillations are still present. Here again, all microfacies are represented except one (MFb5). This trend is linked to the maximal development of ooidal shoals.

(c) The third deepening upward-trend corresponds to the uppermost part of unit O and to units P, Q and R. The base of this trend is dominated by protected settings (MFb6) whereas the top is characterized by storm deposits (MFb2 and MFb4).

5. Magnetic susceptibility

5.1. Principles

Magnetic susceptibility (MS) values were obtained by means of laboratory measurements of the rock sample response to an external magnetic field. Since the pioneer studies performed fifty years ago, the magnetic susceptibility logging and sample measurements in stratal successions have a long history (e.g. Rees, 1961; Hamilton, 1967; Hrouda & Janak, 1971). In 1980's, these methods were further developed and often employed in deep-sea drilling research, studies of loess, or off-shore and lake sediments. First MS logs and sample measurements from the Devonian carbonate beds were published in early 1990's (e.g. Hladil, 1992; see also Fryda *et al.*, 2002). The high-resolution MS stratigraphy in Devonian carbonate sequences was particularly developed for practical use by R. E. Crick & B. B. Ellwood (e.g. Crick *et al.*, 1994; Crick *et al.*, 1997; Crick *et al.*, 2000; Ellwood *et al.*, 2000 and many other papers until the present). These methods have been used in these rocks also in combination with gamma-ray spectrometry and chemical/mineralogical analyses (e.g. Hladil, 2002; Hladil *et al.*, 2006).

For sedimentary rocks, the major influence on MS is the terrestrial fraction (Ellwood *et al.*, 2000). This can generally be linked to eustasy because when sea level falls, erosion of exposed continental masses increases and this leads to higher MS values. On the contrary, when the sea level rises, MS shows lower values. Similarly to delivery of riverine and other terrigenous material, also the role of eolian transport and atmospheric deposits was considered (Hladil, 2002) in terms of fine-scale, stratigraphic MS variations, particularly in very pure and shallow water limestones. It is important to note that other influences like climatic changes (precipitation, ice ages and pedogenesis), tectonism, diagenesis, volcanism, impact ejecta and so on may influence MS values (e.g. Crick *et al.*, 1994; Ellwood *et al.*, 1999; Stage, 2001; Hladil *et al.*, 2006). According to this evidence, these stratigraphic MS variations in limestone rocks provide accurate correlations with higher resolution than that offered by biostratigraphy (Crick *et al.*, 1997; da Silva & Boulvain, 2006; Hladil, 2002). However, the detailed biostratigraphical marks are always a necessary prerequisite of this research (Crick *et al.*, 1994). MS was already tested on Eifelian sections of Belgium. Two main parameters influencing the MS were underlined by survey of these thick, argillaceous limestone deposits: terrigenous input and wave agitation (Mabille & Boulvain, 2007a; Mabille & Boulvain, 2007b).

5.2. MS evolution and discussion

The interpretation of the MS record is focused particularly on evolution of mean magnitudes of this variable and on the comparison with the microfacies evolution. Moreover, a comparison with two important but non exhaustive parameters is proposed. The first one is a semi-quantitative estimation of detrital quartz for each microfacies. While the detrital quartz does not carry the MS signal, it can be considered as a good indicator of the detrital input (Mabille & Boulvain, 2007a). The second parameter is wave agitation, because higher the agitation is, lower is the sedimentation of thin particles carrying the MS signal.

5.2.1. Platform model

Because of the particular sedimentary dynamic of the Hanonet Formation (see 4.1.), there is no relationship between MS curves and microfacies evolution in the first part of the section. However, it is important to keep in mind that these MS trends are significant because they allow correlations with contemporary sections (Mabille & Boulvain, 2007a). Four successive trends in MS evolution (numbered 1 to 4 on Fig. 5) are defined.

Concerning the Trois-Fontaines Formation, the MS and microfacies curves show a well-marked parallelism (Fig. 6). This parallelism is in agreement with Crick *et al.* (1997) model because each deepening-upward trend corresponds to a lowering of MS values. Shallowing-upward trends gives the opposite evolution. In details, five MS trends are defined within the Trois-Fontaines Formation (numbered 5 to 9 on Fig. 6).

The evolution of MS values along the platform profile (Fig. 9) is similar to these previously described for the Couvin platform (Mabille & Boulvain, 2007b) and easily related to wave agitation and detrital quartz content. These parameters are discussed for four microfacies belts: fore-reef, reef, back-reef and lagoon.

Within the fore-reef environment, the MS values are decreasing from distal to proximal settings. The values are ranging from 6.63x10-8 m^3/kg (MFa1) to 2.30x10-8 m^3/kg (MFa6). This decreasing evolution is also observed in the detrital quartz abundance and can be related to a global increasing in wave agitation from MFa1 to MFa6.

The reef (MFa7) is characterized by the absence of detrital quartz and negative MS values: -0.096x10-8 m^3/kg. This is due to the permanent agitation of the environment.

The back-reef area shows increasing values from distal to proximal microfacies. The low values observed in MFa8 (0.670x10-8 m^3/kg) and in MFa9 (1.27x10-8 m^3/kg) can be explained as above by high degree of agitation. At the opposite, the quiet settings associated to MFa10 are responsible for increasing MS (7.57x10-8 m^3/kg). It also allows the deposition of detrital quartz.

In the lagoon, the MS values are very different for MFa11 (12.14x10-8 m^3/kg) and MFa12 (3.94x10-8 m^3/kg). This is the combination of a high terrigenous influence present in MFa11 but ineffective in MFa12 because of a permanent agitation. Note that in MFa13, the MS values are higher again because of quiet conditions allowing mud decantation and deposition of detrital quartz.

5.2.2. Ramp model

Here again, and in agreement with Crick *et al.* (1997) model, trends defined in MS signal (numbered 10 to 12 on Fig. 7) and in microfacies evolution are parallel. This is due to a general increasing of mean MS values along the ramp profile from distal (6.48x10-8 m^3/kg for MFb1) to proximal settings (7.98x10-8 m^3/kg for MFb6). This general trend is probably related to an increasing proximity of continental area considered as the source of MS carrying particles.

The detailed evolution of MS values along the ramp profile (Fig. 10) pinpoints the importance of water agitation as main factor affecting MS signal. Smaller MS values and detrital quartz content are observed for microfacies exposed to an intense reworking under storm action (4.64x10-8 m^3/kg for MFb2 and 3.27x10-8 m^3/kg for MFb4). MFb3 also recorded relatively important wave agitation as shown by the abundance of ooids and therefore corresponds to relatively low values (6.09x10-8 m^3/kg).

Concerning the mid-ramp area, MS values are decreasing from 6.48x10-8 m^3/kg (MFb1) to 4.64x10-8 m^3/kg (MFb2) and detrital quartz content from 5 to 0%. This can be easily explained by an important increasing of wave agitation from MFb1 to MFb2.

In the inner ramp, the evolution of mean MS values and detrital quartz content is fully explained by degree of agitation. Higher agitation is recorded in MFb4 which corresponds to lowest MS values (3.27x10-8 m^3/kg) and detrital quartz content. Then a decreasing of wave agitation in MFb5 and MFb6 leads to an increasing in quartz content (≈ 5%) and to higher MS values (7.34x10-8 m^3/kg and 7.98x10-8 m^3/kg respectively).

An important point to note is the relative homogeneity of mean MS values observed in the ramp model compared to the range of values observed for the platform model. This is probably the result of higher homogenization of the terrigenous input in the ramp than in the platform.

6. Conclusions

This study is dedicated to Les Monts de Baileux section which provides an outstanding succession of strata from the top of the Jemelle Formation to the base of Mont d'Haurs Formation. It therefore offers the opportunity of investigate the entire Hanonet, Trois-Fontaines and Terres d'Haurs Formations.

Petrographic analyses led to the definition of 21 microfacies. They correspond to two distinct palaeoenvironmental models. Thirteen microfacies describe the platform model proposed for the Jemelle, Hanonet and Trois-Fontaines Formations (Model a). In this model, the fore-reef environment (MFa1 to MFa6) is characterized by high influence of storm events and substantial carbonate input coming from proximal settings. The reef is mainly composed of an accumulation of stromatoporoids, crinoids, tabulate corals and rugose corals with a peloidal matrix (MFa7). Finally, the back-reef environment (MFa8 to MFa13) is mainly dominated by shoals and lagoons. Locally, low agitation and non-restricted settings allow the development of massive and laminar organisms.

The second model proposed concerns the Terres d'Haurs Formation. This ramp model is divided into a mid-ramp (MFb1 and MFb2) and an inner ramp (MFb3 to MFb6). The mid-ramp is characterized by an open-marine sedimentation interrupted by storm events. The inner ramp setting is associated to the development of ooidal shoals, back-shoal sedimentation and storm related deposits.

Two other microfacies are defined for the Mont d'Haurs Formation (MFc1 and MFc2). Unfortunately, it is impossible to integrate them in any model because of important dolomitization.

Magnetic susceptibility (MS) analyses coupled with microfacies interpretation allowed to reconstruct the sedimentary dynamics of each formation. Moreover, the MS values were interpreted microfacies by microfacies. This led to the recognition of two main MS controlling parameters. The first one is the amount of detrital fraction, including MS carrying minerals (evaluated by detrital quartz abundance). The second one is the agitation of the environment possibly responsible for the non-deposition of the MS carrying minerals (defined on the base of microfacies interpretation). The wave energy profile along the platform and the ramp models is responsible for different repartition of mean MS values along a distal-proximal scale. Concerning the platform model, fore-reef shows decreasing MS values, related to a global increasing in wave agitation from distal to more proximal areas. Wave agitation was so high in the reef environment that MS carrying minerals were enable to settle, leading to low negative MS values. The back-reef shows low MS values where wave agitation was permanent and increasing values in less agitated areas or more proximal area. On the other hand, the ramp model exhibits lower values in storm-related deposits and in ooidal shoals. A general increasing trend in mean MS values is also observed from distal to proximal settings. This is explained by an increasing proximity of land masses (source of detrital input carrying MS signal)

These evolutions of the mean MS value along a distal-proximal scale are responsible for the parallelism between MS and microfacies curves, according to the generally admitted model of MS, in the back-reef settings and in the ramp model. For the fore-reef settings, the particular sedimentary dynamics muddles up the relationship between both curves, preventing for accurate comparisons.

7. Acknowledgements

C. Mabille benefited from a F.R.I.A. grant from the Belgian Fond National de la Recherche Scientifique (F.N.R.S.). F. Boulvain acknowledges support through research grant FRFC 2-4501-02 (F.N.R.S.). The authors are especially thankful to M. Humblet for help during field study and to E. Poty, M. Coen, M. Coen-Aubert and to A.-C. da Silva for interesting discussions. We are deeply grateful to A. Préat for critical reading of the manuscript, as well as to J. Hladil for accurate and very enthusiastic criticisms and recommendations.

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Manuscript received on 05.03.2007; accepted on 26.06.2007; published on line on 15.10.2007

Plate 1.

A. Les Monts de Baileux quarry. Studied section corresponds to dotted line.
B. Boundary between the Jemelle and the Hanonet formations.
C. Biostromal unit of the Trois-Fontaines Formation corresponding to our lithological unit I.
D. Boundary between the Trois-Fontaines and the Terres d'Haurs formations.

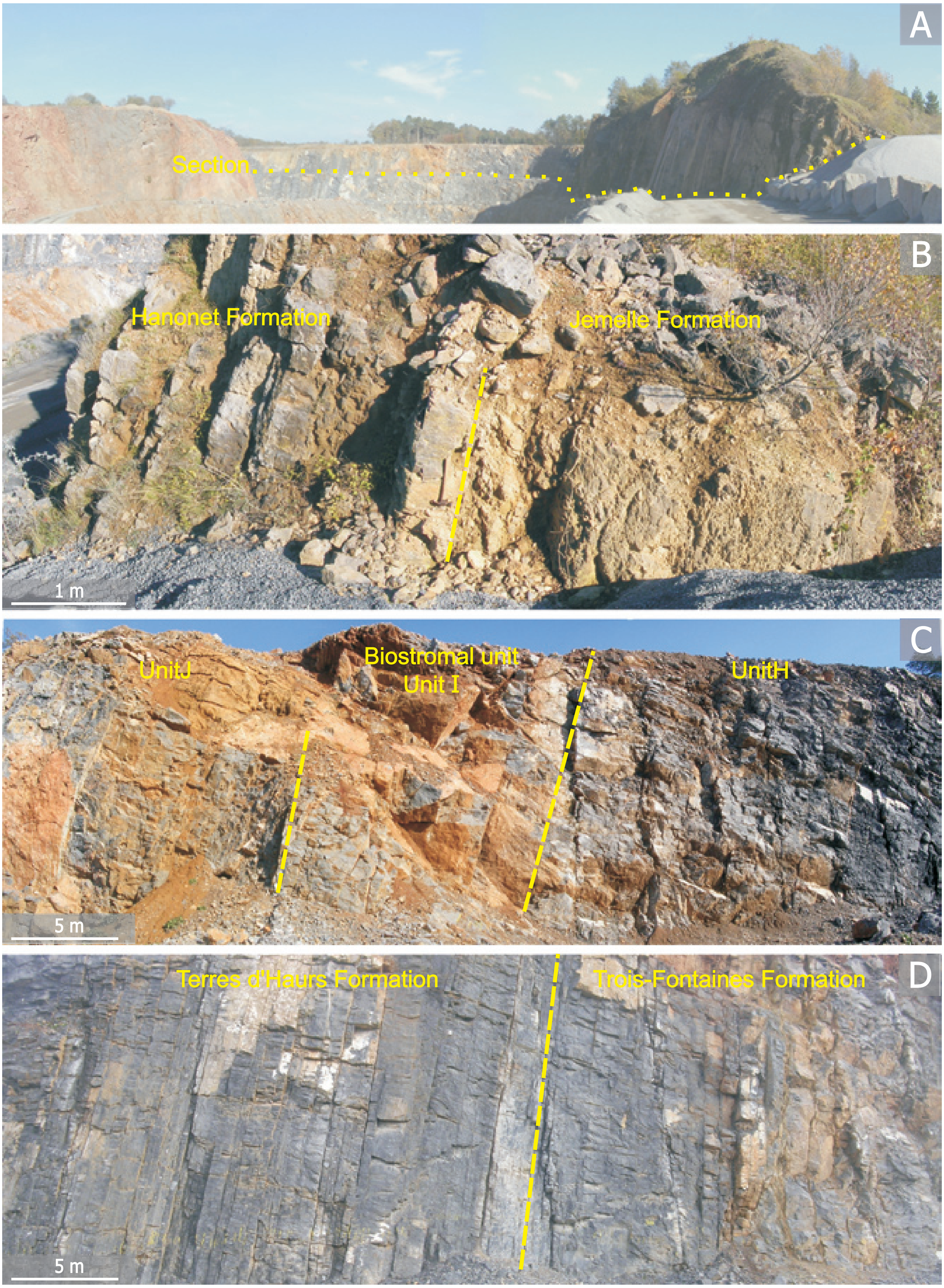

A
Section
B
Hanonet Formation
Jemelle Formation
1 m
C
UnitJ
Biostromal unit
Unit I
UnitH
5 m
D
Terres d'Haurs Formation
Trois-Fontaines Formation
5 m

Plate 2.

Microfacies of the Jemelle, Hanonet and Trois-Fontaines formations (Model a). Numbers correspond to bed numbers on Fig. 5 and Fig. 6. See text for more explanations:

A. MFa1: Mudstone with high terrigeneous content (BX1).
B. MFa2: Peloidal wackestone with some broken crinoids (BX34).
C. MFa3: Floatstone with massive tabulate corals in a mudstone matrix (BX101b).
D. MFa4: Coverstone with stromatoporoids in a slightly argillaceous matrix (BX178b).
E. MFa5: Crinoidal packstone and grainstone (BX17).
F. MFa6: Poorly-sorted grainstone dominated by peloids and crinoids (BX228).
G. MFa7: Peloidal floatstone with stromatoporoids and crinoids (BX279a).
H. MFa8: Poorly-sorted peloidal grainstone; the lamination corresponds to more bioclastic layers interbedded with more peloidal sediment (BX341).
I. MFa8: Poorly-sorted bioclastic grainstone with crinoids, stromatoporoids and some peloids (BX346a).
J. MFa9: Well-sorted peloidal grainstone (BX343).
K. MFa10: Rudstone with massive tabulate corals, massive rugose corals and branching tabulate corals (BX380).
L. MFa11: Wackestone with calcispheres (BX357b).
M. MFa12: Peloidal grainstone with elongated *fenestrae* related to algal mats (BX379).
N. MFa13: Silty shale (BX373).

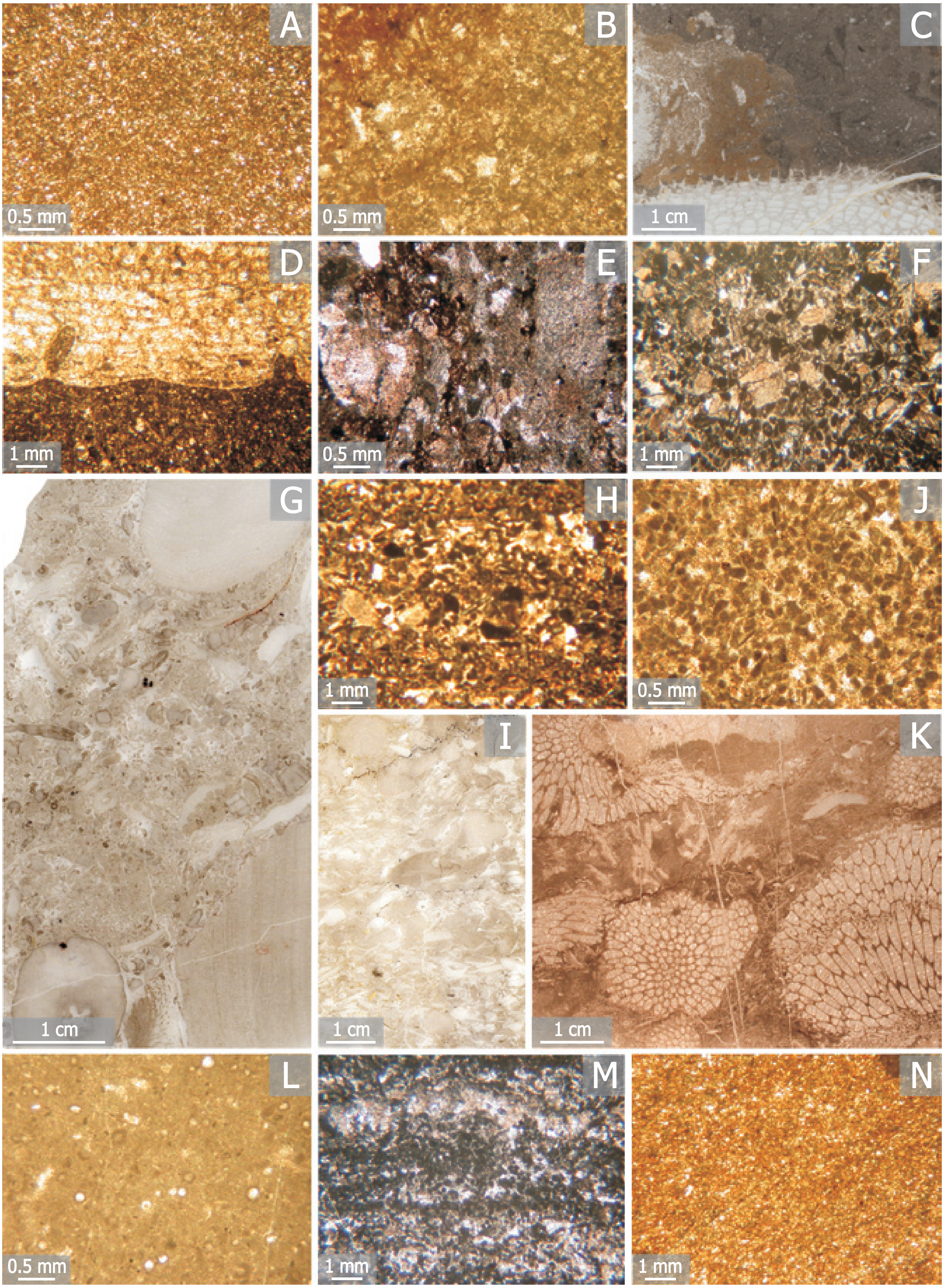
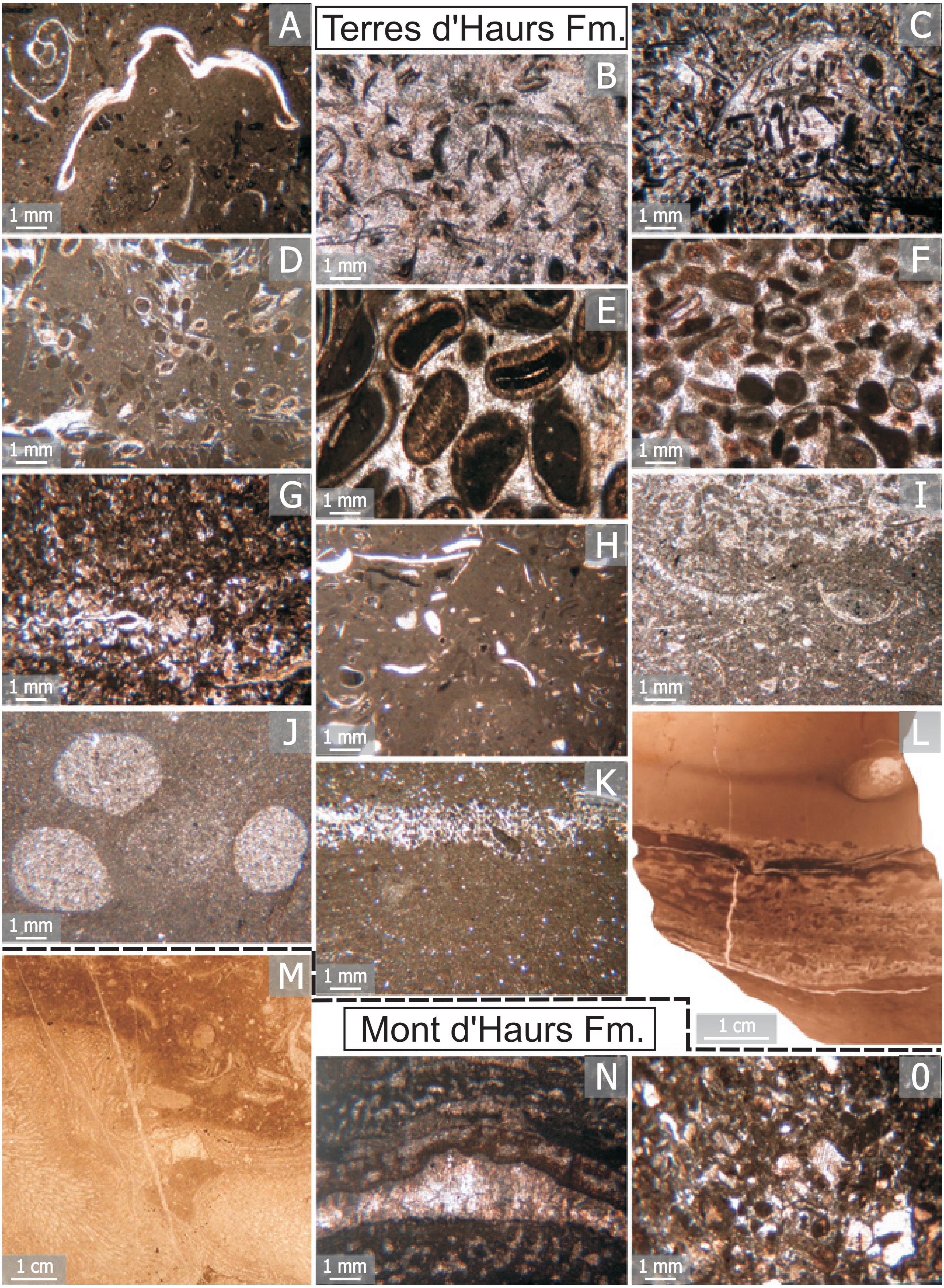

A
0.5 mm
B
0.5 mm
C
1 cm
D
1 mm
E
0.5 mm
F
1 mm
G
1 cm
H
1 mm
J
0.5 mm
I
1 cm
K
1 cm
L
0.5 mm
M
1 mm
N
1 mm

Plate 3.
Microfacies of the Terres d'Haurs (Model b) and Mont d'Haurs formations (Model c). Numbers correspond to bed numbers on Fig. 7. See text for more explanations:
A. MFb1: Wackestone with trilobites (BX554).
B. MFb2: Well-sorted bioclastic grainstone dominated by poorly-preserved broken shells, some peloids are present (BX418).
C. MFb2: Well-sorted peloidal graintone, some broken shells are observed (BX482).
D. MFb3: Ooidal packstone with ostracods filled by darker micrite (BX488).
E. MFb3: Ooidal grainstone, ooids/cortoids are ovoid and coarse (BX520).
F. MFb3: Ooidal grainstone, ooids/cortoids are more spherical and smaller (BX525).
G. MFb4: Laminated peloidal graintone; lamination is underlined by more bioclastic layers (BX529).
H. MFb5: Wackestone with ostracods (BX564).
I. MFb4-MFb5: Wackestone with ostracods (MFb5) interbedded with peloidal grainstone related to MFb4 (BX426).
J. MFb6: Burrowed mudstone (BX550).
K. MFb6: Burrowed mudstone interbedded with peloidal grainstone (BX440).
L. MFb6: Burrowed mudstone interbedded with peloidal grainstone (BX547b).
M. MFc1: Floatstone with tabulate corals encrusted by stromatoporoids (BX626).
N. MFc1: Shelter porosity between two laminar stromatoporoids (BX613).
O. MFc2: Peloidal packstone with crinoids (BX603a).


Terres d'Haurs Fm.
Mont d'Haurs Fm.
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
1 mm
1 cm