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**Field trip 3:**

**Uppermost Devonian and Lower Carboniferous of Southern Belgium**

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*Rugose corals – Tabulate corals – Stromatoporoids – Heterocorals – classical fauna – Strunian –  
Tournaisian – Viséan – Mississippian – Belgium – Tournai – Visé – Dinant*

**ABSTRACT.** The present guide illustrates a three-day field trip to coral-bearing sections in the Strunian and Dinantian strata of southern Belgium. It includes the classical sites of Tournai and Visé, from where in the 19<sup>th</sup> century important coral faunas had been collected and described.

The first day starts with the historical stratotype of the Viséan at Visé. The abandoned quarries are largely inaccessible today, but an overview on the section is given from the bank of the Meuse River. Afterwards the Strunian succession with its stromatoporid-coral biostromes in a mixed carbonate-siliciclastic facies, the Devonian-Carboniferous boundary and lower Tournaisian strata are studied in the Vesdre Massif (Vesdre Valley) and eastern Dinant Synclitorium (Ourthe Valley). The lower Tournaisian mainly consists of carbonate facies with exception of the fossiliferous dark shales of the Pont d'Arcole Formation. Following the extinctions in the end-Devonian Hangenberg event, the Hastarian is characterised by a relative low diverse coral fauna, before an important diversification took place in the early Ivorian.

The second day starts with two sections in the Hoyoux Valley. The trenches at Royseux expose upper Warnantian strata containing the most diversified Dinantian coral fauna of Belgium. The second section exposes a fossiliferous Middle-Upper Tournaisian succession including the "*Petit Granit de l'Ourthe*". Exposures in the Dinant region show the Devonian-Carboniferous transition and the Tournaisian. Additionally the poorly fossiliferous Waulsortian facies will be observed in its type locality at Waulsort. On the way towards Namur a quarry with a well-exposed fossiliferous Tournaisian succession forms a contrast to previous stops and illustrates the different facies realms encountered during this field trip. The last stops of this day in the Namur vicinity expose the stratotype of the Livian substage and Middle Viséan microbial-bryozoan

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buildups capped by *Siphonodendron martini* beds.

The third day is dedicated to the classical "Tournai" fauna in the Hainaut region. The first stop at Soignies illustrates the intensively quarried Tournaisian succession of that region. Differences in the fauna and facies to the Tournai region but also to the already visited Condroz region will be discussed. This is followed by a detailed study of the type locality including the classical fauna of the Tournaisian in the Lemay Quarry (Tournai).

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## INTRODUCTION

This three-day field trip in southern Belgium illustrates uppermost Devonian (Strunian) to lower Carboniferous fossiliferous sections and outcrops, among which, the classical sites of Tournai and Visé (Fig. 1). Quality and accuracy of available data differ from one section to the other but the collection of fossils is mostly possible. Changing exposure quality or weather may alter slightly the visited localities during this trip.

The first day focuses on the outcrops around Liège. It starts with an overview on the classical Visé quarries, the stratotype for the Viséan stage (stop D1-1). The Strunian stromatoporoids-corals biostromes and lateral equivalent, the Devonian-Carboniferous transition and the Lower Tournaisian will be observed in the Vesdre (stops D1-2, 1-3) and the Ourthe valleys (stops D1-4, D1-5, D1-6).

The second day will focus on the Namur and Dinant areas. Sections in the Hoyoux valley will be visited: the upper Viséan *Siphonodendron-Lithostrotion* biostromes (stop D2-1) and the fossiliferous Middle-Upper Tournaisian (stop D2-2). In the Dinant vicinity sections exposing the Devonian-Carboniferous transition and the Tournaisian will be seen in a railway section at Gendron-Celles (stop D2-3). Additionally the poorly fossiliferous Waulsortian facies will be observed in its type locality at Waulsort (stop D2-4). On the way towards Namur a quarry with a well-exposed fossiliferous Tournaisian succession (stop D2-5) forms a contrast to previous stops and illustrates the different facies realm encountered during this field trip. The last stops in the Namur vicinity present the stratotype of the Livian substage (stop D2-6) and Middle Viséan microbial-bryozoan buildups capped by *Siphonodendron martini* beds (stop D2-7).

The third and last day of the field trip is dedicated to the Hainaut area. After a stop at Soignies (stop D3-1) the type locality of Tournaisian including its classical fauna will be examined in detail in the Lemay Quarry (stop D3-2).

## 1. Historical background

Southern Belgium is a classical area for the study of the lower Carboniferous (=Dinantian) geology and palaeontology. It has received much attention since the works of DUMONT (1832) who subdivided "calcaire à crinoïdes" and "calcaire à *Productus*" as his lower and upper stages. These two stages were later named "calcaire de Tournai" (or Tournaisian) and "calcaire de Visé" (or Viséan). GOSSELET (1860) confirmed the stratigraphical succession "calcaire de Tournai"/ "calcaire de Visé" and more formally subdivided the "Terrain Carbonifère" into 3 stages. The "Etage du calcaire de Visé" as the middle stage was sandwiched between the older "Etage du calcaire de Tournai" and the younger "Etage houiller" (upper Carboniferous). DE KONINCK approved this succession in 1878 and promoted the international recognition of the two lower stages, by his palaeontological studies on the Tournai and



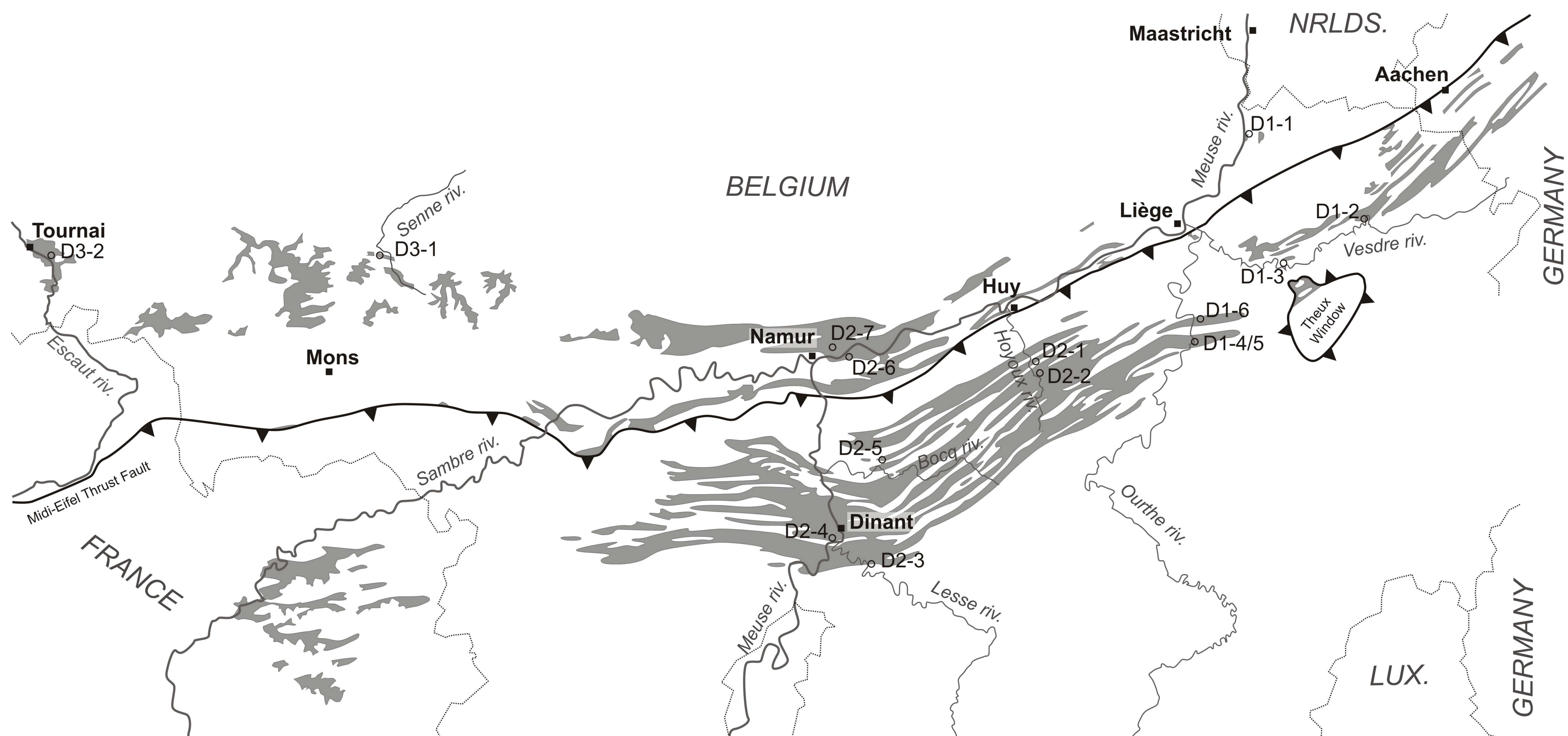


Fig. 1: Map showing the distribution of Dinantian strata in southern Belgium and neighbouring areas. Numbers refers to the outcrops visited during the field trip and details in the text.

Visé fauna. Most "Visé fossils" and "Tournai fossils", known in museums worldwide, were extracted from these quarries during the 19<sup>th</sup> century and abundantly described by DE KONINCK (1842-1851, 1872, etc.), DEMANET (1923, 1958), and others.

The Belgian lower Carboniferous corals were firstly described from the highly fossiliferous limestone of Tournai and Visé and published in the monographies of DE KONINCK in 1842, followed by a second publication by the same author in 1872. In parallel, MILNE-EDWARDS and HAIME included in their monography (1850-1855), several rugose corals from Belgium. In the beginning of the 20<sup>th</sup> century, SALÉE published two important monographies: on the genus *Caninia* in 1910 (including many so called "caninomorphic" corals), and on the "Clisiophyllids" in 1913 (including solitary corals with axial structure). It was followed by another paper on lithostrotionids, *Dorlodotia* and other corals in 1920. Belgian lower Carboniferous rugose corals together with British and French corals were also figured by MCCOY (1849), THOMSON (1880), CARRUTHERS (1910), DELÉPINE (1911), VAUGHAN (1917), and DEMANET (1923, 1938, 1958). After the First World War, the study of the Devonian corals eclipsed somewhat the Carboniferous ones and very little work was made on this subject until the 1970's. Works of POTY (1975a, 1975b, 1975c, 1981, 1982, 1983, 1984, 1986, 1989, 1993, 1999, 2007a, POTY & BOLAND 1994, POTY & HANNAY 1994) on rugose corals and TOURNEUR (TOURNEUR et al. 1989) on tabulate corals revised and completed the former studies.

The rugose corals found in the Strunian and Dinantian strata of Belgium and surrounding areas and their stratigraphical and spatial distributions are separately described and illustrated in an atlas (DENAYER et al. this volume).

## 2. GEOLOGICAL SETTING

Southern Belgium is part of the Rheno-Hercynian Fold Belt, which extends from Southern Portugal through southern England, northern France, Belgium, and Germany, into the Czech Republic and Poland. The tectonic setting is relatively complicated as a result of Variscan deformation, but considerably varies in the fold belt.

The Variscan foreland Basin to its north is less deformed, but several fault-bounded blocks can be separated. Most of the Variscan foreland is covered by the thick Mesozoic-Cainozoic sediments. The Brabant Massif, the eastern part of an important Caledonian consolidated basement complex, formed a solid tectonic block during the Variscan deformation. An important thrust fault, the Midi-Eifel Fault, separates autochthonous (north of the fault) and allochthonous (southward) tectonic units of southern Belgium. In Belgium the distribution of platforms and basins is largely connected to the shape of the Brabant Massif. Sedimentation in its south took place in the Namur-Dinant Basin, which extends eastwards into the Vesdre Massif and the Aachen region and westwards into the Avesnois and Boulonnais regions in France. The Campine Basin, north of the Brabant Massif, is separated from the Visé area by a graben system, termed Maastricht graben (POTY 1997).



The Visé area has a transitional position between the Campine Basin and Namur-Dinant Basin. As a consequence of important vertical movements of tectonic blocks (POTY 1982, 1991, POTY & DELCULÉE 2011), the area is connected during the Late Devonian and Tournaisian time with the Namur-Dinant Basin, whereas during the Viséan it is connected with the Campine Basin and separated from the Namur-Dinant Basin by the Booze-Val Dieu high.

The Namur-Dinant Basin only exposes platform sediments. Deeper water environment of Kulm facies was suggested to the south of the Namur-Dinant Basin for most of the Dinantian, based on the westward facies prolongation into the British Isles where a southern Kulm-styled basin existed (Cornubian or Munster Basin). However, the presence of proximal carbonate facies in the southern Avesnois suggests at least the local or regional presence of platform areas southwards.

POTY (1997) proposed six sedimentation areas for the Namur-Dinant Basin and the Visé area corresponding to tectono-sedimentary units (Fig. 2). ARETZ et al. (in press) added one sedimentation area in the eastern part of Belgium and its continuity in western Germany.

The **Namur sedimentation area** (NSA) is located immediately south of the Brabant Massif. It displays an incomplete stratigraphic succession characterized by proximal facies. The total thickness increases locally from south to north due to a northward tectonic tilting.

The **Condroz sedimentation area** (CSA) extends south of the NSA and also exposes

proximal facies with stratigraphic gaps in the east and a more complete succession to the west.

The **Dinant sedimentation area** (DSA) was marked by relatively deep-water sedimentation and was strongly influenced by the development of Waulsortian build-ups, which formed a discontinuous barrier during the Ivorian.

The **Hainaut sedimentation area** (HSA) was an area in which subsidence allowed accumulation of about 2500 m of Dinantian rocks of very different facies, including several thick evaporitic intercalations.

The **southern Avesnois sedimentation area** (ASA), northern France, whose eastern extent is unknown, displays facies similar to those in the CSA. The northern Avesnois, where Dinant-type facies occur, belongs to the Dinant sedimentation area.

The **Visé sedimentation area** (VSA) is a small area at the south-eastern end of the Brabant Massif, which suffered block faulting during Devonian-Carboniferous time. It was connected with the NSA during the Upper Devonian and Tournaisian and connected to a graben open to the Campine Basin during the Viséan (POTY 1997).

The **Vesdre-Aachen Sedimentation Area** (VASA) is the eastern continuation of the CSA and NSA, but displays an incomplete stratigraphic succession characterized by more proximal facies. Similarities to the NSA are found in northern parts of the VASA. The transition to the CSA is gradually (e.g. Dison area). The succession in the eastern VASA is less complete and already ends in the Moliniacian (Neffe Fm), whereas the more com-

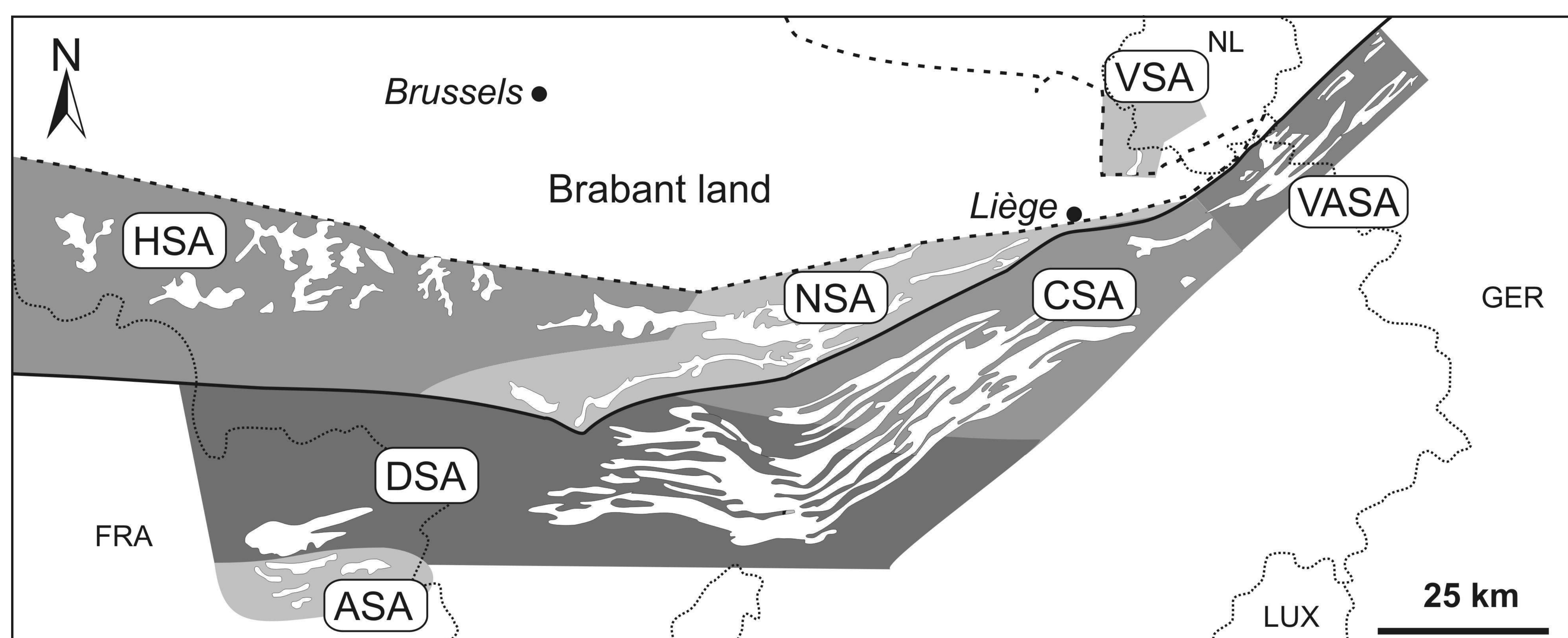


Fig. 2: Sedimentation areas for the Dinantian strata around the Brabant Massif in Belgium and western Germany. Dinantian strata in white. ASA: Avesnois Sedimentation Area, CSA: Condroz Sedimentation Area, DSA: Dinant Sedimentation Area, HAS: Hainaut Sedimentation Area, NSA: Namur Sedimentation Area, VSA: Visé Sedimentation Area, VASA: Vesdre-Aachen Sedimentation Area, (modified from ARETZ et al. in press).



plete transition to the CSA contains late Viséan rocks. Characteristic for much of the VASA is the important dolomitisation of the Tournaisian strata and marked evaporitic horizons on its top (palisadic calcite of JACOBS et al. 1982). The VASA continues north-eastwards under the thick Tertiary cover of the Lower Rhine Embayment.

### 3. SEDIMENTARY HISTORY

#### 3.1. Tournaisian

The Hastarian (Lower Tournaisian) succession is rather uniform throughout the Namur-Dinant Basin, and the facies are similar in every sedimentation area. Towards the south the succession becomes thicker and more complete. The combination of (1) an inherited Late Devonian palaeotopography and (2) somewhat deeper facies in the south points to a very smooth ramp setting for the Hastarian (HANCE & POTY 2006).

The Pont d'Arcole Fm is a rather singular feature of the Dinantian corresponding to the development of black shale facies on the lower Hastarian carbonate ramp. However, the carbonate factory was only slowed down but does not seem to have stopped for some times as indicated by the relatively high carbonate content of the Pont d'Arcole shales. The gradual changes from the underlain upper member of the Hastière Fm, the abundance of fossils in the Pont d'Arcole Fm, and the abundance of mud in the overlain lower Landelies Fm may not fully support the idea of a disastrous black shale event.

The Ivorian (Upper Tournaisian) ramp evolved progressively into the Moliniacian (Lower Viséan) rimmed-shelf. The higher sea-level gradient across the shelf results in more diversified facies patterns. Inner shelf facies cover the Namur (NSA), Condroz (CSA), and Avesnois sedimentation areas (ASA) whereas outer shelf facies are restricted to the Dinant sedimentation area (DSA) where Waulsortian buildups developed. During the Ivorian the clinoform-bounded inner-outer shelf transition prograded southward and reached the Ciney-Yvoir line during the earliest Moliniacian. There is no evidence for a deeper water basin towards the south as known from the British Isles.

#### 3.2. Viséan

Submarine topographic irregularities inherited from different sedimentation rates and Waulsortian buildups were smoothed out in the late Moliniacian. The restricted facies of the "Black Marble" (Molignée Fm) developed in a depression between the prograding inner-outer shelf

transition and local highs in the south (e.g. ASA). The Neffe Fm composed of high energy facies deposited on a shelf extending through the VASA, NSA, DSA and ASA. This formation is capped by the "Banc d'Or de Barchant", a bentonite, partly reworked in paleosoil (DELCAMBRE 1989).

During the Livian (middle Viséan) and much of the Warnantian (upper Viséan), sedimentation was controlled by an aggrading shelf (CHEVALIER et al. 2006). Glacio-eustatic sea-level fluctuations are the driving force for the sedimentation patterns. Particular parasequences can be correlated along the entire shelf from Belgium to the Boulonnais. The Livian is characterized by a marked change in the facies distribution. Now, open marine facies were restricted to the north, while evaporites developed in the south. This basin configuration continued into the lower Warnantian.

Upper lower Warnantian and upper Warnantian strata crop out only locally, and thus hamper the basin reconstruction. In the DSA and CSA the platform development stopped in the early late Warnantian (early Brigantian). The Warnantian of the Anhée and Clavier areas are characterized by the "bleu belge" and "couches du passage" (DEMANET 1938). MESTERMANN (1998) indicated the presence of the important sea-level oscillation on top of the early Warnantian (*crenistrina*-horizon). However, the varied composition of the upper Warnantian sediments, the low thickness, slow sedimentation rates, condensation (phosphates nodules), and reworking in combination with the shallow marine environments of the older and younger formations, point to a rather shallow depositional environment for the rocks previously summarised under the former Warnant Fm (PAPROTH et al. 1983). It may be assumed that sedimentation during upper Warnantian times was restricted to small residual basins, whereas surrounding areas have been emerged. Because the abundance of upper Warnantian strata increases towards the south, the Namur-Dinant basin may have been deepened in this direction.

#### 3.3. Namurian

A stratigraphic gap between the youngest Viséan limestones, which varies from the Livian to the late Warnantian, and the succeeding Namurian shales (Arnsbergian, E2 goniatite biozone) is normally found in southern Belgium. Only the Gottignies Fm in the western HSA contains questionably the Viséan/Namurian boundary.

The stratigraphic gap is related to emergence of the entire basin and palaeokarst formation is



widely observed. Lower Namurian sediments are mainly dark, marine mudstones to siltstones, local with interbedded limestones (Tramaka limestone, E2, GROESSENS 1982). The base of the "Namurian shales" represents rather shallow water facies as evidenced by their various compositions (mudstones to few sandstones, with some carbonate content), associated sedimentological features (erosional surfaces, cross-stratification), and associated carbonate shoals (Tramaka).

#### 4. LITHOSTRATIGRAPHY AND SEQUENCE STRATIGRAPHY

HANCE et al. (2001) and emended by DEVUYST et al. (2005) proposed a sequence stratigraphic model for the Dinantian of the Namur-Dinant Basin (Fig. 2). It is based on a new litho- and biostratigraphic interpretations of the Dinantian (e.g. POTY et al. 2002; POTY et al. 2006). Nine third order sequences have been recognized in the Belgian Tournaisian and Viséan. System tracts follow the terminology of PLINT & NUMMEDAL (2000). The following description of the sequences is mainly from DEVUYST et al. (2005).

**Sequence 1** straddles the Devonian-Carboniferous boundary. Its transgressive system tract (TST) covers the Etroeungt Fm and its lateral equivalent, and the lower member of the Hastière Fm ("Tn1b $\alpha$ "). The highstand system tract (HST) is represented by the middle Member of the Hastière Fm ("Tn1b $\beta$ "), which directly overlies Famennian siliciclastics in the northern part of the NSA.

**Sequence 2** starts abruptly in the DSA and CSA with the upper Member of the Hastière Fm ("Tn1b $\gamma$ ") and the Pont d'Arcole Fm as TST. Deposition of the Pont d'Arcole Fm indicates the input of argillaceous deposits on the lower Hastarian carbonate ramp. The medium to thick-bedded crinoidal limestones of the Landelies Fm form the HST-FSST.

**Sequence 3** can clearly be recognised in the DSA and CSA. Its TST are formed respectively by the Maurenne and Yvoir formations in the

northern part of the DSA and by the Maurenne and Bayard formations in the southern part of the DSA. The LST is not developed in the northern part of the CSA. The Ourthe Fm represents the HST. The development of Waulsortian facies initiated during the TST.

**Sequence 4** is represented in the DSA by the LST-TST deposits of the lower part of the Leffe Fm and in the CSA with the TST deposits of the Martinrive Fm. The crinoidal rudstones of the Flémalle Mbr and the overlying oolitic limestone of the Avins Mbr correspond to the HST and HST-FSST. These two members corresponding respectively to the lower and upper parts of the Longpré Fm prograded southwards and thus produced a clinoform profile.

**Sequence 5** is most likely only present in the DSA and in the Visé sedimentation area (VSA). In the transition CSA-DSA, it corresponds to the Sovet Fm, except its lowermost 4 m, and its equivalents to the south, namely, the upper part of the Leffe Fm and the overlying Molignée Fm. In the VSA, the HST is locally represented by massive grainstones. It followed a strong sea-level fall, which probably corresponds to the formation of an ice cap marking the onset of the Carboniferous Glaciations. From this sequence onward glacio-eustatic parasequences developed.

**Sequence 6** filled the inherited topographic irregularities. In the CSA and NSA the LST may be formed by the evaporitic facies developed locally in the lower part of the Terwagne Fm, which rests abruptly on the underlying Avins Mbr (sequence 4) with local karst development in the NSA and VASA. In these sedimentation areas, the TST corresponds to the peritidal facies of middle and upper Terwagne Fm. In the DSA, the Salet Fm and, further south, the upper part of the black limestones of the strongly diachronous Molignée Fm forms the LST and TST. In the entire Namur-Dinant Basin, the sequence ends with the thick-bedded packstones and grainstones of the Neffe Fm as the HST and FSST.

**Fig. 3 (next page): Lithostratigraphic, biostratigraphic and sequence stratigraphic framework for the uppermost Devonian, Tournaisian, Viséan and lower Serpukhovian of Southern Belgium and surrounding areas. Gaps are indicated by gray zones. Third-order sequences according to HANCE et al. 2001 and DEVUYST et al. 2005. Biostratigraphy (foraminifers and rugose corals biozones) after POTY et al. 2006. Legend: St: stages, Sub-st.: sub-stages, Coral: Rugose Corals biozone, Foram.: Foraminifers biozones, 3rd Seq.: third order sequences, Srp.: Serpukhovian, P. A.: Pendleian and Arnsbergian, L.-F.: Limont-Fontaine Fm, Mol.: Molignée Fm, Walh.: Walhorn Mbr, B.-R.: Belle-Roche Breccia, B.-B.: Bay-Bonnet Mbr, T.-S.: Thon Samson Mbr, G. B.: Grande Brèche, Ch.: Chabôfosse Facies, Tra.: Tramaka Mbr, Dendre Grp: Dendre Group, Namur Grp: Namur Group. Tournai Fm includes Crampon, Allain, Providence, Pont-à-Rieu and Vaulx Mbr. Antoing Fm includes Calonne lower and upper members, Vignoble, Gaurain-Ramecroix and Warchin Mbr. Lives Fm includes Haut-le-Wastia, Corphalie and Awirs Mbr. Modified after POTY et al. (2002, 2006), POTY & HANCE (2006a, 2006b), DEVUYST et al. (2006), HANCE & POTY (2006), HANCE et al. (2006a, 2006b, 2006c), AMLER & HERBIG (2006) and POTY & DELCULÉE (2011).**



Sr.	Sub-st	Coral	Foram.	3rd Seq.	HSA(W)	HSA(E)	VSA	VASA	NSA(N)	NSA(S)	CSA	DSA(N)	DSA(S)	ASA							
	P. A.		MFZ16			Blaton Gottignies	Souvré Chokier	Chokier	Chokier	Tra.	Chokier	"Couches de passage"									
	RC8	MFZ15				Viesville											Anhée	Polivache	Thon-Samson	G. B.	St-Hilaire
	R C 7	MFZ14		9																	
	R C 7	MFZ13		8																	
	R C 6	MFZ12		7																	
	R C 5	MFZ11		6																	
	R C 4	MFZ10		5																	
	R C 3	MFZ9		4																	
	R C 3	MFZ8		3																	
	R C 3	MFZ7		2																	
	R C 2	MFZ6		1																	
	R C 1	MFZ5																			
	R C 1	MFZ4																			
	R C 0	MFZ3																			
	R C 0	MFZ2																			
	R C 0	MFZ1																			
	R C 0	DFZ8																			
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**Sequence 7** includes the Lives Fm and the lower part of the Grands-Malades Fm, corresponding respectively to the LST (Haut-le-Wastia Mbr)-TST (Corphalie and Awirs Mbrs) and HST (-FSST?) (Seilles Mbr and its lateral equivalents).

**Sequence 8** corresponds to the Bay-Bonnet Mbr (TST and TST), characterised by stromatolitic limestones, and to the bioclastic limestones of the Thon-Samson Mbr (HST) of the Bonne Fm. It is the thinnest of all observed sequences.

**Sequence 9** is the youngest sequence of the Belgian Dinantian in the CSA and DSA. It includes the Poilvache Mbr (LST?-TST, Bonne Fm) and the Anhée Fm (HST). These units are composed of shallowing-upward parasequences. In the VSA, the sequence is well developed in the Berneau and Visé Fms. This last sequence is lacking in many parts of the NSA, VASA and ASA, due to non deposition or subsequent erosion.

## 5. BIOSTRATIGRAPHY

POTY et al. (2006) published a revised biostratigraphic chart for the Strunian and Dinantian of the Namur-Dinant Basin based foraminifers, rugose corals and conodonts (Figs. 3, 4). In this new biozonation, the old foraminifers zones of CONIL (CONIL et al. e.g. 1977, 1991,) have been replaced by a new zonal scheme (DFZ, MFZ). The coral zonations of POTY (1984, CONIL et al. 1991) has been improved by new findings and the corrections of erroneous attribution due to incorrect foraminifers data. The conodont zones of GROESSENS (1975) have been adapted to the new scheme. Only the revised coral zones are explained herein, for the other groups the reader is referred to the original publication of POTY et al. (2006).

**Zone RC0:** "Clisiophyllyd"-*Campophyllum* interval zone

This first assemblage corresponds to the first marked radiation of rugose corals following the Late Frasnian extinction events (POTY 1999). After a very long interval almost devoid of corals, the latter reappeared at the base of the Strunian Substage (sensu CONIL et al. 1986). The RC0 zone is subdivided in two sub-zones: RC0 $\alpha$  characterized by the occurrence of "Clisiophyllids" (taxa with querying affinity with the Viséan Clisiophyllids) and *Campophyllum*; and RC0 $\beta$  characterized by *Campophyllum flexuosum* (GOLDFUSS), *Campophyllum gosseleti* WEYER, "Clisiophyllum" *omaliusi* HAIME, "Dibunophyllum" *praecursor* FRECH and "Palaeosmilia" *aquisgranensis* (FRECH). This Strunian fauna became globally extinct at the Hangenberg event, a short time before the Devonian-Carboniferous boundary (POTY 1999).

The RC0 $\alpha$  is only known from the Epinette Fm (ASA) whereas the RC0 $\beta$  correspond to the Etroeungt Fm (ASA, DSA), Comblain-au-Pont (CSA) and Dolhain (VSA) formations

**Zone RC1:** *Coniophyllum* interval zone

The recovering coral faunas were poorly diversified but widespread and occur from the base of the Carboniferous Hastière Fm (except the first bed, yielding reworked RC0 $\beta$  corals, still Devonian). In the Namur-Dinant Basin, three interval subzones are recognized. RC1 $\alpha$  corresponds to the appearance of *Coniophyllum priscum* (MÜNSTER) and *Kizilia kremersi* (POTY). RC1 $\beta$  corresponds to the entrance of *Coniophyllum streeli* (POTY) and *Siphonophyllia cylindrica hastariensis* (SALÉE). The appearance of *Uralinia lobata* POTY & BOLLAND and *Saleelasma delepinei* (VAUGHAN) defines the base of the subzone RC1 $\gamma$ . In southern Belgium, RC1 $\alpha$  corresponds to the lower member of the Hastière Formation, whereas the middle and upper members corresponds to the RC1 $\beta$  subzone. The Pont d'Arcole Fm corresponds to the RC1 $\gamma$  subzone.

**Zone RC2:** *Siphonophyllia rivagensis* interval zone

This zone is characterized by the appearance of *Siphonophyllia rivagensis* POTY & BOLLAND. In the Namur-Dinant Basin, the RC2 zone corresponds to the Landelies and Maurenne formations (ASA, DSA and CSA) and to the dolomitized Engihoul Formation (NSA).

**Zone RC3:** *Caninophyllum patulum* interval zone

The RC3 zone is marked by the first diversification of the rugose corals following the Devonian-Carboniferous boundary crisis. Its base (RC3 $\alpha$  subzone) is defined by the appearance of *Caninophyllum patulum* (MICHELIN) and *Sychnoelasma konincki* (MILNE-EDWARDS & HAIME), followed by *Caninia cornucopiae* MICHELIN in GERVAIS, *Uralinia* cf. *gigantea* (YÜ), the genera *Cyathoclisa* DINGWALL, *Solenodendron* SANDO, *Heterostrotion*, POTY & XU, *Bifossularia* DOBROLJUBOVA, and *Keyserlingophyllum* STUCKENBERG. The RC3 $\beta$  corresponds to an interval almost devoid of corals, whereas the RC3 $\gamma$  is marked by the appearance of the genus *Cravenia* Hudson. In the CSA, the zone comprises the Yvoir Fm (RC3 $\alpha$ ), the Ourthe Fm (RC3 $\beta$ ) and the Martinrive Fm (RC3 $\gamma$ ). In the DSA, the zone is not easily recognized because it corresponds to the Waulsortian complex (Waulsort, Bayard and Leffe formations almost devoid of corals). In the ASA, it corresponds to the Grives Fm. In the NSA and VASA, it corresponds to dolomitized units of the



Chronostrat.			Foraminiferal zones			Conodont zones		Coral zones	3rd order seq. strati.																			
			Poty et al. in press	Conil et al., 1991	Mamet, 1974	Conil et al., 1991 & Poty et al. in press		Poty et al. in press	Hance, et al., 2001																			
MISSISSIPPIAN	S.	Arnsb.	MFZ16	Cf7		17-19	boll.	<i>Adetognathus unicornis</i> <i>Gn. bilin. bollandensis</i>	RC9	11																		
		Pend.																										
	VISEAN	Warnantian	MFZ15	Cf6	δ	16s	bilineatus	<i>Gn. bilineatus bilin.</i>	RC8	10																		
			MFZ14		γ	16i																						
			MFZ13		α-β	15																						
			Liv.		MFZ12	Cf5			14 13	<i>T. transatlanticus</i>	RC7	β	9															
		Moliniacian	MFZ11	Cf4	γ-δ	12	RC6		α		8																	
			MFZ10		β	11																						
			MFZ9		α2	10	RC5		β2		7																	
			Ivorian		MFZ8	Cf3						α1	9	RC4	β1	6												
		MFZ7		Cf2	8		α		5																			
		MFZ6									Cf1			γ	7	RC3	γ	4										
		MFZ5		Df3	ε		6		RC2										β	3								
		MFZ4	α			pre-7						RC1	α			2												
	MFZ3	β						5	RC0								β	1										
	MFZ2										γ	5																
	MFZ1			δ	5																							
	DFZ8		γ			5																						
	DFZ7	γ					5																					
	DFZ6									γ	5																	
	DFZ5			γ	5																							
	"Strunian"																											

Fig 4: Overview on the biostratigraphic divisions for the Belgian Namur-Dinant Basin (from POTY et al. 2006). Arnsb = Arnsbergian; Liv = Livian; Mol. emend. = Moliniacian emended; Pend. = Pendleian; S. = Serpukhovian; S. = *Scaliognathus*.



Engihoul and Vesdre formations. The formations of the HAS are not very well dated because the main guide taxa are lacking, probably due to palaeoenvironmental parameters. The presence of *Caninophyllum patulum* and *Sychnoelasma konincki* in the Tournai and Ecaussinnes formations indicates RC3 biozone but the under- and overlying formation are not dated neither with corals, nor with conodonts and foraminifers.

**Zone RC4:** *Sychnoelasma hawbankense* interval zone

This zone straddling the Tournaisian-Viséan boundary is divided in three subzones. The RC4 $\alpha$  subzone is marked by the appearance of *Sychnoelasma hawbankense* MITCHELL & SOMERVILLE and *Cyathoclisia modavensis* (SALÉE). The RC4 $\beta$ 1 is characterized by the first appearance of typically worldwide Viséan taxa: *Amygdalophyllum* DUN & BENSON, *Merlewoodia* PICKETT, *Palaeosmilia* MILNE-EDWARDS & HAIME, *Dorlodotia* SALÉE and *Corphalia* POTY. The RC4 $\beta$ 2 recorded the delayed appearance of other Viséan taxa: *Axophyllum* MILNE-EDWARDS & HAIME, *Haplolasma* SEMENOFF-TIAN-CHANSKY and *Clisiophyllum* DANA. These last subzones were long considered as earliest Viséan (CONIL et al. 1989, 1991) but the review of the foraminifers of these strata proved their typical uppermost Tournaisian character (HANCE et al. 2001). The base of the RC4 $\beta$ 2 subzone approximately matches the base of the MFZ9 foraminifer biozone which coincide with the base of the emended Moliniacian substage and the Viséan (POTY et al. 2006). The RC4 $\alpha$  corresponds to the Flémalle Mbr of the Longpré Fm (NSA and CSA), to brecciated units of the Belle-Roche Fm (VASA), to the upper part of the Grives Fm (AVA) and to the Waulsortian buildups and lateral facies devoid of coral in the DSA. The RC4 $\beta$ 1 corresponds to the Avins Mbr of the Longpré Fm (NSA and CSA), to brecciated units of the Belle-Roche Fm (VASA), to Godin Fm (AVA), to the lower part of the Visé Fm (VSA) and to different formations of the Waulsortian complex (DSA) or to the Sovet Fm (transitional zone between DSA and CSA). The RC4 $\beta$ 2 corresponds to the Terwagne Fm (CSA, VASA, NSA, and ASA) and to the Sovet, Salet and Molinee formations (DSA).

**Zone RC5:** *Siphonodendron* interval zone

In Western Europe, the base of RC5 coincides with the appearance of the first *Siphonodendron* species: *Siphonodendron ondulosum* POTY, *Siphonodendron martini* (MILNE-EDWARDS & HAIME) and *Axophyllum mendipense* (SIBLY) are also guides for the RC5 $\alpha$ . The RC5 $\beta$  subzone is a local range-zone of *Corphalia mosae* POTY. The RC5 $\gamma$  is characterized

by *Axophyllum vauhani* (SALÉE), *Siphonodendron irregulare* (PHILLIPS), *Caninophyllum archiaci* (MILNE-EDWARDS & HAIME) and *Clisiophyllum garwoodi* (SALÉE). In the Namur-Dinant Basin, the RC5 $\alpha$  correspond mainly to the Neffe Fm, whereas the RC5 $\beta$  corresponds to the Haut-Le-Wastia Member (Lives Fm) throughout all sedimentation areas.

**Zone RC6:** *Lithostrotion araneum* interval zone

The RC6 zone is characterized by the appearance of *Lithostrotion araneum* (MCCOY), the first representative of the genus *Lithostrotion*. The other guides for this zone are *Lithostrotion vorticale* (PARKINSON) and *Siphonophyllia siblyi* SEMENOFF-TIAN-CHANSKY.

In southern Belgium, the RC6 comprises the Corphalie and Awirs members of the Lives Fm, the Seilles and Bay-Bonnet members of the Grands-Malades Fm throughout all sedimentation areas.

**Zone RC7:** *Dibunophyllum* interval zone

This zone is divided into two subzones: RC7 $\alpha$  is characterized by the first appearance of *Dibunophyllum* followed the species *Siphonodendron pauciradiale* (MCCOY), *Siphonodendron scaleberense* NUDDS & SOMERVILLE, *Siphonophyllia samsonensis* (SALÉE), *Hexaphyllia marginata* (FLEMING) and *Diphyphyllum furcatum* HILL. The RC7 $\beta$  subzone is characterized by the appearance of *Lithostrotion maccoyanum* MILNE-EDWARDS & HAIME, *Siphonodendron junceum* (FLEMING), *Diphyphyllum lateseptatum* MCCOY, *Diphyphyllum fasciculatum* (FLEMING), *Aulophyllum fungites* (FLEMING) and *Pseudozaphrentoides juddi* (THOMSON). *Siphonodendron intermedium* POTY, *Lithostrotion decipiens* (MCCOY), *Clisiophyllum keyserlingi* MCCOY and *Dibunophyllum bipartitum* (MCCOY) are other common taxa from this zone. The RC7 $\alpha$  corresponds to the Thon-Samson and Poilvache members of the Bonne Fm, whereas the RC7 $\beta$  is represented by the lower part of the Anhée Fm throughout all sedimentation areas.

**Zone RC8:** *Lonsdaleia* interval zone

The base of this last zone is marked by the appearance of the genera *Lonsdaleia* (subgenera *Lonsdaleia* MCCOY, *Serraphyllum* POTY & HECKER and *Actinocyathus* D'ORBIGNY) and *Palastrea* McCoy. *Thysanophyllym* NICHOLSON & THOMSON, *Nemistium* SMITH, *Corwenia* SMITH & RYDER and *Orionastraea* SMITH are other genera typical of this zone. The latter are guide-taxa for the definition of the British Brigantian substage. In southern Belgium, only the base of the RC8 is known in few localities where it corresponds to the top of the Anhée Fm (CSA) and to the Visé Fm (VSA).



## 6. FIELD TRIP ITINERARY

### Saturday 27th August 2011

- 9:00 Departure from Liège and drive to Visé
- 9:30 STOP D1-1 - Visé disused quarries (Upper Viséan, landscape)
- 10:30 STOP D1-2 - Dolhain railway section (Lower Tournaisian)
- 11:30 STOP D1-3 - Trooz quarry (Strunian)
- 12:30 Lunch in Chaudfontaine vicinity
- 14:00 STOP D1-4 - Rivage road section (Lower-Upper Tournaisian)
- 16:00 STOP D1-5 - (optional) Pont-de-Scay road section (Strunian - Upper Tournaisian)
- 17:30 STOP D1-6 - La Préale quarry (Upper Tournaisian, building stone quarry)
- 18:30 Diner and overnight in the Namur vicinity

### Sunday 28th August 2011

- 9:00 Departure from Namur and drive to the Hoyoux valley
- 9:30 STOP D2-1 - Royseux (Upper Viséan)
- 11:00 STOP D2-2 - Pont-de-Bonne quarry (Upper Tournaisian)
- 12:00 STOP D2-3 - Gendron-Celles railroad section (Strunian-Upper Tournaisian, Waulsortian)
- 13:00 Lunch and short visit of Dinant (Bayard Rock, old town, etc.)
- 14:00 STOP D2-4 - Moniat (Waulsortian build-up, landscape)
- 15:00 STOP D2-5 - Chansin "Les Nutons" quarry (Tournaisian), "Petit-Granit du Bocq" building stone quarry
- 17:00 STOP D2-6 - Lives Rock and disused quarry (Middle Viséan)
- 18:00 STOP D2-7 - Bomel disused quarry (Middle Viséan microbes-fenestellid bryozoans reef and coral beds)
- 19:00 Diner and overnight in the Namur vicinity

### Monday 29th August 2011

- 9:00 Departure from Namur and drive to the Hainaut area
- 10:00 STOP D3-1 - Soignies quarry (Tournaisian "Petit-Granit de Soignies" building and ornamental stone)
- 12:30 Lunch in the Soignies vicinity
- 14:00 STOP D3-2 - Tournai quarry (Tournaisian)
- 16:30 Short visit of Tournai and its roman-gothic cathedral classed in the mondial patrimoine of humanity
- 17:30 End of the field trip FT4, stop possible at the Tournai railway station with easy

connection to Paris and Brussels, and way back to Liège (arriving in the evening).

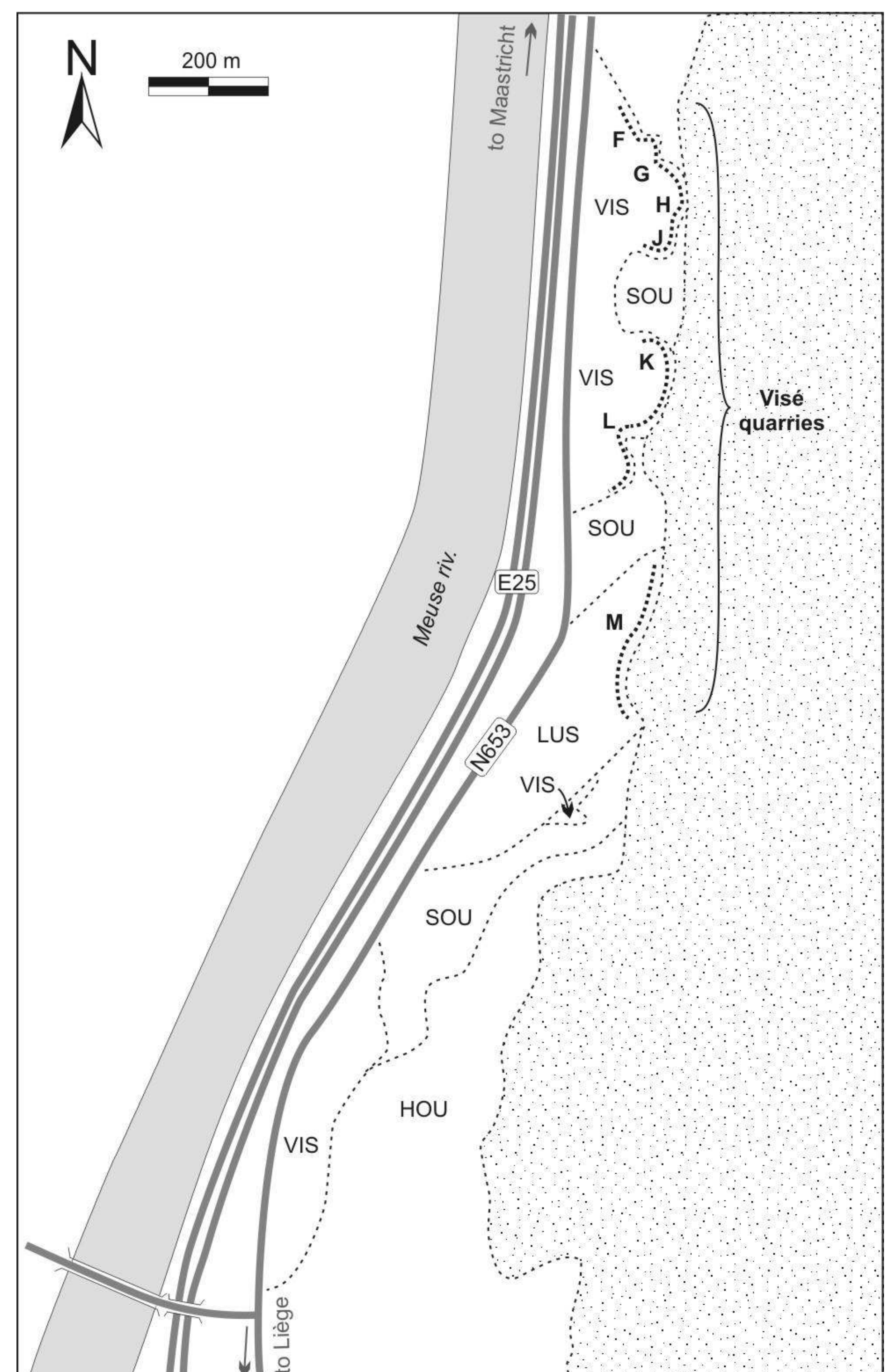
### STOP D1-1 - VISE QUARRIES

#### References

- PIRLET (1967)
- CONIL et al. (1977, 1991)
- POTY (1978, 1981, 1982, 1991, 1997)
- POTY et al. (1982, 1991, 2002)
- BARCHY & MARION (2000)
- HANCE et al. (2006b)
- POTY & DELCULEE (2011)

#### Location and access

Meuse valley, Visé Sedimentation Area (VSA). Disused quarries along the road from Liège to Visé, on the eastern bank of the Meuse River (Figs. 5, 6, 7). The quarries are mostly in private properties and, unfortunately, inaccessible.



**Fig. 5: Geological map of the Visé quarries. Letters F-M refers to the name of the quarries after PIRLET (1967). Legend: LUS: Lustin Fm, VIS: Visé Fm, SOU: Souvré Fm, HOU: Houiller Gp (Namurian-Westphalian coal measures). Modified after BARCHY & MARION (2000).**



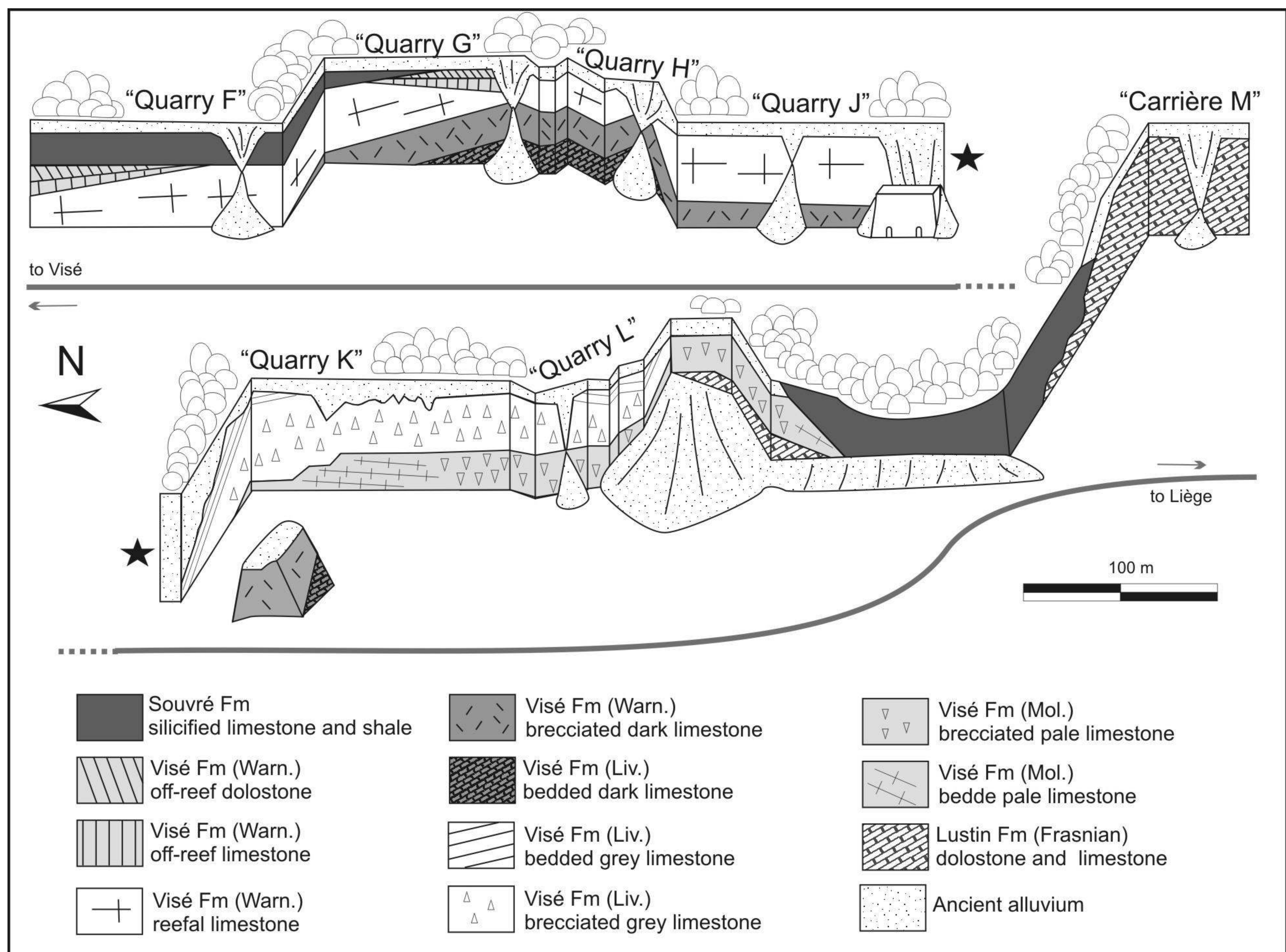


Fig. 6: Schematic representtation of the classical Visé quarries showing the main facies. Modified after PIRLET (1967).

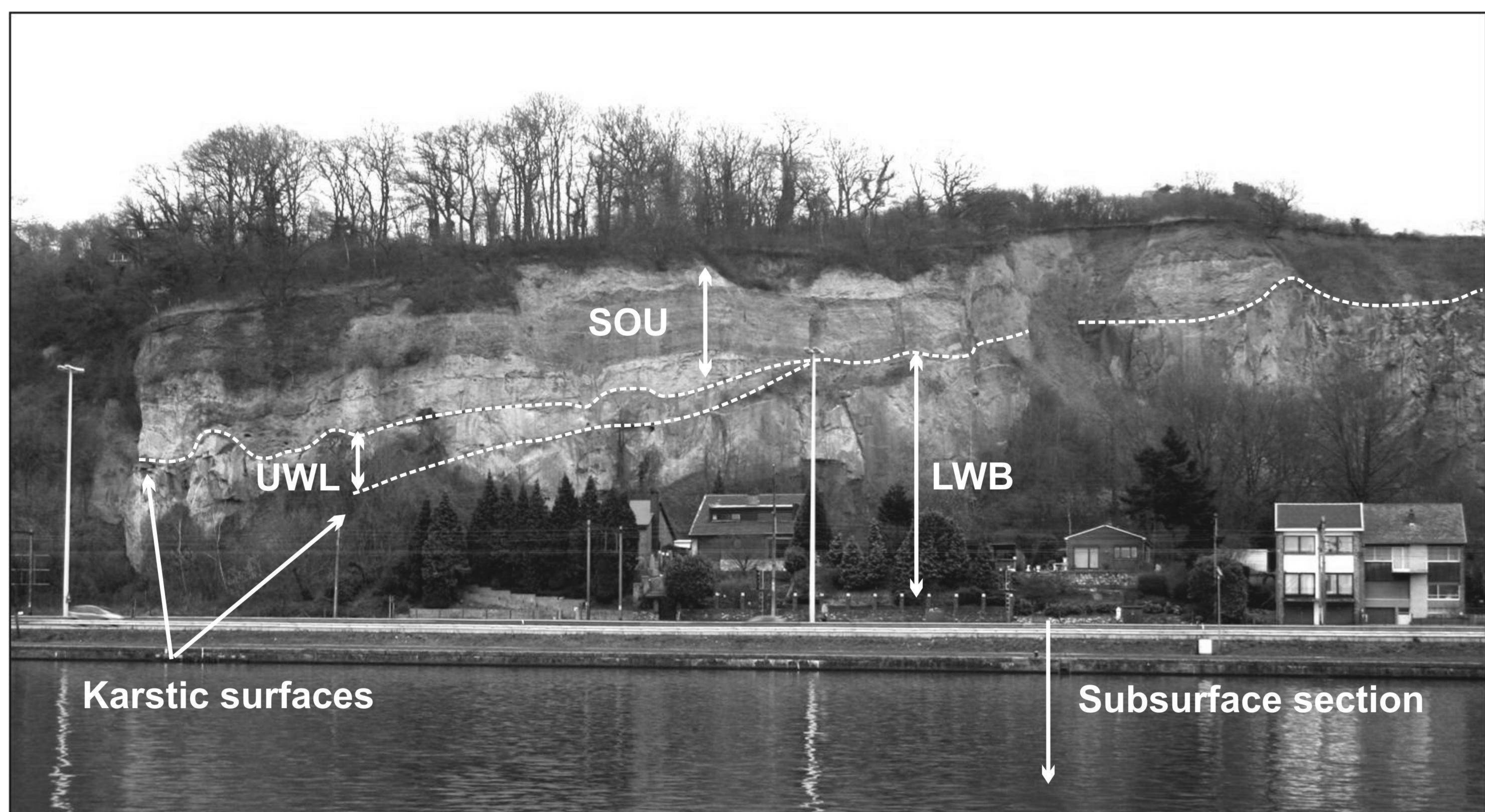


Fig. 7: Visé "F-G" quarry. SOU: Souvré Fm (silicified limestone and shale), UWL: upper Warnantian off-reef limestone and dolostone of the Visé Fm, LWB: Lower Warnantian bioherm. Modified after POTY & DELCULÉE (2011).



### Lithostratigraphy and age

Visé Fm (uppermost Ivorian to upper Warnantian, with many stratigraphic gaps), Souvré Fm (Lower Namurian - E2).

### Description

The Visé quarries are the historical type locality for the Viséan (due to the quality and abundance of its fossils) but the base of the stage cannot be located here. The Visé Fm is a complex formation with a thickness varying locally from zero to several hundreds of meters due to the syn-sedimentary tectonics of the area (POTY 1982, 1991, 1997; POTY & DELCULÉE, 2011). BARCHY & MARION (2000) and POTY et al. (2002) recognized four main facies in the Visé Fm:

(1) sedimentary limestone breccias with centimetric to pluri-decamic blocks of Frasnian age ("cyclopean breccia");

(2) thick-bedded packstone to rudstones forming pluri-decimetric to metric parasequences often beginning with brecciated level, fining-upward and ending with laminated levels corresponding to calciturbidites.

(3) thick-bedded packstone to rudstones beds;

(4) massive buildups (microbial-metazoan reefs) composed of light grey microbial boundstones with abundant macrofossils (mainly brachiopods) resembling the Cracoan Facies of the British Isles (ARETZ & CHEVALIER 2007).

This last facies, exposed in the quarry "F" - "G", has yielded the famous Visé fossils, extracted during the 19<sup>th</sup> century. The unit is locally topped by yellowish dolomitized limestone, and capped with silicified shales and limestones (lydites or "phtanites") of the Souvré Fm (Fig. 7).

### Interpretation

The limestones of the Visé quarries were deposited on the Hermalle-sous-Argenteau tectonic block of Poty (1991), close to a cliff of Frasnian limestone corresponding to another block (Souvré Block). The Hermalle-sous-Argenteau block is limited southwards by the Booze-Le-Val-Dieu high, and is open northwards to the Maastricht graben. The continuous erosion of the Souvré cliff resulted in the deposition of the cyclopean breccia during the Viséan (POTY 1991, 1997). The palaeogeography (including tectonics) and the sequence stratigraphy of the Visé area have been re-interpreted recently by POTY & DELCULÉE (2011). The lower Warnantian microbial buildup (Fig. 7) corresponds to the highstand of sequence 9 of HANCE et al. (2001), whereas the silicified limestone and shale of the Souvré Fm correspond to the sequence 10 (POTY & DELCULÉE 2011).

### Biostratigraphy

The microbial buildup belongs to the MFZ14 Foraminifer zone, RC7 $\beta$  Coral Subzone; the overlying levels belong to the MFZ15 and RC8 Zones.

### Main faunal component

#### Visé Fm (upper part), Warnantian, RC7 $\beta$

*Bradyphyllum rotiphylloides*

*Cyathaxonia cornu*

*Rotiphyllum rushianum*

*Rotiphyllum* sp.

*Pentaphyllum* sp. B

*Caninia* sp.

*Caninia* aff. *cornucopiae*

*Viseaulina singularis*

*Amplexus coralloides*

*Amplexocarinia* cf. *muralis*

*Koninckophyllum* sp.

*Aulokoninckophyllum ubaghsi*

*Siphonophyllia samsonensis*

*Kizilia gregaria*

*Kizilia* cf. *conccavitabulata*

*Kizilia* sp.

*Palaeosmilia murchisoni*

*Clisiophyllum keyserlingi*

*Dibunophyllum bipartitum*

*Amygdalophyllum* sp. D

*Axophyllum densum*

*Axophyllum lonsdaleiforme*

*Axophyllum expansum*

*Axophyllum pseudokirsopianum*

*Axophyllum* aff. *kirsopianum*

*Gangamophyllum densitabulatum*

*Semenoffia viseensis*

"*Botrophyllum*" sp.

*Merlewoodia* sp. D

*Pareynia splendens*

*Solenodendron furcatum*

*Siphonodendron pauciradiale*

*Siphonodendron kleffense*

*Siphonodendron scaleberense*

*Siphonodendron martini*

*Siphonodendron irregulare*

*Lithostrotion vorticale*

*Siphonodendron intermedium*

*Lithostrotion decipiens*

*Lithostrotion mccoynum*

*Diphyphyllum lateseptatum*

*Diphyphyllum furcatum*

#### Visé Fm (top), Uppermost Viséan, RC8:

*Lonsdaleia* (*Actinocyathus*) *floriformis floriformis*

*Cyathaxonia rushiana*

N.B.: There are hints that these latter corals could also occur in layers today attributed to the Souvré Formation.



STOP D1-2 - DOLHAIN RAILROAD  
SECTION

References

LALOUX et al. (1996b)

Location and access

The new Dolhain section cut in 2010 and is situated 2.2 km north of the centre of Dolhain town, along the western railway trench (Fig. 8). Vesdre Area, Vesdre-Aachen sedimentation are (VASA).

Lithostratigraphy and age

Dolhain Fm, Hastière Fm, Pont d'Arcole Fm, Landelies Fm (Hastarian).

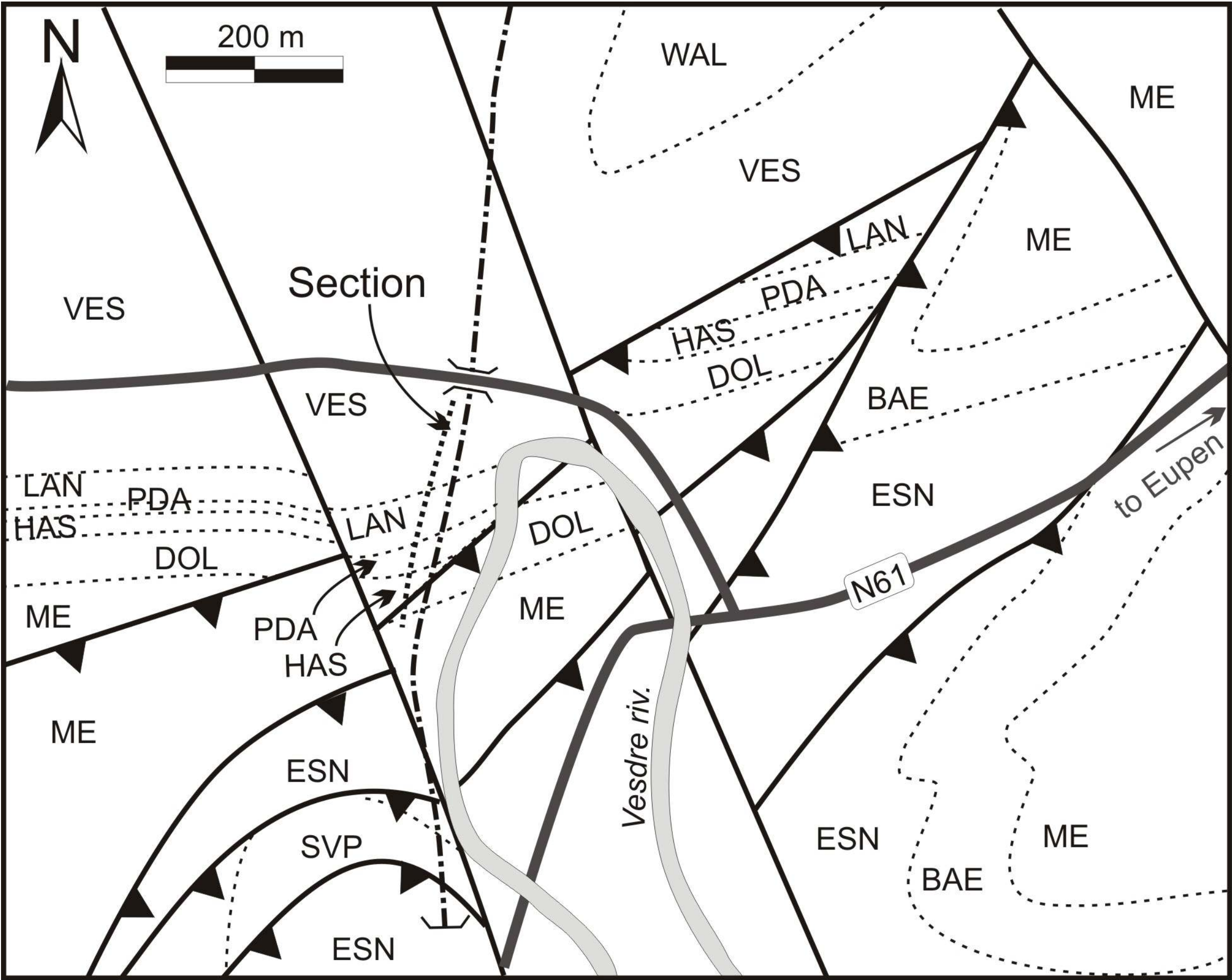
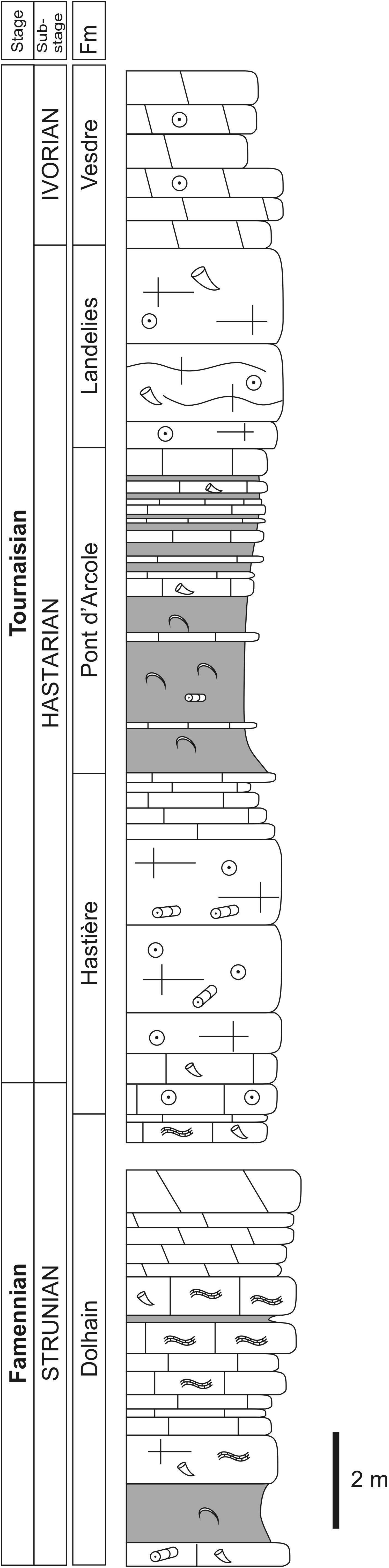


Fig. 8: Geological map of the Dolhain-Limbourg area with the location of the Dolhain section. Legend: see Fig. 10. Modified after LALOUX et al. (1996b).

Description

This section begins with the top of the Strunian Dolhain Fm and the base of the Tournaisian Hastière Fm, highly tectonised. The upper part of the Hastière Fm is mainly composed of thick bedded crinoidal packstone with few corals and brachiopods. The transition to the overlying Pont d'Arcole Fm is marked by the appearance of centimetric to decimetric shale beds. The argillaceous sediments rapidly increase in quantity and thickness. The Pont d'Arcole Fm is shaly to silty and shows numerous limestone nodules often containing fossils, among which large *Uralinia*. The silty shale contains also bioclastic levels very rich in fossils including brachiopods (*Spiriferina peracuta*), bryozoans and trilobites. The Landelies Fm begins at the top of the last decimetric shale bed. The limestone shows facies similar to the Hastière Fm but the beds are thicker and richer in macrofossils. Long *Siphonophyllia rivagensis* are





**Fig. 9 (previous page): Lithostratigraphic log showing the units cropping out along the Dolhain section. Modified after LALOUX et al. (1996b)**

particularly abundant (LALOUX et al. 1996b). The upper part of the formation is slightly dolomitized. (Fig. 9).

### Interpretation and Biostratigraphy

See STOP D1-6, Rivage section.

### Main faunal component

Pont d'Arcole Fm, Hastarian, RC1y:

*Uralinia lobata*

Landelies Fm, Hastarian, RC2:

*Siphonophyllia rivagensis*

## STOP D1-3 - TROOZ QUARRY

### References

CONIL et al. (1986)

HERBIG & WEBER (1996)

LALOUX et al. (1996a)

WEBER (2000)

ARETZ & CHEVALIER (2007)

POTY (2007b)

### Location and access

Section on the upper bench of the Trooz quarry, on the northern bank of the Vesdre River (Fig. 10). Eastern part of the Namur sedimentation area (NSA) or transitional zone to the Vesdre-Aachen sedimentation area (VASA).

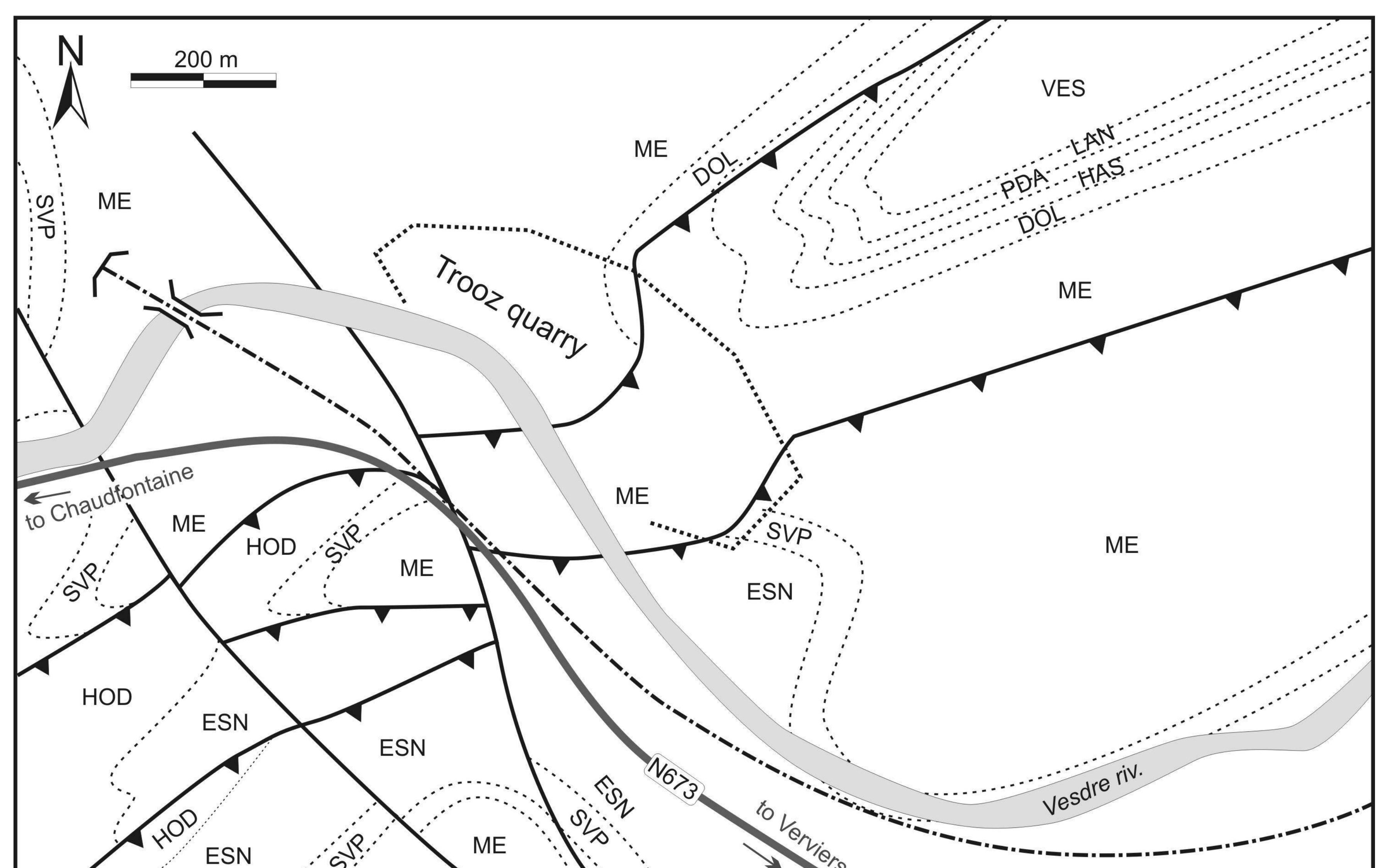
### Lithostratigraphy and age

Souverain-Pré, Montfort, Evieux and Dolhain Fms, (lower Upper to Uppermost Famennian).

### Description

On the visited bench, the upper part of the Dolhain Fm and the transition to the Tournaisian are cut by a fault. The base of the section exposes the Upper Famennian siliciclastics of the Evieux Fm, made of sandstone and siltstone with plant remains, paleosoils with dolomite and green shale (LALOUX et al. 1996a). The Dolhain Fm grades into a succession of small siliciclastics-carbonates cycles in which the carbonate proportion of each cycle increases upward. Within the carbonate part, two small 0.5 m-thick stromatoporoids biostromes occur (Fig. 11). The stromatoporoids developed on bioclastic, crinoidal packstone-grainstone rich in tabulate and solitary rugose corals, brachiopods, bryozoans, trilobites, algae, foraminifera, ostracods, and stemmed echinoderms. The biostromes s.s. are mainly lamellar or domal stromatoporoid bindstones, but few syringoporid or amphiporid bafflestones are also present (POTY 2007b). Sediment or sparry calcite-filled cavities are common. Moreover, large solitary corals ("*Palaeosmilia*", *Campophyllum*), syringoporids and *Pseudochaetetes* are in living position and often encased in argillaceous sediments (Fig. 12). The diversity of stromatoporoids is high (10 genera after WEBER, 2000), as well as the rugose corals (5 genera) and other organisms as stemmed echinoderms and trilobites.

**Fig. 10: Geological map of the Trooz quarry. Legend: HOD: Hodimont Fm, ESN: Esneux Fm, BAE: Baelen Fm, SVP: Souverain-Pré Fm, ME: Monfort-Evieux Gp, DOL: Dolhain Fm, HAS: Hastière Fm, PDA: Pont d'Arcole Fm, LAN; Landelies Fm, VES: Vesdre Gp, WAL: Walhorn Mbr. Modified after LALOUX et al. (1996a).**





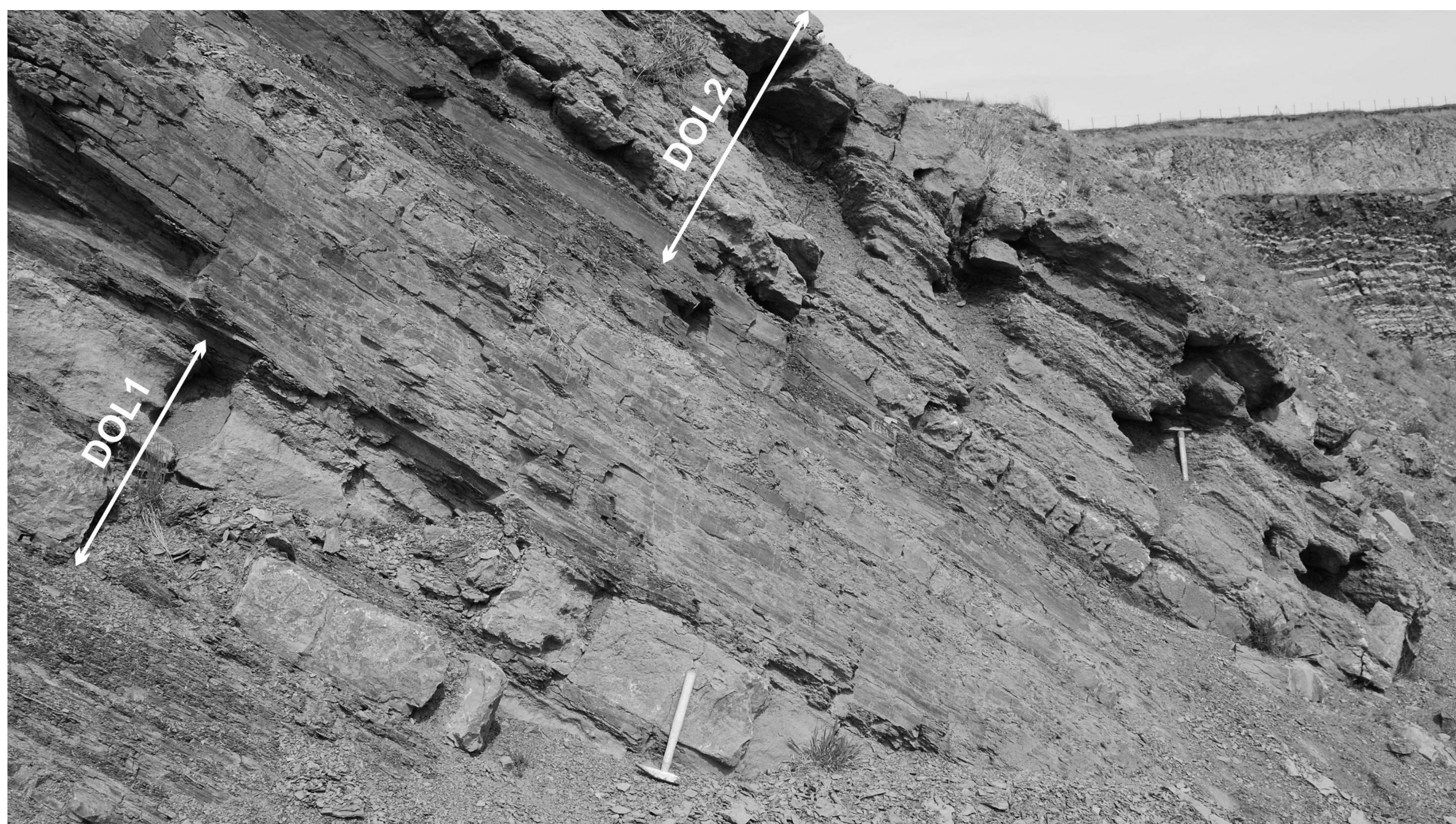


Fig. 11: First and second stromatoporoids biostromes (DOL1, DOL2) of the Dolhain Fm in the Trooz quarry (hammers for scale).

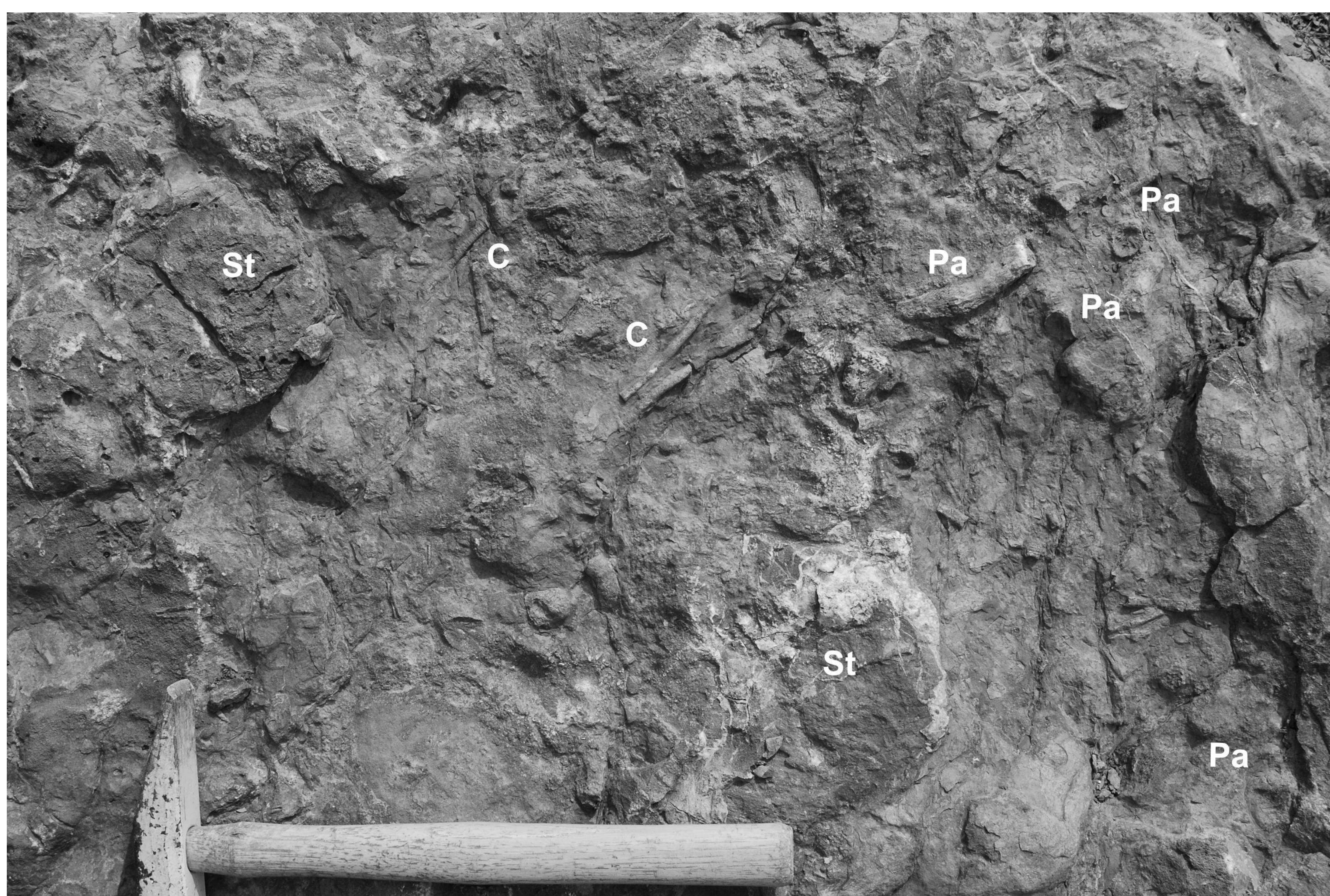


Fig. 12: Weathered uppermost bedding surface of the second biostrome of the Dolhain Fm showing stromatoporoids (St) and rugose corals ("Palaeosmilia" aquisgranensis, Pa) in living position and long fragments of crinoid stems (C), hammer for scale.

### Interpretation

Strunian biostromes constituted the first appearance of stromatoporoids after their demise during the Late Frasnian, but also their last occurrence before their extinction with the Hangenberg event (ARETZ & CHEVALIER 2007). The abundance and diversity in these biostromes varies in the individual section, but also between sections. The increase of the carbonate content during the Strunian is attributed to the climatic warming following the Early-Middle Famennian cooling, and to a third order transgression (sequence 1 of HANCE et al., 2001). The biostromal facies corresponds to the fair-weather zone depositional environment marked by episodic argillaceous inputs probably linked to climatic cycles (POTY 2007b).

### Biostratigraphy

Dolhain Fm is included in the DFZ7 of POTY et al. (2006), corresponding to the Df3ε zone of CONIL et al. (1977). The coral fauna is typical of the RC0β of

POTY et al. (2006). The shale intercalations have yielded typical LV zone spores (PAPROTH et al. 1983, THOREZ et al. 2006).

### Main faunal component

Dolhain Fm, Uppermost Devonian, RC0:

"Palaeosmilia" aquisgranensis

"Dibunophyllum" praecursor

"Clisiophyllum" omaliusi

Campophyllum flexuosum

stromatoporoids

syringoporids

## STOP D1-4 - RIVAGE RAILWAY AND ROAD SECTION

### References

POTY (1981)

CONIL et al. (1986)

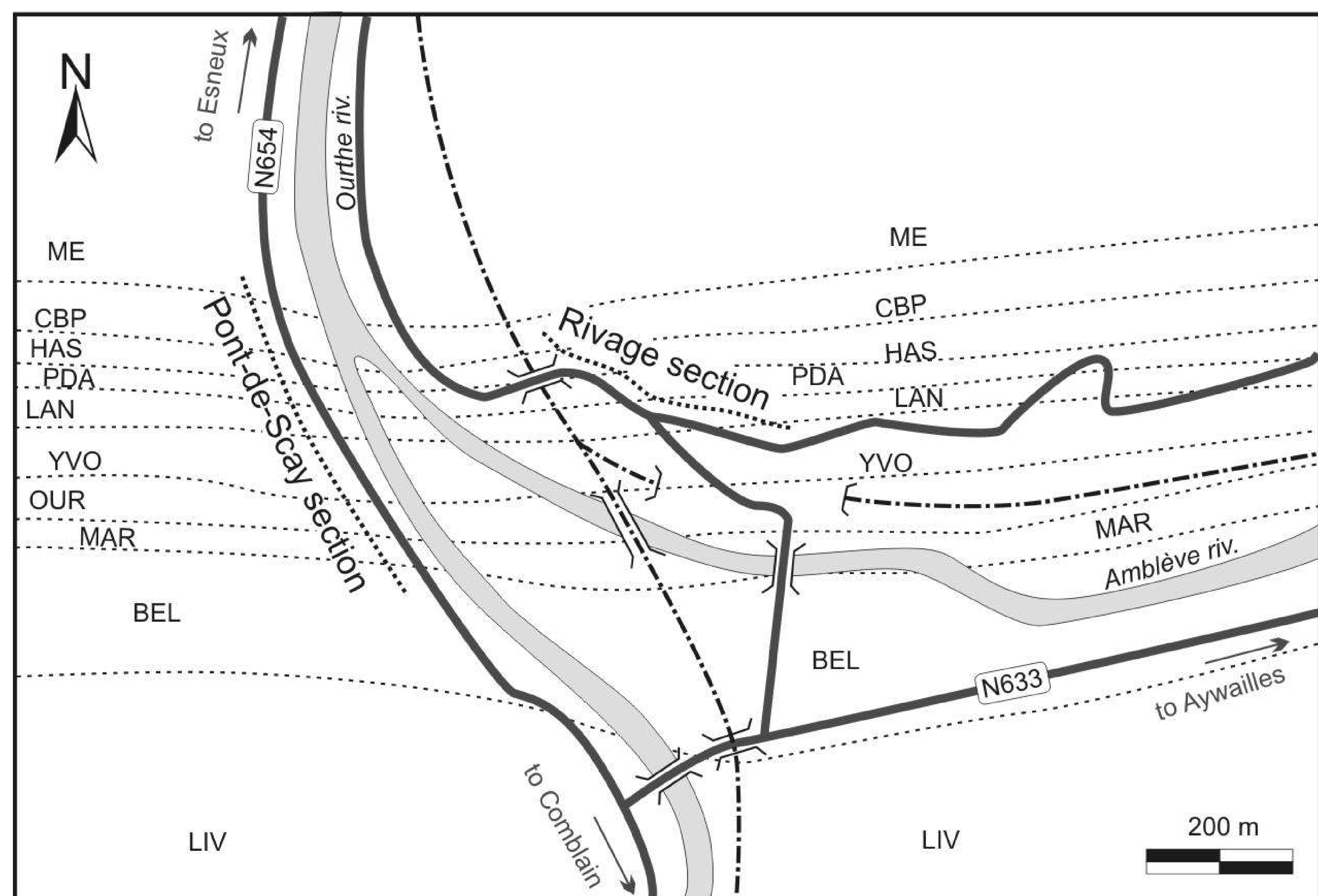
POTY et al. (1991)

POTY & BOLLAND (1994)

DEVUYST et al. (2005)



Fig. 13: Geological map of the Comblain-au-Pont area with the location of the Rivage (D1-4) and Pont de Scay (D1-5) section. Legend: ME: Monfort-Evieux Gp, CBP: Comblain-au-Pont Fm, HAS: Hastière Fm, PDA: Pont d'Arcole Fm, LAN: Landelies Fm, YVO: Yvoir Fm, OUR: Ourthe Fm, MAR: Martinrive Fm, LON: Longpré Fm, BEL: Belle-Roche breccia, LIV: Lives Fm. Modified after BELLIÈRE & MARION (in press).



#### Location and access

Railway cutting and road section between the Rivage train station and the Pont-de-Scay village, on the eastern bank of the Ourthe River (Fig. 13). Eastern part of the Condroz Sedimentation Area (CSA). Only the road section will be visited.

#### Lithostratigraphy and age

Hastière (mid. and upper members), Pont d'Arcole Formation and Landelies Fms. All are Hastarian.

#### Description

The section in the railway trench exposes the top of the Evieux Fm (late Famennian), the Comblain-au-Pont Fm (latest Famennian, lateral equivalent of the Dolhain Fm) and the lower member ("Tn1b $\alpha$ ") of the Hastière Fm. These units are better exposed in the Pont-de-Scay section (STOP D1-5).

The section (Figs. 14, 15) along the road begins with the middle member of the Hastière Formation ("Tn1b $\beta$ ") consisting of thick-bedded crinoidal packstones and grainstones. The upper member ("Tn1b $\gamma$ ") consists of some metres of thin-bedded limestone. The succeeding 10 metres-thick Pont d'Arcole Fm (Fig. 14) consists mainly of greenish to black shales. The carbonate content decrease progressively from the base to the middle part of the formation then increases towards the top, and thin-bedded crinoidal limestone beds occur. The formation is highly fossiliferous, especially in parts with carbonate concentrations. The fauna comprises bryozoans, crinoids, syringoporids, partly dissolved rugose corals and brachiopods including the guide *Spiriferina peracuta*.

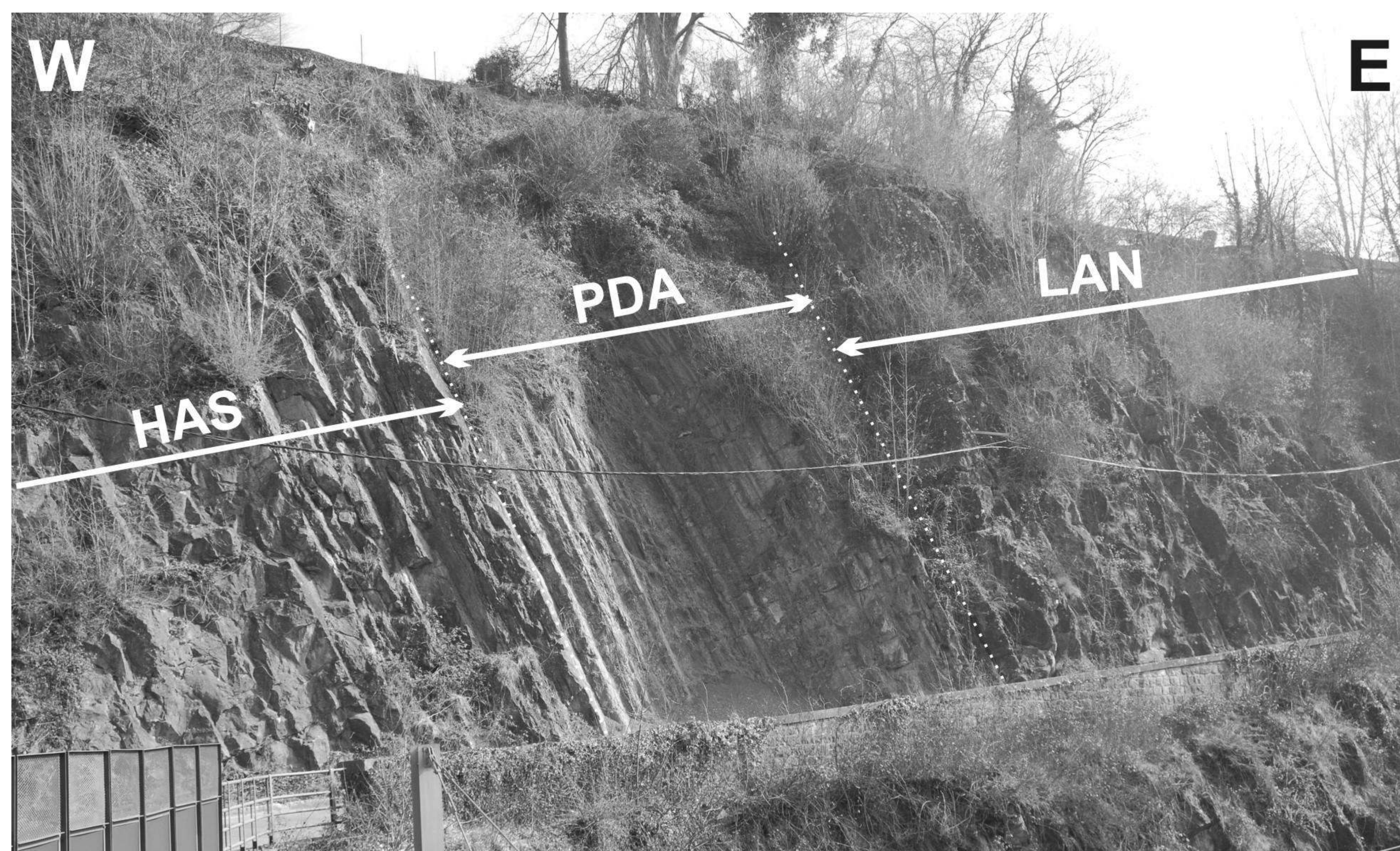


Fig. 14: Rivage road section showing the upper member of the Hastière Fm (HAS), the Pont d'Arcole Fm (PDA) and the base of the Landelies Fm (LAN).



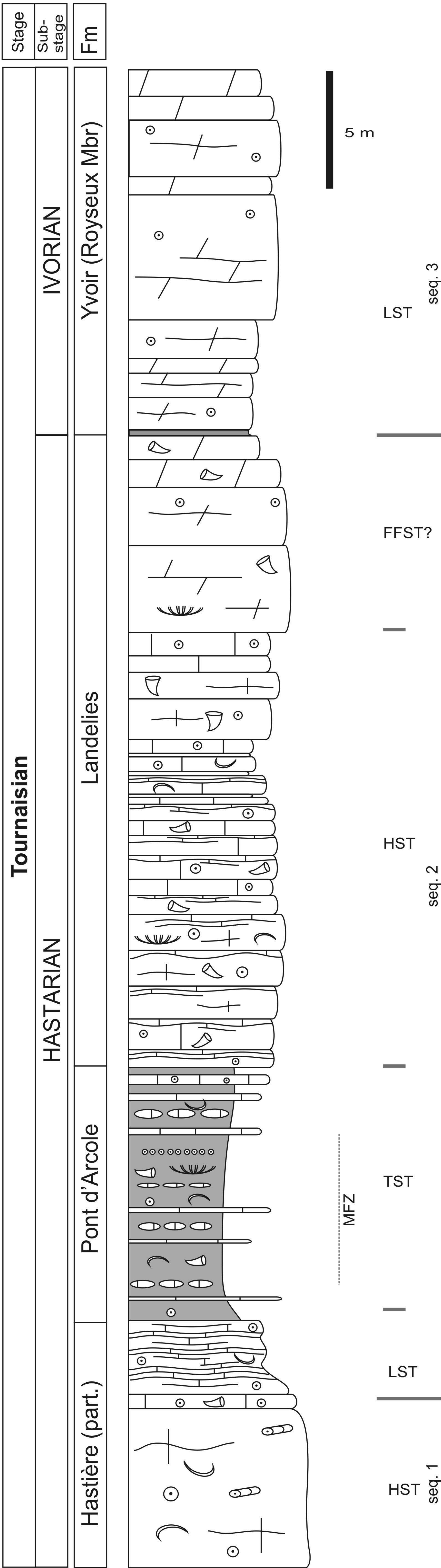


Fig. 15: Lithostratigraphic log of the Rivage road section and interpretation of the sequence stratigraphy.

The Pont d'Arcole Fm is topped by bedded limestones of the Landelies Fm. An alternation of thick-bedded, often nodular limestone with thin dark calcareous shale horizons characterises the lower part of the Fm. The limestones consist of crinoidal-peloidal packstones to grainstones, which are rich in rugose corals (mainly *Siphonophyllia rivagensis*) and brachiopods. The upper part of the Fm is dolomitized (Royseux Mbr) passing to the cherty limestone of the Yvoir Fm. (Figs. 14, 15).

**Interpretation**

The entire Comblain-au-Pont Fm and the lower Mbr of the Hastière Fm form the TST of the first third-order sequence of HANCE et al. (2001). Thus the Hangenberg-Event is only a short-termed perturbation and may correspond to a single sequence of higher order. The HST-FSST of the sequence 1 is recorded in the middle Mbr of Hastière Fm. The upper member and the Pont d'Arcole Fm form the LST and the TST, and the Landelies Fm the HST-FSST of the sequence 2 (Fig. 15).

The Pont d'Arcole Fm is correlated with the Lower Alum Shale Event of Germany. Similar facies for the sequence 2 are known through Western Europe and South China.

**Biostratigraphy**

The Hastarian is thought to coincide with the range of the siphonodellid conodonts from the entry of *S. sulcata*. Unfortunately, the oldest Siphonodellid representatives are lacking everywhere in Belgium in the lower part of the Hastière Fm (DEVUYST et al. 2005). The foraminifers biozones MFZ1, MFZ2 and MFZ3 are identified respectively in the lower and middle members of the Hastière Fm, from the upper member of the Hastière Fm to the lower part of the Landelies Fm and in the upper part of the latter. The rugose corals biozones RC1 and RC2 correspond respectively to the Hastière Fm and to the Pont d'Arcole and Landelies Fms (POTY et al. 2006).

**Main faunal components**

Hastière Fm, Hastarian, RC1 $\beta$ - $\gamma$ :

*Coniophyllum priscum*

*Coniophyllum streeli*

Pont d'Arcole Fm, Hastarian, RC1 $\gamma$ :

*Uralinia lobata*

*Cyathaxonia cornu*

*Syringopora* sp.

Landelies Fm Hastarian, RC2:

*Eostrotion tortuosum*

*Salelasma delepinei*



*Siphonophyllia cylindrica*  
*Siphonophyllia rivagensis*  
*Uralinia lobata*

STOP D1-5 - PONT-DE-SCAY (RIVAGE W)  
ROAD SECTION

References

CONIL (1968)  
GROESSENS (1975)

Location and access

Ourthe valley, eastern part of the Condroz Sedimentation Area (CSA). Road embankment along the road from Esneux to Comblain-au-Pont, on the western bank of the Ourthe River (Fig. 13). This section is the equivalent of the Rivage road section (STOP D1-5) but it exposes a larger stratigraphic range.

Lithostratigraphy and age

Evieux Fm, Comblain-au-Pont Fm, Hastière Fm, Pont d'Arcole Fm (badly exposed), Landelies Fm (discontinuous outcrop), Yvoir Fm, Ourthe Fm, Martinrive Fm and Belle-Roche Breccia Fm (Fig. 16). Upper Famennian to lower Ivorian.

Description

The top of the Evieux Fm is mainly made of greyish to greenish shale and sandstone with plant remains. The base of the Comblain-au-Pont Fm is defined at the top of the last massive sandstone bed. The marine character of the Comblain-au-Pont Fm is progressively marked. The lower part of the Fm consists of an alternation of crinoidal limestone and grey micaceous shale with small plant remains. Up-section, the limestone beds become dominant, the bed thickness increases and the facies is usually a crinoidal to bioclastic grainstone-packstone, more or less sandy or argillaceous (CONIL 1968). The fauna is abundant: brachiopods, tabulate and rugose corals, crinoids and stromatoporoids. The base of the Hastière Fm is defined with the first meter-thick bed of limestone. The facies is unchanged but the last Strunian fauna (quasiendothyrids, *Cryptophyllus* ostracods) are found in this first bed. The Hastière, Pont d'Arcole and Landelies formations are exactly the same than in the Rivage section but badly exposed. The Yvoir Fm begins with 30 m of pale grey dolostone and dolomitic limestone with rare brachiopods, crinoids and corals (Royseux Mbr). The upper 50 m of the formation is not that strongly dolomitized and presents numerous cherts in

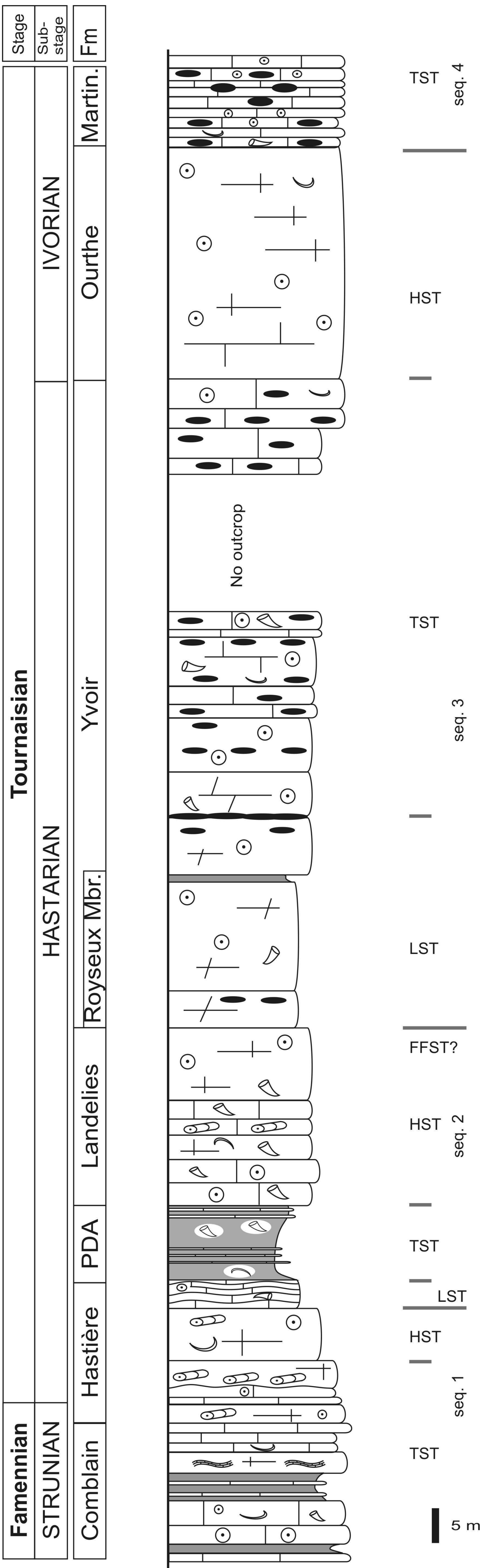


Fig. 16: Lithostratigraphic log of the Pont-de-Scay (Rivage W) road section with interpretation of the sequence stratigraphy.



nodules and beds. The dominant facies varies from crinoidal grainstone to bioclastic and peloidal packstone. The fossils are more abundant. The overlying Ourthe Fm is a massive thick-bedded crinoidal limestone ("*Petit-Granit de l'Ourthe*") made of homogenous crinoidal grainstone with few brachiopods and small solitary rugose corals. The boundary with the Martinrive Fm is not exposed. The last formation shows the same crinoidal packstone-grainstone with cherts than the Yvoir Fm but is usually richer in fossils, especially in small rugose corals. Only the first 16 m of the Martinrive Fm are exposed.

Chicken-wire structures are abundant in the lower part of the formation. The southern part of the section is discontinuous but small exposures of dolostone of the Flémalle Mbr (Longpré Fm) and of the Belle-Roche Breccia are visible southward.

### Interpretation

Comblain-au-Pont, Hastière, Pont d'Arcole and Landelies Fm are interpreted in the previous section (STOP D1-5 Rivage). Thus, the interpretation continues here with the Yvoir Fm. The Royseux Mbr dolomite corresponds to the HST-FSST of the sequence 2 and the rest of the Yvoir Fm forms the TST of the following sequence 3 capped by the Ourthe Fm interpreted as a crinoidal shoal and submarine dunes and attributed to the HST 3 (DEVUYST et al. 2005).

The sequence 4 begins with the transgressive Martinrive Fm in which the upper part is often cut by an erosive surface marking the base of the dolomitized Flémalle Mbr (HST4). This latter formation passes to the oolitic limestone of the Avins Mbr, forming the "highest" system tract and FSST of the sequence 4 and has been recognized worldwide by the development of cosmopolitan fauna ("*Avins event*" of POTY 2007a).

### Main faunal components

#### Comblain-au-Pont Fm, Uppermost Devonian, RC0:

*"Palaeosmilia" aquisgranensis*  
*Campophyllum flexuosum*  
 syringoporids  
*Yavorskia* sp.  
 stromatoporoids

#### Hastière Fm, Hastarian, RC1α-γ:

*Coniophyllum streeli*  
*Coniophyllum priscum*

#### Pont d'Arcole Fm, Hastarian, RC1γ:

*Uralinia lobata*  
*Cyathaxonia cornu*  
*Syringopora* sp.

#### Landelies Fm, Hastarian, RC2:

*Eostrotion tortuosum*

*Saleelasma delepinei*

*Siphonophyllia cylindrica*

*Siphonophyllia rivagensis*

#### Yvoir Fm, Ivorian, RC3α:

*Uralinia multiplex*

*Caninophyllum patulum*

#### Ourthe Fm, Ivorian, RC3β:

*Cyathaxonia cornu*

*Sychnoelasma konincki*

micelinids

## STOP D1-6 - LA PREALE QUARRY

### References

POTY et al. (1991)

### Location and access

Quarry along the road from Chanxhe to Sprimont in the Ourthe valley (Fig. 17). Eastern part of the Dinant Synclinorium, eastern part of the Condroz Sedimentation Area (CSA).

### Lithostratigraphy and age

Yvoir Fm (top), Ourthe Fm ("*Petit-Granit de l'Ourthe*" building stone), Martinrive Fm and lower part of the Flémalle Mbr (Longpré Fm), the latter being partly dolomitized. All are Ivorian.

### Description

The upper part of the Yvoir Fm consists of cherty crinoidal packstone to grainstone. The Ourthe Fm is a 35 m-thick. It consists of a massive thick-bedded crinoidal limestone ("*Petit-Granit de l'Ourthe*", Fig. 17, 18) made of homogenous crinoidal grainstone with few brachiopods, micelinids and small solitary rugose corals (first 5 m are partly dolomitized).

It is overlain sharply by the Martinrive Fm composed of thin-bedded mudstone and wackestone with numerous cherts and quartz and/or calcite nodules with chicken-wire structure (pseudomorphs of anhydrite). The Flémalle Mbr is a thick-bedded crinoidal limestone secondarily dolomitized, containing also nodules pseudomorph of anhydrite.

### Interpretation

The Yvoir and the Ourthe Fms correspond respectively to the TST and HST-FSST of the Ivorian sequence 3. The Martinrive Fm is the LST (?) and the TST, and the Flémalle Mbr the lower part of the HST of the Ivorian sequence 4. The Ourthe Fm is interpreted as a crinoidal shoal forming locally submarine dunes colonized by abundant but poorly diversified fauna (Fig. 20).



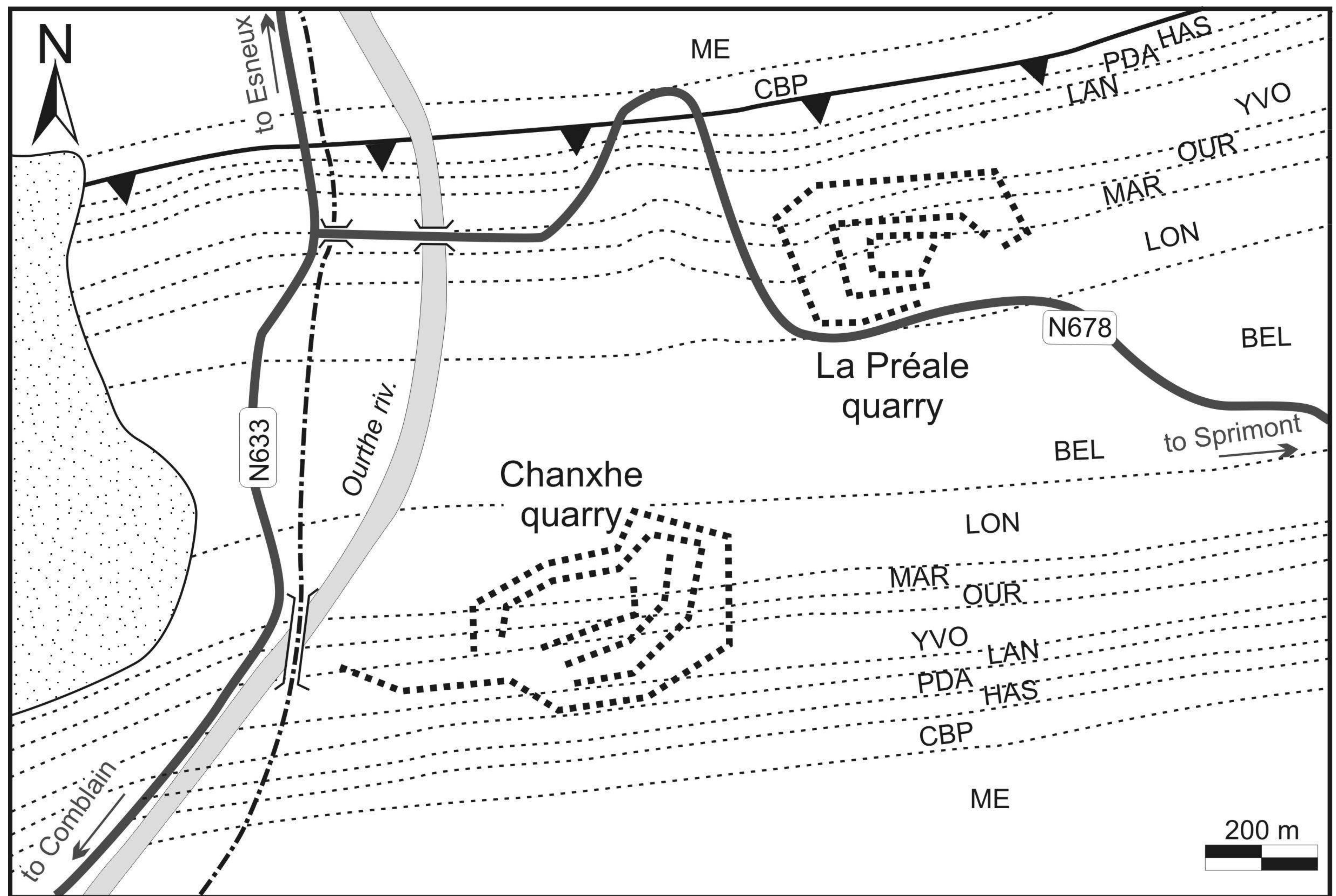


Fig. 17: Geological map of the Chanxhe area with the location of the La Préale quarry. Legend: see Fig. 13. Modified after BELLIÈRE & MARION (in press).

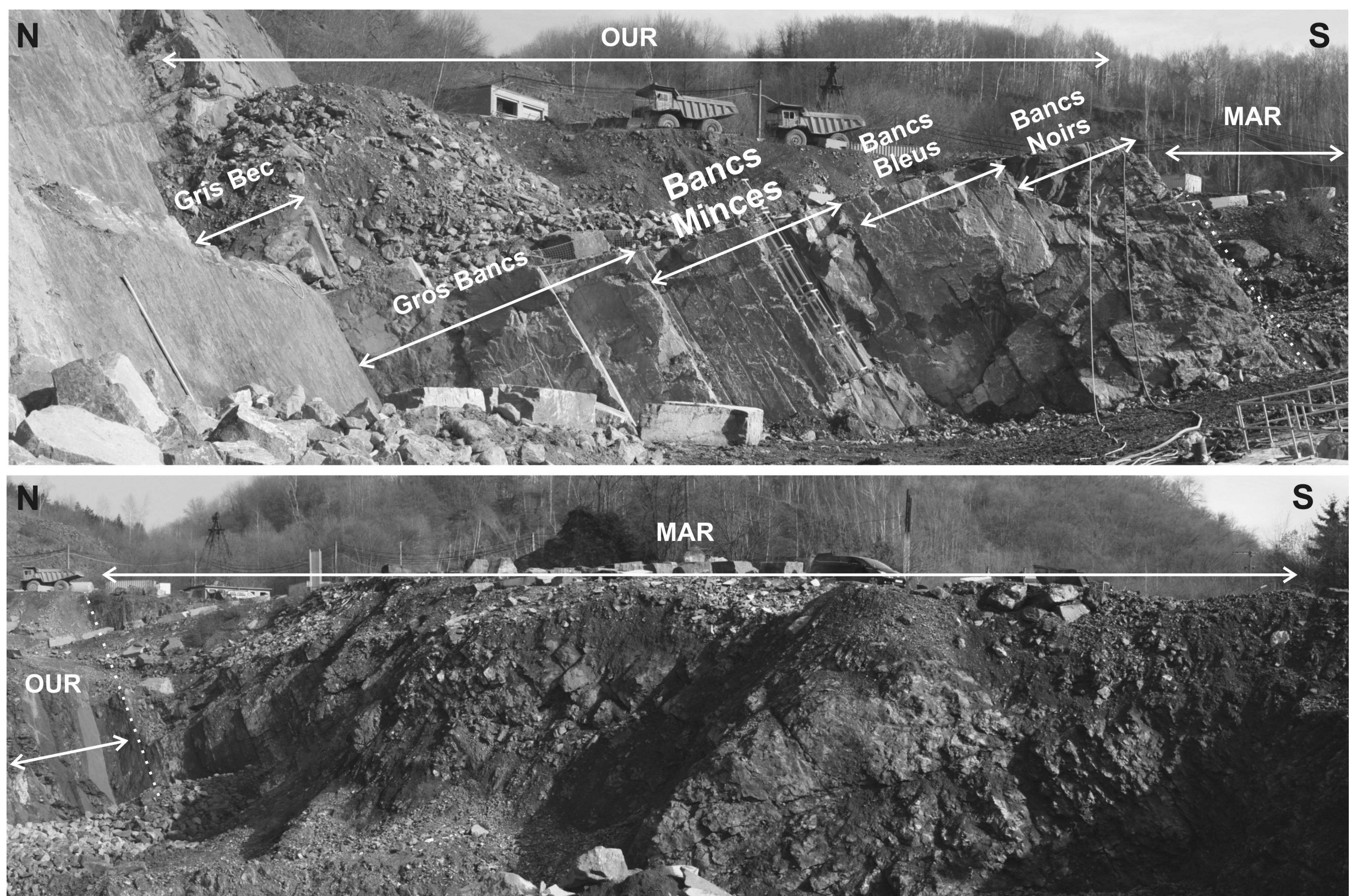


Fig. 18: Northern cliff of the La Préale quarry with the different units quarried as the "Petit Granit de l'Ourthe" building stone (Ourthe Fm, OUR) and the overlying Martinrive Fm (MAR).



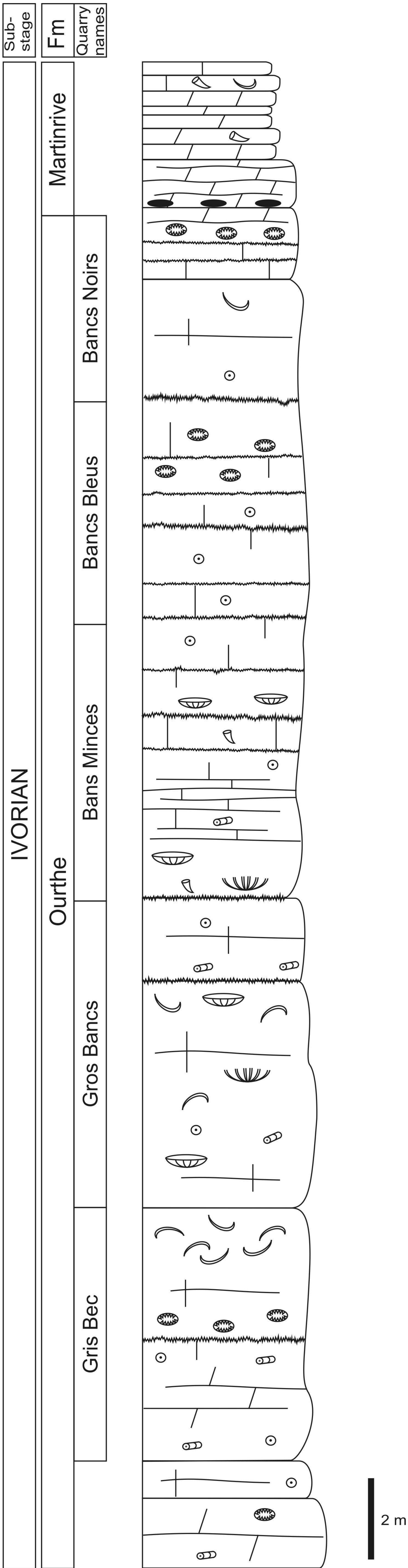


Fig 19: Detailed log of the Ourthe Fm, with the names of the different quarried units.

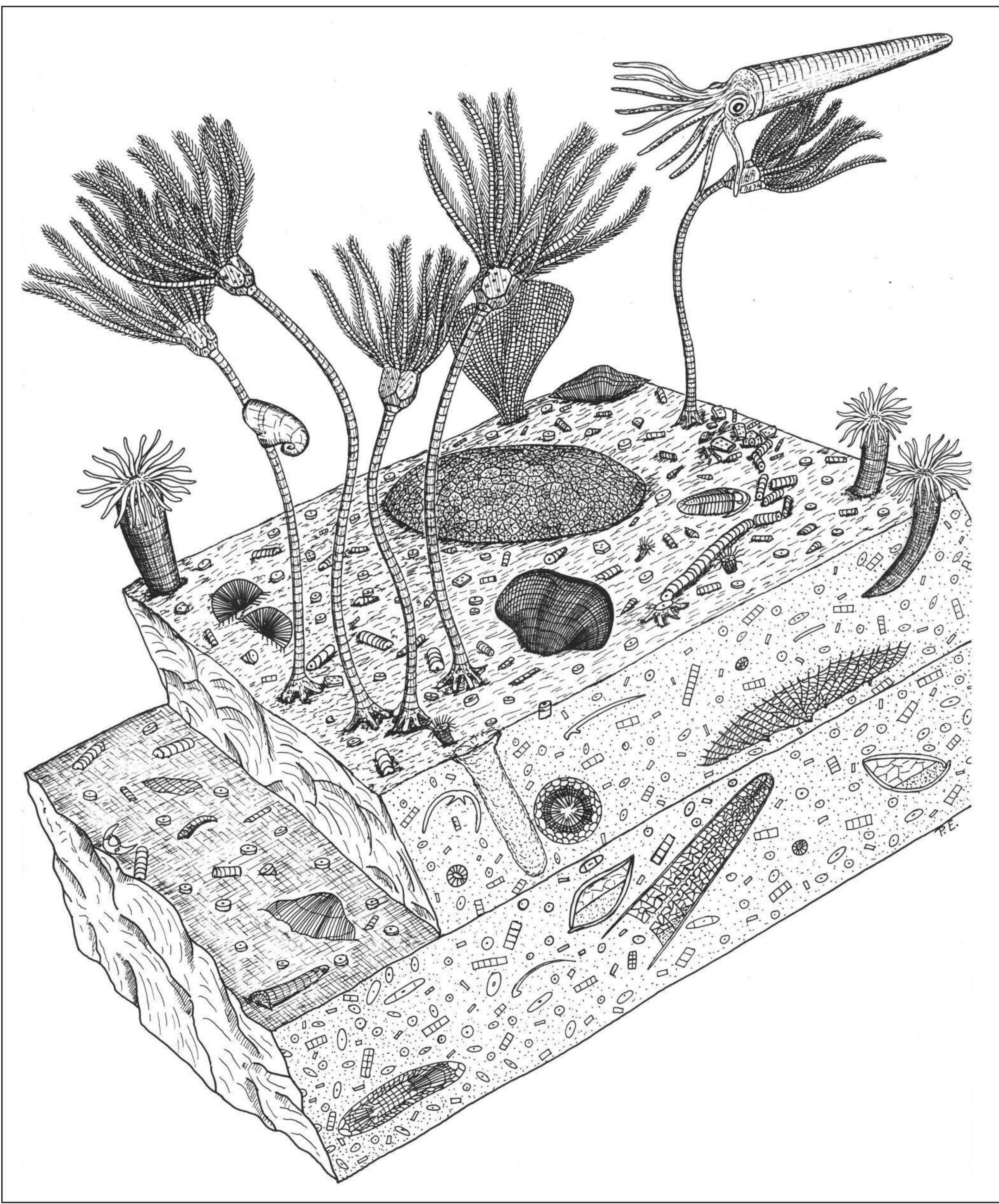


Fig. 20: Reconstruction of the "Petit Granit" community and depositional environment of the Ourthe Fm. The main components are: crinoids, michelinids, Siphonophyllia, Cyathaxonia, productids, spiriferids and chonetids brachiopods. Occasional dwellers are: Platyceras (gastropod), trilobites and Rayonoceras.

**Biostratigraphy**

The foraminiferal content of the Yvoir Fm indicates MFZ4-MFZ5 and the corals belong to the RC3 $\alpha$  zone. The Ourthe Fm is included into MFZ5 and RC3 $\beta$  zones, the Martinrive Fm into MFZ6 and RC3 $\gamma$  and the Flémalle Mbr into MFZ7 and RC4 $\alpha$  zones.

**Main faunal components**

Yvoir Fm, Ivorian, RC3 $\alpha$ :

- Caninophyllum patulum*
- Siphonophyllia cylindrica*
- Cyathoclisia* aff. *soshkinae*

Ourthe Fm, Ivorian, RC3 $\beta$ :

- Sychnoelasma* sp.
- Caninophyllum patulum* (very rare)
- Cyathaxonia cornu*
- Zaphrentis* cf. *delanouei*
- michelinids (*Turnacipora* sp.)

Martinrive Fm, Ivorian, RC3 $\gamma$ :

- Caninia* aff. *cornucopiae*
- Caninophyllum* sp.
- Cravenia rhytoides*
- Gen. et sp. nov. C

Flémalle Mbr, Ivorian, RC4 $\alpha$ :

- Cyathoclisia modavensis*
- Sychnoelasma hawbankense*



## STOP D2-1 - ROYSEUX (CHABOFOSSE) TRENCHES

### References

- PIRLET (1964, 1968)  
 POTY (1981)  
 POTY et al. (1988, 1991)  
 ARETZ (2001, 2002)  
 POTY & HANCE (2006b)

### Location and access

Royseux is situated in the Hoyoux Valley, about 3 km upstream of Pont-de-Bonne. The section Royseux I crops out along the western bank of the Hoyoux River and the section Royseux II along the road from Pont-de-Bonne to Huy (Fig. 21). Two other sections exist on the hill east of Royseux II corresponding to two trenches duged in the late 1990's and named Royseux III A and B. Only these two latter sections are rich in macrofossils of the RC7 $\beta$  Coral Subzone and will be visited. Central part of the CSA, northern limb of the Dinant Synclinorium.

### Lithostratigraphy and age

Bonne Fm (Poilvache Mbr) and Anhée Fm. Upper Viséan (Warnantian substage), RC7 $\alpha$  and RC7 $\beta$ .

### Description

The bases of the sections expose the upper part of the Bonne Fm (Poilvache Mbr). It is composed of peloidal, stromatolitic and oncolitic limestones, which are organised in parasequences. The top of some sequences are formed by paleosols with

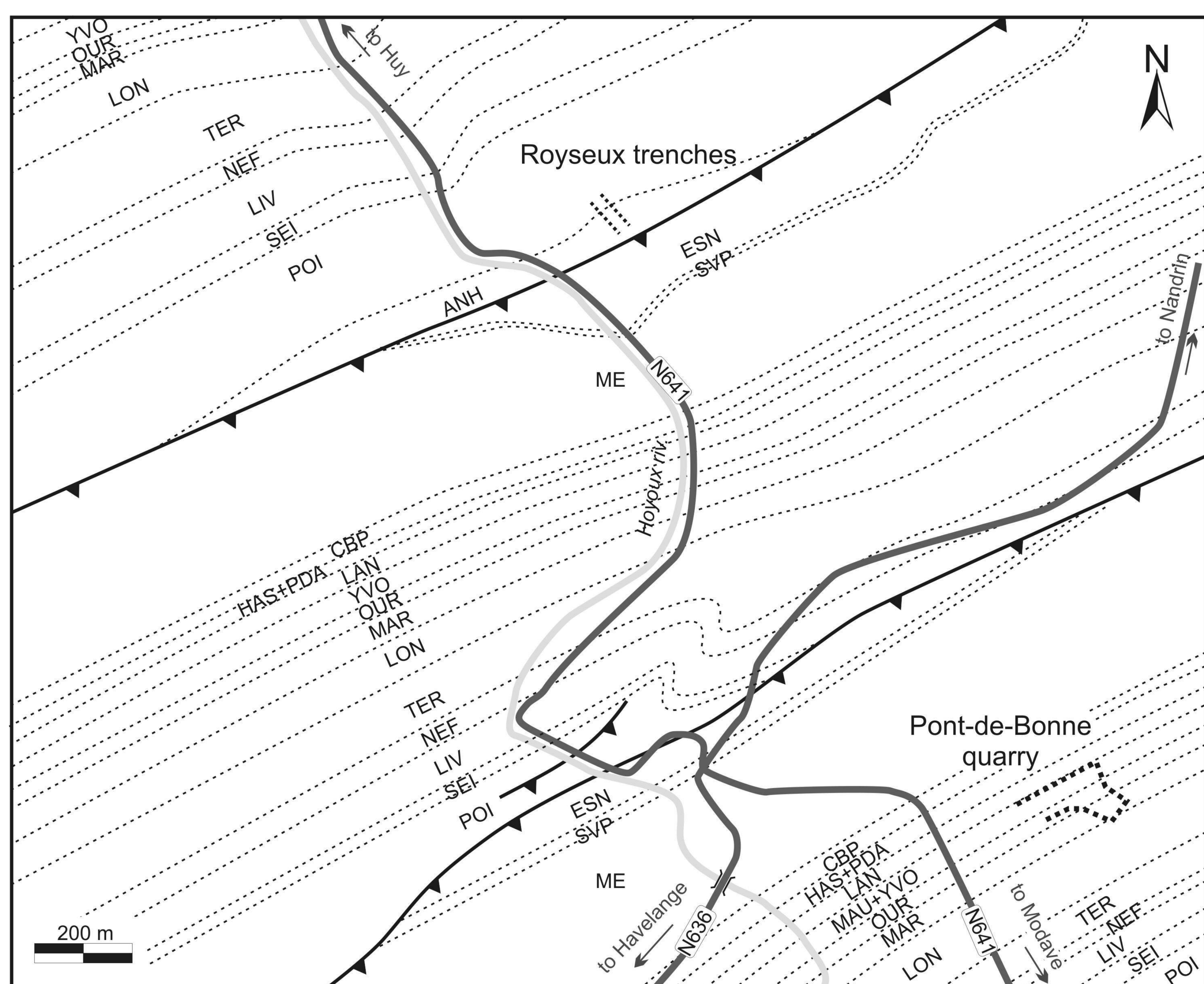
*Stigmaria* remains. Overall sequences show high lateral and vertical variations in relation to thickness and composition.

The base of the Anhée Fm is defined by a shift from the peloidal facies to the dominance of bioclastic facies. Following the nomenclature of Pirlet (1968), this change occurs at the base of sequence +2. Most parts of an individual sequence formed under full marine conditions, however some more restricted facies conditions may be formed locally on top. All sequences are shallowing upwards. The sequences show some differences to the general pattern.

The Royseux trenches expose an uncommon facies (Chabôfosse facies) of the Anhée Fm which is very limited laterally (Fig. 22). The first bed of the Anhée Fm is a coarse crinoidal pack/grainstone topped by a ca. 50 cm-thick coral horizon (Fig. 23). Its base is formed by a layer of *Siphonodendron junceum* and *Lithostrotion maccoyanum*, and is succeeded by a monospecific layer of *S. junceum*. The top of the horizon is significantly diversified, and contains syringoporids, *S. pauciradiale*, and the heterocoral *Hexaphyllia mirabilis*.

The coral horizon is topped by a bioclastic packstone, which contains at its base some coral fragments. Within few decimetres the grain sizes decreases, and the carbonate mud content increases. In the middle of sequence +2 bioclastic wackestones contain only few bioclasts (red algae, crinoids, and fenestellid bryozoans). Some pelecypods, trilobites and few ammonoids were found around this level.

Fig 21: Geological map of the Pont-de-Bonne area with the location of the Royseux outcrops (D2-1) and the Pont-de-Bonne ("Les Ornaïs") quarry (D2-2). Legend: ESN: Esneux Fm, SVP: Souverain-Pré Fm, ME: Monfort-Evieux Gp, CBP: Comblain-au-Pont Fm, HAS: Hastière Fm, PDA: Pont d'Arcole Fm, LAN: Landelies Fm, MAU: Maurenne Fm, YVO: Yvoir Fm, OUR: Ourthe Fm, MAR: Martinrive Fm, LON: Longpré Fm, LON: Longpré Fm, TER: Terwagne Fm, NEF: Neffe Fm, LIV: Lives Fm, SEI: Seilles Mbr, POI: Poilvache Mbr, ANH: Anhée Fm. Modified after BARCHY & MARION (in press, a).





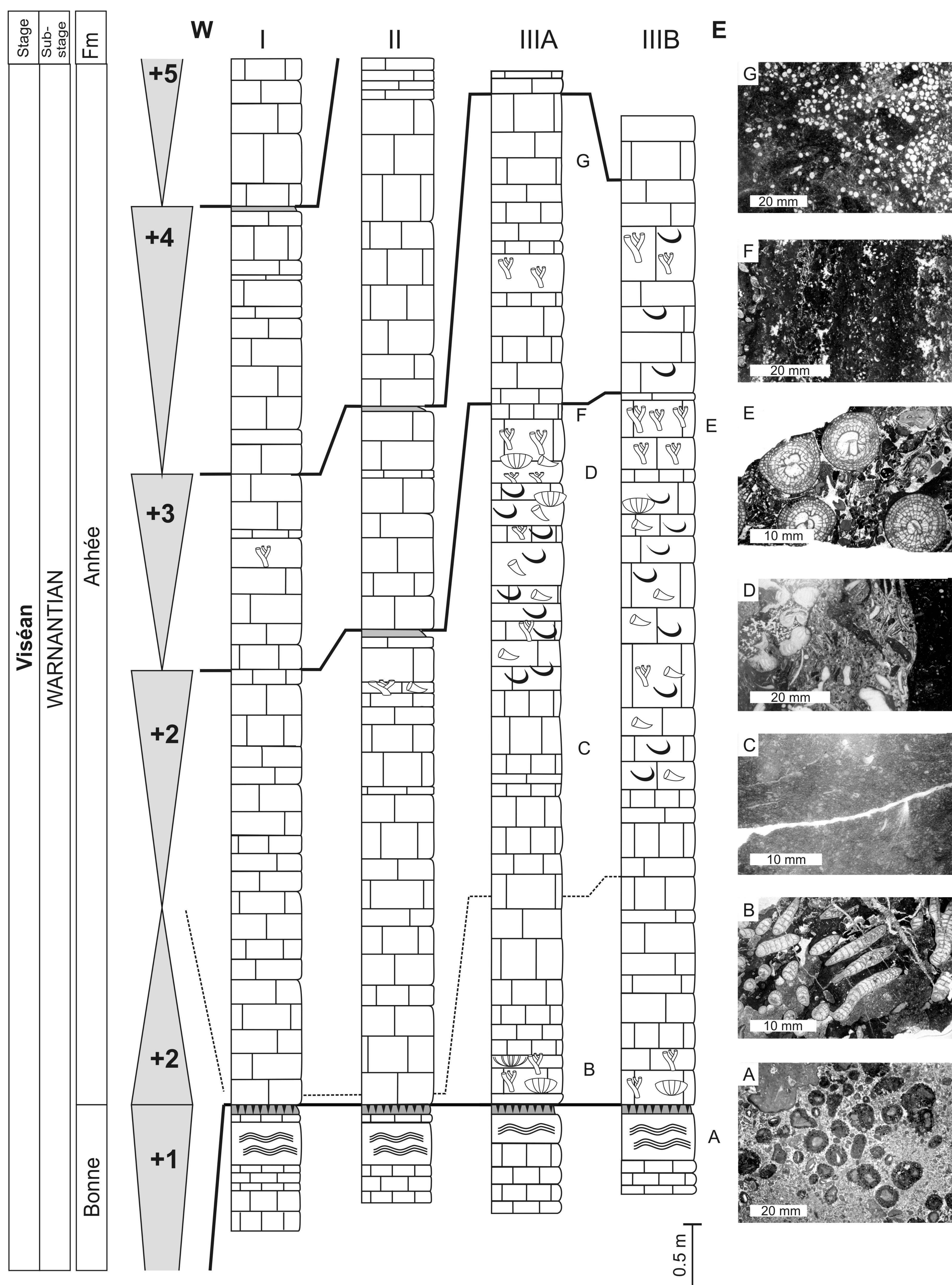


Fig. 22: Sections Royseux I - IIIB: Logs with indications of the sequences, main occurrence of macrofossils, and some representative facies types (after ARETZ et al. in press).

Sequence +3 starts with bioclastic wackestones and packstones containing small coral colonies. In its upper part *Saccaminopsis* wackestones are abundant. The top of sequence +3 is formed by small centimetre-scaled algal-heterocorals build-ups with local concentrations of microconchids.

The base of sequence +4 is the youngest strata exposed in the two trenches. It starts in both sections with bioclastic packstones.

Younger limestone beds occur discontinuously above the trenches and contain a coral fauna indicating the Brigantian (RC 8).



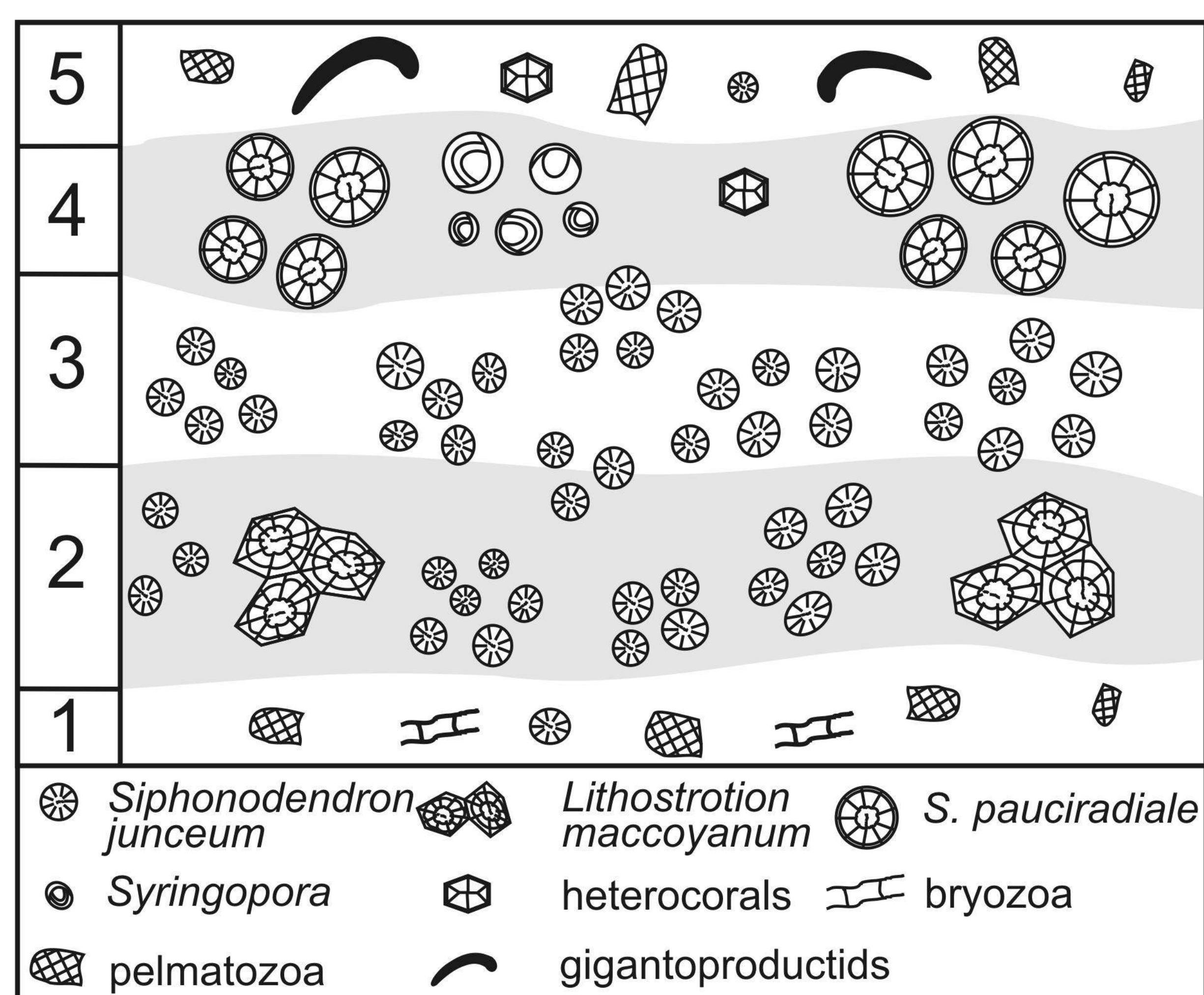


Fig. 23: Sketch of the lower coral horizon at the base of sequence +2 (from ARETZ 2001).

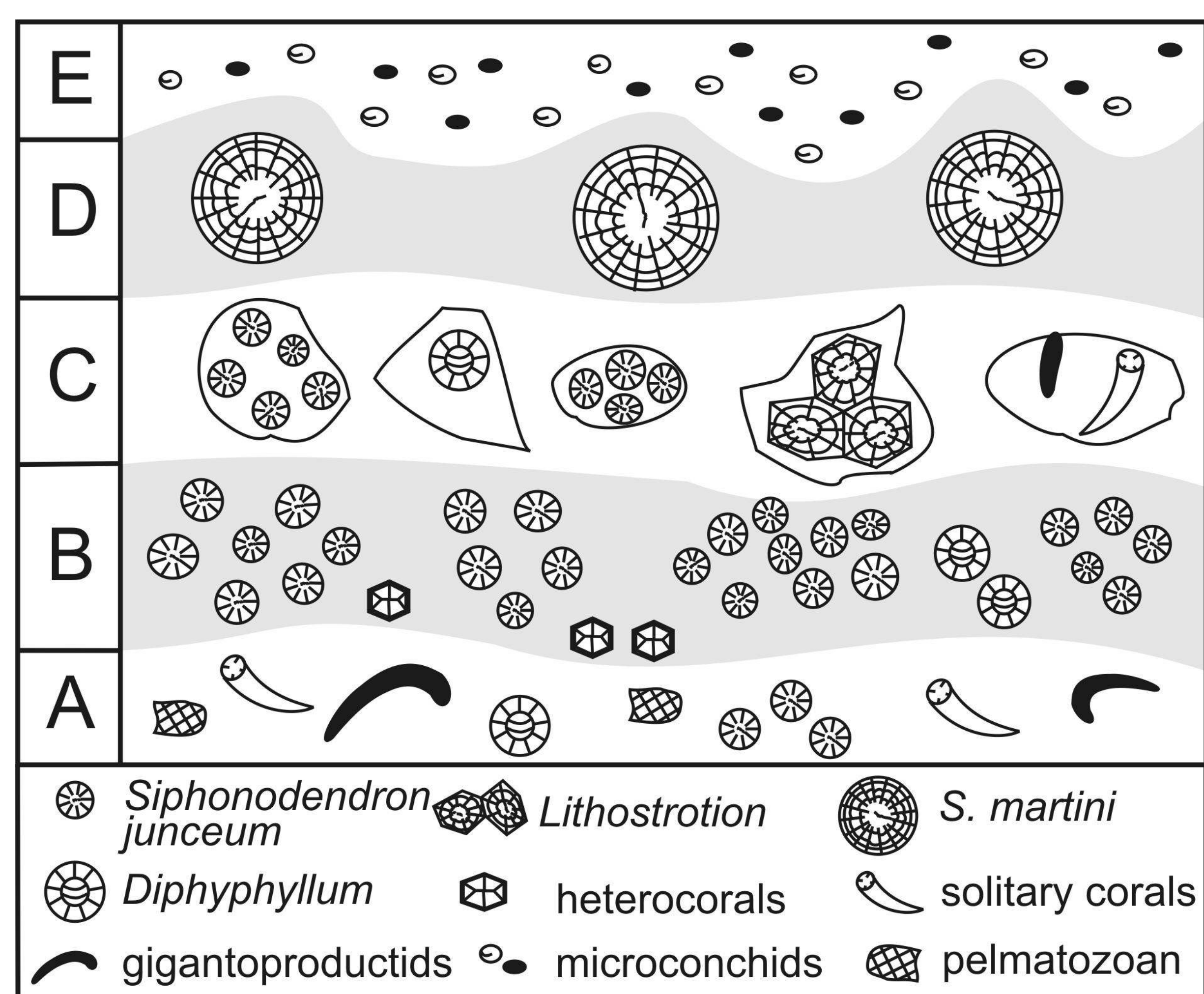


Fig. 24: Sketch of the upper coral horizon on top of sequence +2 (from ARETZ 2001).

### Interpretation

The very singular facies observed in the sections IIIA and IIIB (e.g. coral horizons, gigantoproductids beds, small algal build-ups) have no equivalents in the western sections I and II. ARETZ (2001, 2002) proposed a synsedimentary fault between sections II and IIIA to explain these differences, and thus a "deeper block" within the area of sections III A and B. The somewhat deeper position enabled the development of coral dominated facies at the base of sequence +2 during a time of non-deposition on "higher" blocks. The onset of sedimentation there is correlated with the mud-rich sediments in the middle part of sections IIIA and B.

ARETZ (2001, 2002) interpreted the first coral horizon as a polyspecific biostrome, which

immediately formed as a consequence of the availability of the new full marine habitats at the base of sequence +2. The regressive part of sequence +2 starts within the bioclastic wackestones. The facies rich in gigantoproductids is a typical level bottom community of Dinantian time and in this community solitary and colonial rugose corals occur in variable abundance. In the second coral horizon the development of the initial *Siphonodendron junceum* biostrome quickly ends with deposition of a conglomerate, interpreted as storm layer (hurricane?). Then a *Siphonodendron martini* meadow developed. All coral growth stopped when restricted facies conditions occurred, and microconchids flourished.

### Biostratigraphy

POTY et al. (1988) described from sequence 0 (uppermost part of the Poilvache Mbr) at Royseux an association of foraminifers, which contained *Bradyina rotula*, and thus indicates biozone MFZ14. The major part of the trenches IIIA and IIIB are included in the MFZ15. The base of the Anhée Fm coincides with the base of the rugose coral biozone RC7 $\beta$ , whereas the uppermost part of the section I represents the transition MFZ15-MFZ16 and contains *Lonsdaleia* and *Palastrea* thus indicating the biozone RC8. The foot of the hill below the sections IIIA and IIIB also yielded *Lonsdaleia* but the corresponding levels crop out very poorly.

### Main faunal components

Anhée Fm (Chabôfosse facies), Warnantian, RC7 $\beta$ :

*Siphonodendron martini*  
*Siphonodendron irregulare*  
*Siphonodendron intermedium*  
*Siphonodendron pauciradiale*  
*Siphonodendron junceum*  
*Lithostrotion vorticale*  
*Lithostrotion decipiens*  
*Lithostrotion maccoyanum*  
*Diphyphyllum furcatum*  
*Diphyphyllum lateseptatum*  
*Diphyphyllum fasciculatum*  
*Diphyphyllum maximum*  
*Aulophyllum fungites*  
*Arachnolasma* sp.  
*Clisiophyllum keyserlingi*  
*Clisiophyllum keyserlingi crassiseptatum*  
*Dibunophyllum bipartitum*  
*Palaeosmilia murchisoni*  
*Caninophyllum archiaci halkynense*  
*"Bothrophyllum" lateseptatum*  
*Koninckophyllum interruptum*  
*Koninckophyllum magnificum*  
*Siphonophyllia samsonensis*  
*Pseudozaphrentoides juddi*



*Haplolasma densum*  
*Axophyllum nanum*  
*Axophyllum densum*  
*Axophyllum pseudokirsopianum*  
*Rylstonia* cf. *benecompecta*  
*Guadatia* sp.  
*Heterophyllia ornata*  
*Hexaphyllia mirabilis*  
 syringoporids  
 multithecporids  
 chaetetids  
Anhée Fm (Chabôfosse facies), Uppermost Viséan, RC8:  
*Lonsdaleia* aff. *duplicata*  
*Palastrea* cf. *carbonaria*  
*Dibunophyllum bipartitum*

## STOP D2-2 - "LES ORNAIS QUARRY" AT PONT-DE-BONNE

### References

ARETZ et al. (in press)

### Location and access

"Les Ornaïs" quarry is situated southeast of the village of Pont-de-Bonne (Fig. 21), in the subvertical northern limb of a syncline within in the central part of the Dinant Synclinorium. Central part of the Condroz Sedimentation area.

### Lithostratigraphy and age

Maurenne, Yvoir, Ourthe, Martinrive Fms and Flémalle Mbr of the Longpré Fm (Ivorian).

### Description

The top of the Maurenne Fm, mainly composed of brownish to greenish calcareous shales, is exposed in the northern part of the quarry (Fig. 25). It contains some rugose corals.

The overlying Yvoir Fm begins at the top of the last thick shale bed and consists of a 33 m-thick unit of well-bedded dark cherty limestone (mainly packstone-grainstone), and of an upper 5.5 m-thick unit of massive light grey cherty limestone (grainstone). Corals and brachiopods are common in the formation and particularly in the upper massive bed (Fig. 26).

The Ourthe Fm is a 20 m-thick unit topping the Yvoir Fm, which consists of grey-blue, thick-bedded to massive crinoidal limestone (packstone to rudstone). This formation is still quarried for the production of building stones and "marble", known as "*Petit Granit de l'Ourthe*". The Ourthe Fm is well known for the abundance of crinoid ossicles which here are particularly abundant. Corals and brachiopods are present here but not as common as in the Ourthe area. Their diversity is low (Fig. 20).

The first few meters of the succeeding Martinrive Fm consist of dark cherty limestone with abundant calcite nodules with chicken-wire structure. The Martinrive Fm is 43.5 m-thick. The dominant lithofacies is a black cherty limestone (mudstone to wackestone), interbedded with some crinoidal packstone layers. The top of the formation is dolomitized but still contains cherts, contrarily to the overlying crinoidal dolostone of the Flémalle Member (Longpré Fm).



Fig. 25: View on the "Les Ornaïs Quarry" illustrating the exposed formations. Legend see Fig. 21.



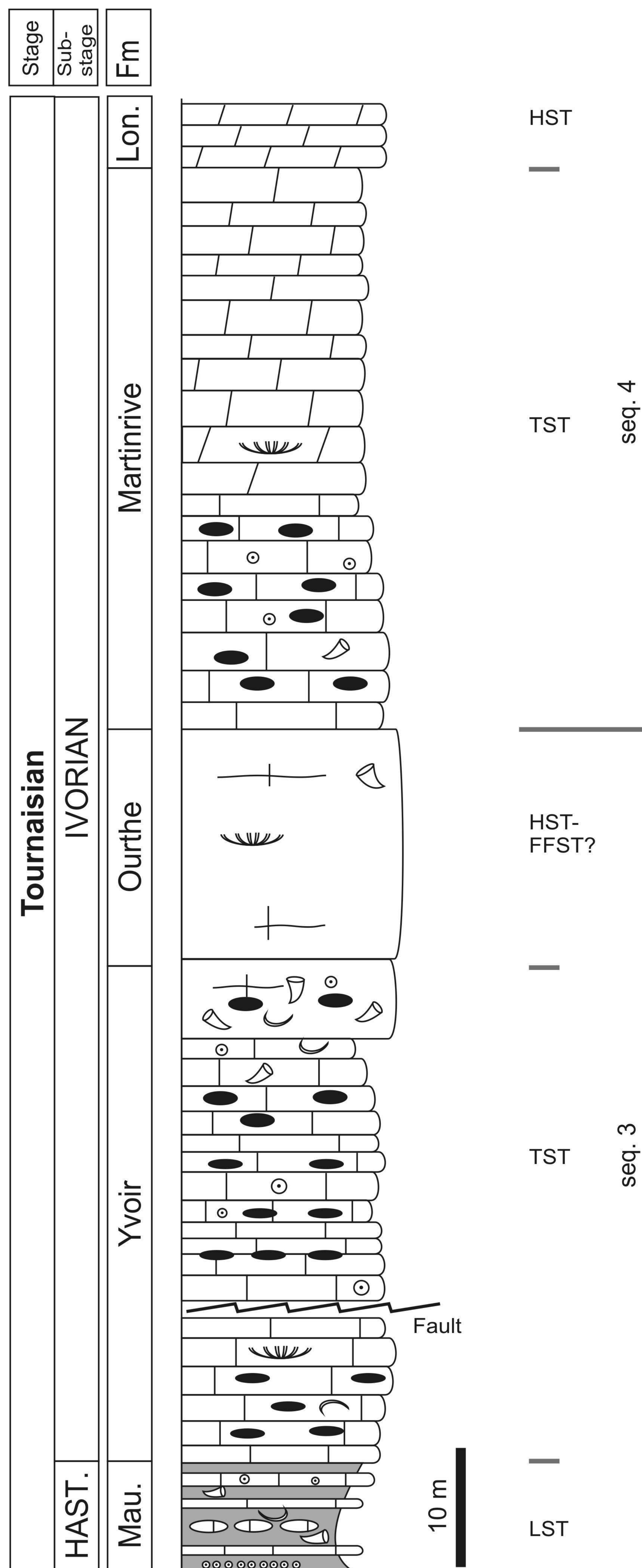


Fig. 26: Lithostratigraphic log of the Pont-de-Bonne quarry ("Les Ornaïs") showing the different units and their corresponding sequence stratigraphy equivalent (after ARETZ et al. in press).

### Biostratigraphy

Several carbonate layers of the shaly Maurenne Fm yielded foraminifers belonging to the MFZ4. The corals are typical of the RC2. The foraminifers of the Yvoir Fm indicate MFZ4-MFZ5 and the corals belong to the RC3 $\alpha$  zone. The Ourthe Fm is included in MFZ5 and RC3 $\beta$  zones, the Martinrive

to the MFZ6 and RC3 $\gamma$  and the Flémalle Mbr to the MFZ7 and RC4 $\alpha$  zones.

### Interpretation

The quarry section is the unique continuous insight into the Ivorian succession of the proximal facies of the central CSA. The presence of the Maurenne Fm regarded as restricted to the DSA (POTY et al. 2002) is an unusual feature and shows the transitional character of the central CSA during the early part of the Ivorian.

The Maurenne and Yvoir fms are interpreted respectively as LST and TST of sequence 3. This sequence culminates in the HST deposits of the Ourthe Fm. The marked facies change between the Ourthe and Martinrive formations from open-marine to restricted marine in combination with the irregular boundary surface clearly indicates the sequence boundary. The Martinrive Fm corresponds to the LST-TST and the crinoidal rudstones of the Longpré Fm HST deposits of sequence 4.

### Main faunal components

#### Maurenne Fm (top), Hastarian, RC2:

*Saleelasma delepini*  
*Caninia cornucopiae*  
*Caninia* sp.  
*Uralinia multiplex*

#### Yvoir Fm, Ivorian, RC3 $\alpha$ :

*Keyserlingophyllum obliquum*  
*Solenodendron* sp.  
*Siphonophyllia cylindrica*  
*Caninophyllum patulum*  
*Sychnoelasma konincki*

#### Ourthe Fm, Ivorian, RC3 $\beta$ :

*Cyathaxonia cornu*

### STOP D2-3 - GENDRON-CELLES RAILWAY SECTION

### References

- CONIL (1968)
- GROESSENS (1975)
- LEES et al. (1985)
- VAN STEENWINKEL (1990, 1993)
- DELCAMBRE & PINGOT (1993)
- LEES (1997)
- DEVUYST et al. (2005)

### Location and access

Section along the railway Dinant-Bertrix, 200 m north of the Gendron-Celles station, in the Lesse valley (Fig. 27). Dinant Synclinorium, southern part of the Dinant sedimentation area (DSA).



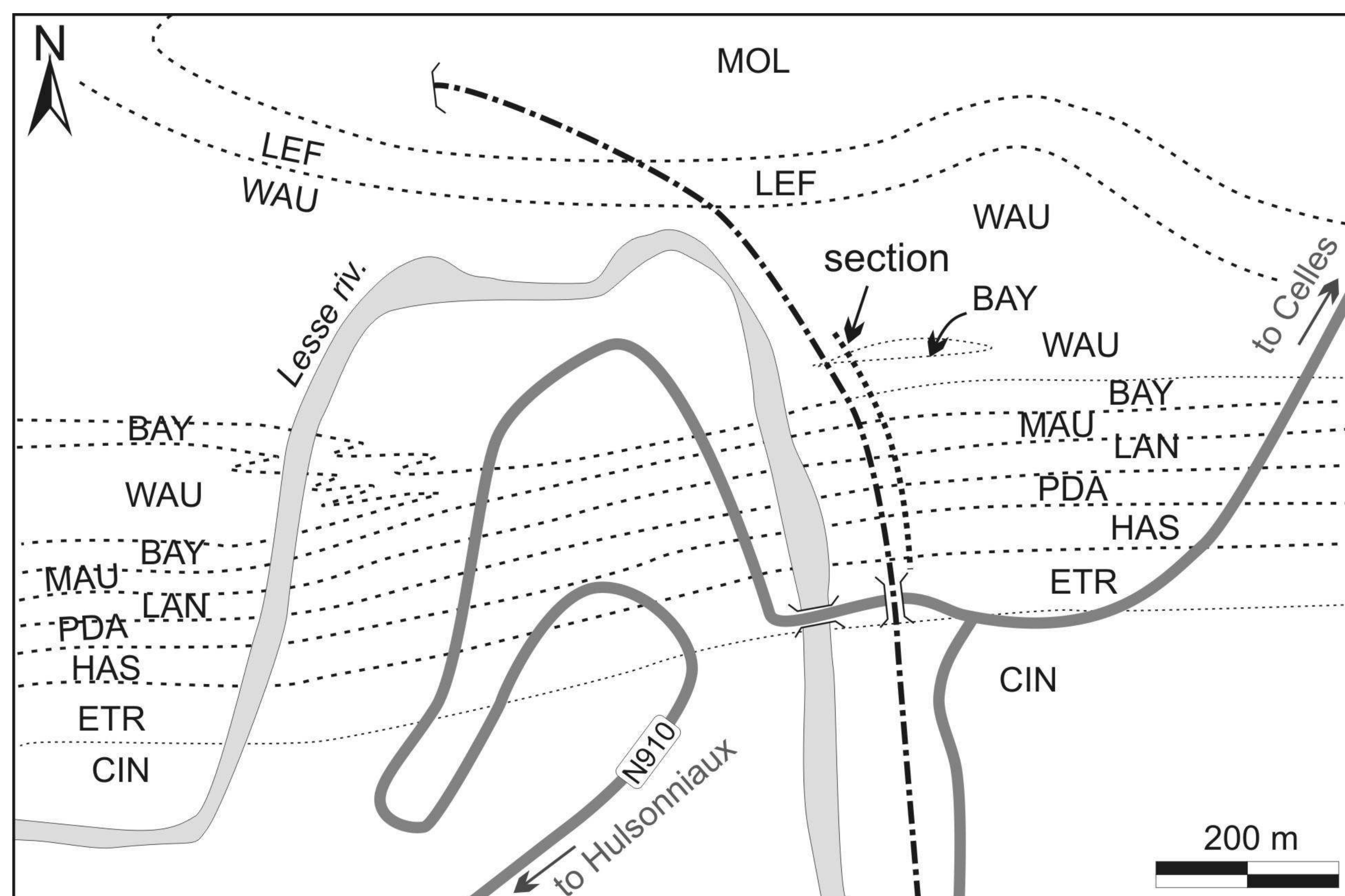


Fig. 27: Geological map of the Gendron area with the location of the Gendron-Celles railroad section. Legend: see Fig. 29. Modified after DELCAMBRE & PINGOT (1993).

### Lithostratigraphy and age

Etroeungt Fm (upper part), Hastière Fm, Pont d'Arcole Fm, Landelies Fm (bad outcrop), Maurenne Fm, Bayard Fm and Waulsort Fm (lower part). Strunian to lower Ivorian.

### Description

The section is almost continuous from the Strunian to the Ivorian. Except some levels hidden by the vegetation, the formations are well exposed.

The upper 15 m of the Etroeungt Fm consist of bioclastic and crinoidal limestones, nodular marly limestone and calcareous shale, usually very fossiliferous (crinoids, corals, brachiopods, trilobites, bryozoans). Up-section, the argillaceous content decreases progressively to the Hastière Fm (Fig. 28).

The lowermost bed of the Hastière Fm is a 2 m-thick massive crinoidal limestone containing reworked Strunian fauna at its base - including *Campophyllum* (VAN STEENWINKEL 1990). The lower member of the Hastière Fm (15 m) consists of pluridecimetre-thick crinoidal packstone interbedded with centimetre-thick shale beds. A 3 m-thick bed of crinoidal packstone/rudstone compose the middle member. The upper member (4 m) is similar to the lower one but shows more shale layers.

The first decimetre-thick shale package defines the base of the overlying Pont d'Arcole Fm. The latter consist of a 13 m-thick unit of calcareous shale and siltstone, usually dark, containing dissolved fossils (brachiopods: *Spiriferina peracuta*, bryozoan and crinoids). Some argillaceous limestone beds occur in the upper part of the formation.

The overlying Landelies Fm (38 m) begins with the first thick crinoidal pack-stone/grainstone bed

with abundant brachiopods and corals. Thick limestone beds alternate with thin calcareous shale interbeds in the lower part of the formation. The shale interbeds disappear in the upper part where the limestone beds become thicker.

The Maurenne Fm is abruptly resting on the last thick crinoidal limestone bed of the Landelies Fm. It consists of folded calcshale and argillaceous limestones containing shell layers with some small solitary rugose corals in the upper part. The formation is topped by a few beds of cherty argillaceous limestone.

The Bayard Fm begins with 20 m of well-stratified crinoidal limestone, dark grey or brownish grey containing cherts. The upper part of the formation is less stratified and locally dolomitized. It passes up-section and laterally into the "Waulsortian mound Facies" of the Waulsort Fm. The latter appear as massive light-grey to beige limestones and diagenetic dolomite devoid of cherts, in which three main facies are easily recognized: (1) Well stratified crinoidal packstone to rudstones, in the lower part of the mounds, passing laterally to the Bayard Fm. (2) The "Veines Bleues" (blue veins) facies, particularly typical in the lower and middle part of the mounds. The "veins" corresponds to voids and cavities (decayed soft organisms, "stromatolactoid") filled with sparry calcite. Fenestellid bryozoans are abundant in the lower part of this facies (LEES 1997). (3) Massive or poorly stratified bioclastic wackestones particularly developed in the upper part of the mounds.

The top of the Gendron-Celles section shows the reappearance of 20 m of the Bayard Fm but with much more cherts. This level corresponds to a lateral facies of a Waulsortian mound. A few metres of a second Waulsortian buildup overlie this Bayard facies.



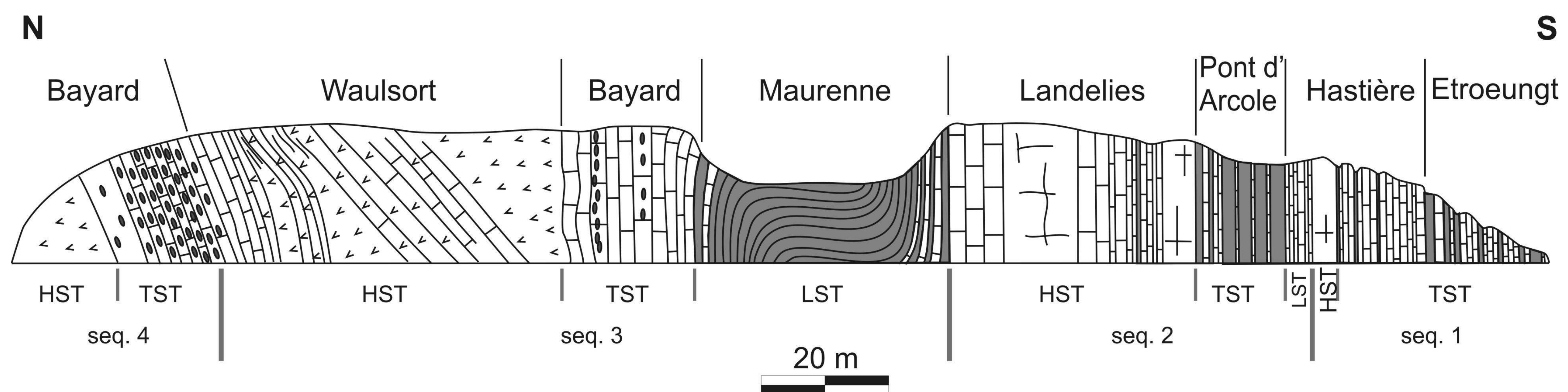


Fig. 28: Schematic sketch of the Gendron-Celles railroad section with the sequence stratigraphical interpretation (modified after CONIL 1968 and DEVUYST et al. 2005).

### Interpretation

The Etroeungt Fm is a westward equivalent of the Comblain-au-Pont and Dolhain Fms, recording the last Devonian transgression developed on the Famennian siliciclastic units ("Old Red Sandstones"). During the Strunian, the carbonate facies reinstalled progressively within a detrital dominated environment.

The uppermost Strunian consists of limestone-marl alternation interpreted as autosequences and storm deposits (VAN STEENWINKEL 1993). HANCE et al. (2001) interpreted this mixed unit as the most part of the TST of their sequence 1. The upper part of the TST corresponding to the lower member of the Hastière Fm. The Strunian limestone recorded the reappearance of the first diversified coral fauna after the end-Frasnian extinction events. These corals show already a Mississippian character (e.g. axial structure) and are particularly difficult to originate in Devonian taxa. They became extinct with the Hangenberg event, a little before the Devonian-Carboniferous boundary. Reworked Devonian fossils (including corals and foraminifers) are present in the lowermost limestone bed of the Hastière Fm (n° 52).

The first Tournaisian coral (*Coniophyllum priscum*) appears at the base of the overlying bed. The HST of sequence 1 is recognized in the middle member of the Hastière Fm, whereas its upper member corresponds to the LST of the overlying sequence 2 of HANCE et al. (2001). The TST of this sequence corresponds to the Pont d'Arcole Fm in which the dark shale corresponds to the maximum flooding surface. This formation is here more silty than in the northern part of the basin but is still fossiliferous; brachiopods, crinoids and bryozoans are common, with some small corals and pelecypods. The Landelies Fm corresponds to the HST (and questionably the FSST) of sequence 2. The sharp contact with the overlying Maurenne Fm corresponds to the sequence boundary.

The Maurenne shale forms the LST of sequence 3 whereas both the Bayard and the Waulsort Fms

form the TST and HST. The Waulsortian buildups started to grow during the TST and reached their maximum development during the HST.

The reappearance of the Bayard facies followed by a new Waulsortian development indicates the LST (?) and TST of the following sequence 4 of HANCE et al. (2001). Interpretation and discussions of the Waulsortian facies are presented in the following stop (D2-4 - Moniat).

### Biostratigraphy

The uppermost Devonian Etroeungt Fm belongs to the LN miospore biozone (PAPROTH et al. 1983), to the DFZ7 foraminifer biozone and to the RC0 rugose coral biozone of POTY et al. (2006) and classically attributed to the upper *praesulcata* conodont biozone of CONIL et al. (1991). The Hastière Fm yields a poorly diversified coral fauna typical of the RC1. The Pont d'Arcole Fm corresponds to RC1 $\gamma$ , Landelies and Maurenne Fm, to RC2. The Bayard Fm is devoid of corals, and the Waulsort Fm yields only *Amplexus*, but they can be included in the RC3 biozone. The foraminifers of these formations indicate MFZ1 to MFZ6 after DEVUYST et al. (2005). GROESSENS (1975) recognized conodonts belonging to the *duplicata* to *Dolymae* biozones.

### Main faunal components

#### Etroeungt Fm, Uppermost Devonian, RC0:

*Campophyllum gosseleti*  
*Yavorskia* sp.  
 syringoporids

#### Hastière Fm, lower Mbr, Hastarian, RC1 $\alpha$ :

*Coniophyllum priscum*

#### Hastière Fm, mid.-up.Mbr, Hastarian, RC1 $\beta$ - $\gamma$ :

*Siphonophyllia cylindrica*  
*Coniophyllum streeli*

#### Landelies Fm, Hastarian, RC2:

*Siphonophyllia rivagensis*  
*Siphonophyllia cylindrica*  
*Eostrotion konincki*



## STOP D2-4 - MONIAT ROCKS SECTION

### References

- LEES (1988, 1997, 2006)  
 LEES & MILLER (1985, 1995)  
 LEES et al. (1985)  
 DELCAMBRE & PINGOT (1993)  
 DEHANTSCHUTTER & LEES (1996)

### Location and access

Composite section of the Moniat Rocks in the northern flank of the Meuse valley, 2.5 km south of Dinant along the road and disused railroad

Dinant-Hastière (Fig. 29). Dinant Synclinorium, southern part of the Dinant sedimentation area (DSA).

### Lithostratigraphy and age

Waulsort and Leffe Fm.

### Description

The two main Moniat Rocks (eastern and western) are comprised of two Waulsortian buildups, separated by peri-waulsortian facies but forming a large complex. The most striking feature of the Waulsortian facies is its massive structure (Fig. 30).

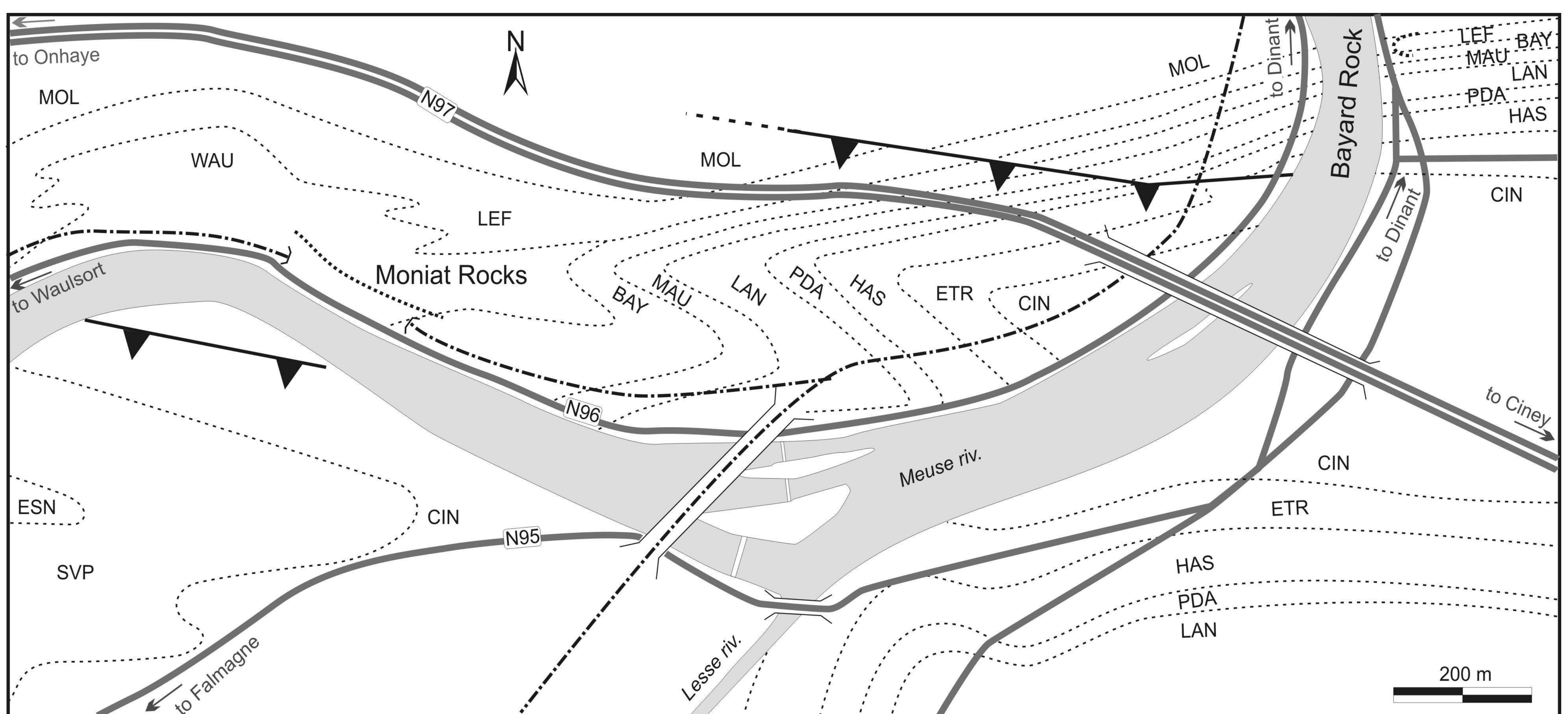


Fig. 29: Geological map of the Anseremme and Dinant area with the location of the Moniat Rock section and the Bayard Rock in Dinant. Legend: CIN: Ciney Fm, ETR: Etroeungt Fm, HAS: Hastière Fm, PDA: Pont d'Arcole Fm, LAN: Landelies Fm, MAU: Maurenne Fm, BAY: Bayard Fm, WAU: Waulsort Fm, LEF: Leffe Fm, MOL: Molignée Fm, NEF: Neffe Fm. Modified after DELCAMBRE & PINGOT (1993).

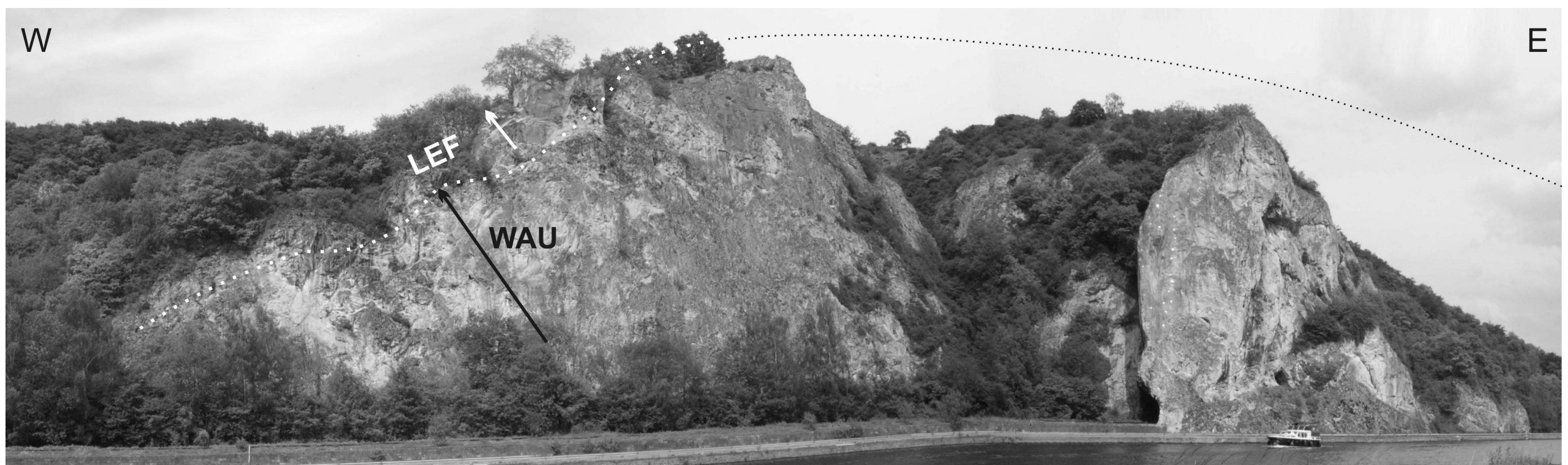
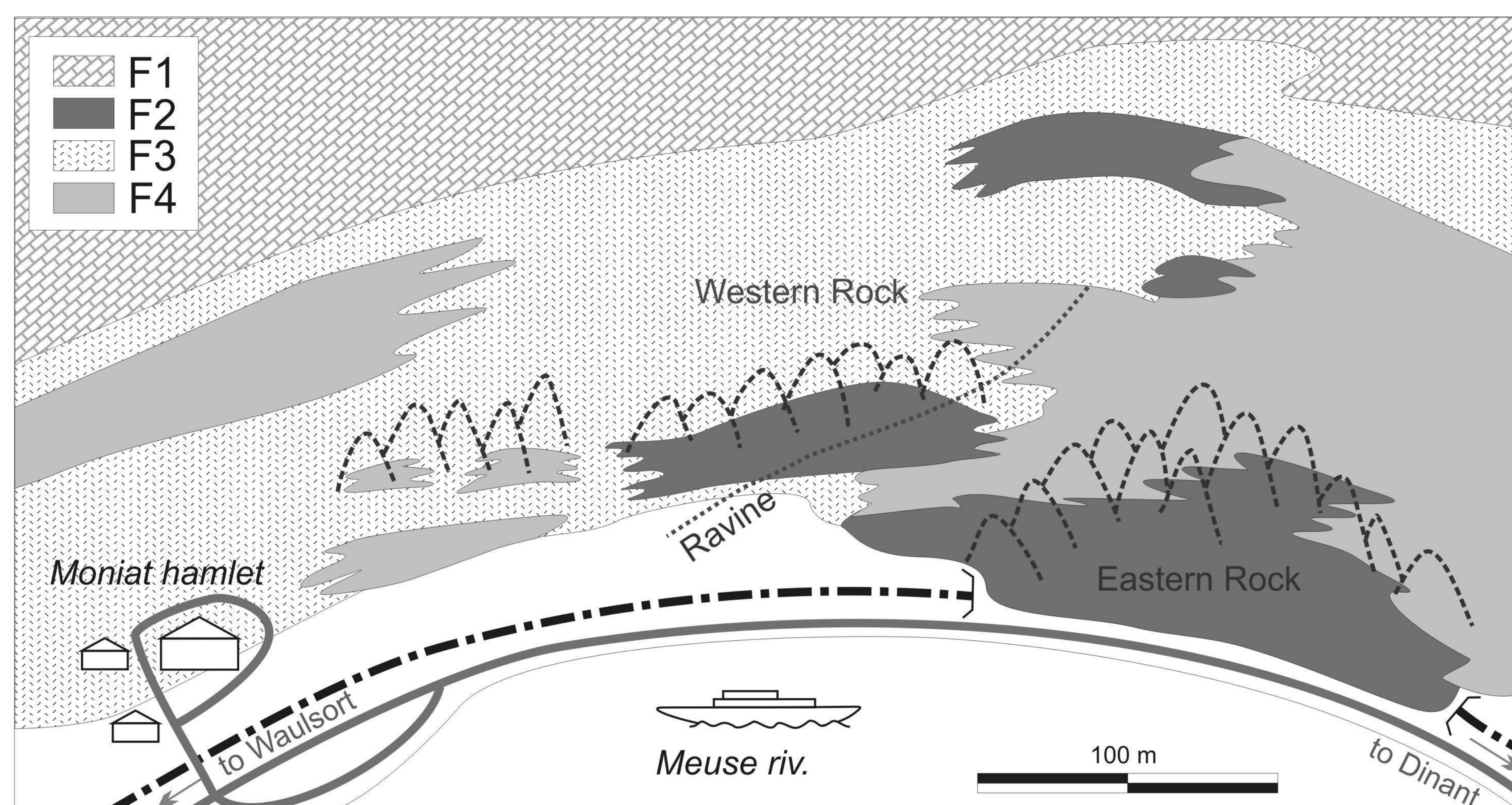


Fig. 30: Eastern Moniat Rock, mainly formed of Waulsortian "veines bleues" facies of the Waulsort Fm (WAU). The upper part of the rock (westernside) is made of thin-bedded Leffe Fm (LEF).



Fig. 31: Detailed lithological map of the Moniat Rocks. Legend: F1: thin-bedded black mudstone (Molignée Fm), F2: Waulsortian "veines bleues" facies, F3: Waulsort and Leffe Fm biomicrites, F4: dolomitized equivalent of F3. Modified after LEES (1977).



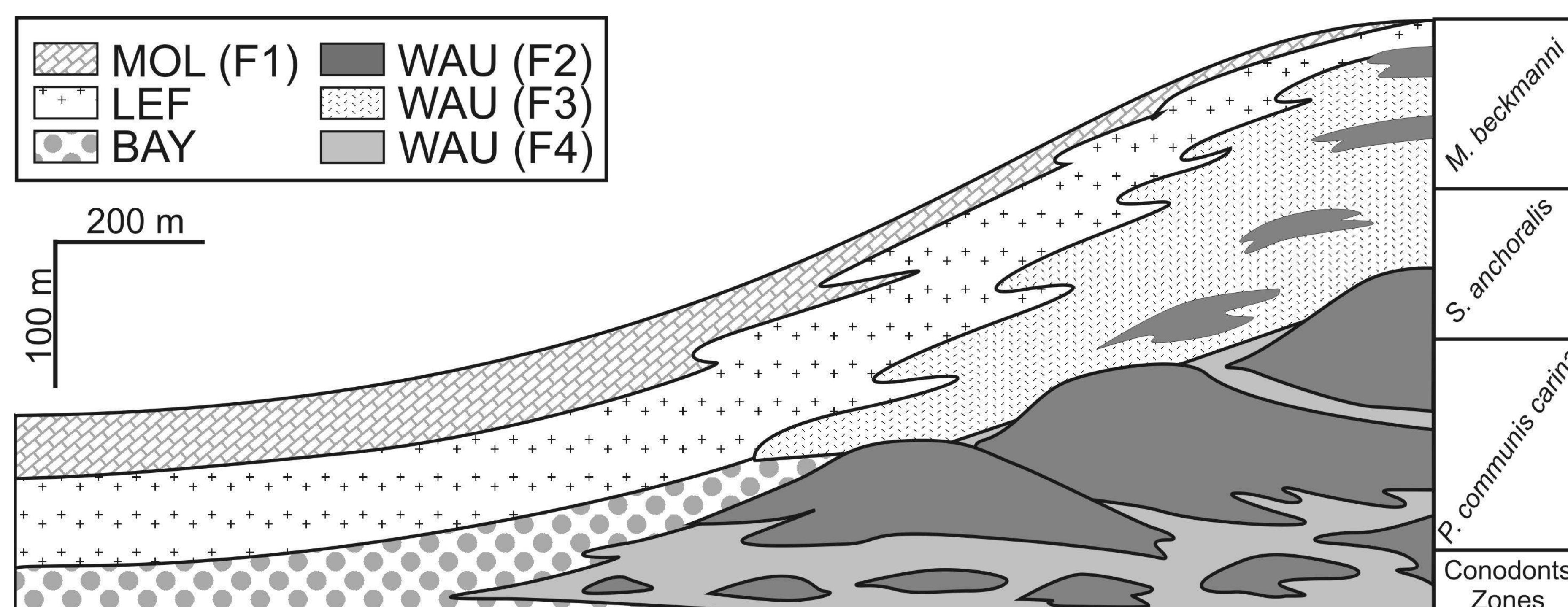
However, in some cases, a crude stratification is visible. The eastern rock is easily accessible along the road and near the railway tunnel where the Bayard Fm crops out with a very cherty facies (Fig. 31, 32). The rock exposes also the "veines bleues" facies, made of fine-grained bioclastic wackestone with sparry calcite patches (in some places, more important volumetrically than the wackestone). The sparry mass occurs under various forms: sparry crusts on fenestellids, cavity fillings ("stromatolactoids") and neomorphosed pseudospar (LEES 1997). Associated with the "Veines Bleues" facies, crinoidal packstone and wackestone occur in the lower part of the buildups (LEES et al. 1985). In the upper part, it is associated with the "biomicrite" facies, made of pale grey wackestone. Bryozoans are the most common organisms of the "Veines Bleues" facies (LEES 1988). Brachiopods, gastropods, crinoids, rare *Amplexus* and other fossils occur sporadically or are clustered in pockets. Unfortunately, good outcrops of the fossiliferous facies are rare. The majority of the Moniat Rocks is made of dolomite affecting both Waulsortian and peri-Waulsortian facies. Along the small ravine north of the western rocks, the massive dolomite passes

through stratified dolomite. The Leffe Fm included well-bedded light or medium grey wackestone and mudstone containing intraclasts of various size and nature. Some parts of the formation show clear fining-upward sequences (LEES & MILLER 1985). The Bayard Rock, located 1.5 km eastward (Fig. 29), on the right bank of the Meuse River, exposes the peri-Waulsortian facies where the Leffe and Molignée Fm lay directly on the Bayard Fm (Fig. 33, 34)

### Interpretation

The Waulsortian buildups have been studied in Belgium since the pioneer work of E. DUPONT in 1863 that already interpreted it as reefal. The most developed and succeeding studies devoted to the Waulsortian are those of LEES 1997, DEHANSCHUTTER & LEES 1996, LEES et al. 1985, LEES & MILLER 1985, 1995). Many details can be found in these publications. The main new interpretation is from HANCE et al. (2001) that recognized the record of two third-order sequences through the Waulsort Fm and its lateral facies. It is, respectively the sequence 3, initiating the buildup, and the sequence 4 finishing it.

Fig. 32: Schematic transect through the Waulsortian complex in the Dinant area. Legend: MOL: Molignée Fm (F1 on Fig. 31), LEF: Leffe Fm, BAY: Bayard Fm, WAU: Waulsort Fm (F1, F2, F3: see Fig. 31). Explanations in the main text. Modified after LEES et al. (1985).





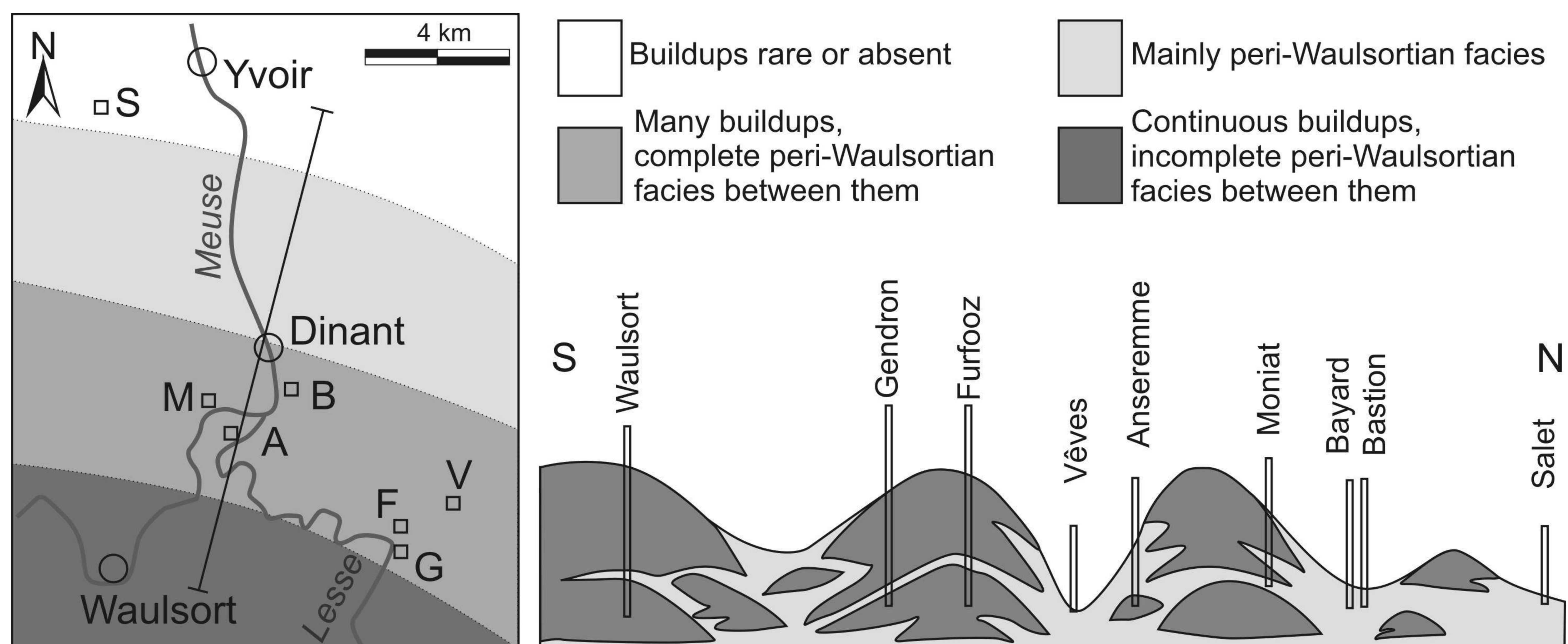


Fig. 33: Development of Waulsortian complex in the Waulsort-Dinant area with the location of the classical section through the Waulsortian. Modified after LEES (1997).

### Biostratigraphy

The only coral known from the Waulsortian buildups is *Amplexus coralloides* that has no biostratigraphical interest. However, the foraminifers are more diversified and distributed in this facies, allowing the recognition of MFZ6, MFZ7 and MFZ8 biozones. The conodont

biostratigraphy was precised by GROESSENS & NOËL (1975, Fig. 32).

### Main faunal components

Waulsort Fm, Ivorian, RC3-RC4 s.l.:

*Amplexus coralloides*

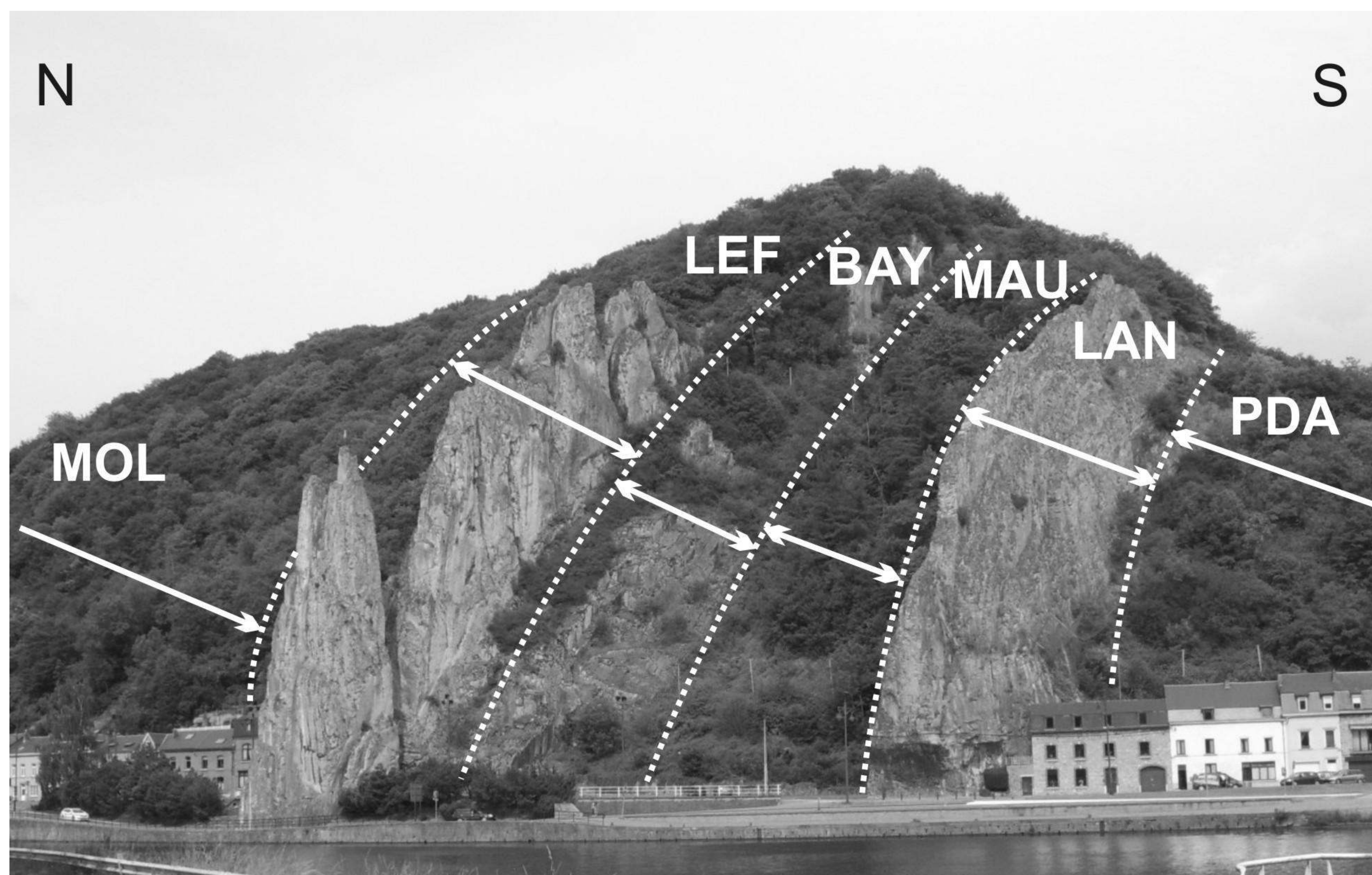


Fig. 34: Bayard Rock in Dinant showing the peri-reefal facies of the Waulsortian facies (the Moniat mound is located 1.5 km westward). Legend: see Fig. 29.





**Cultural notice:** *Le Rocher Bayard* (the Bayard rock) stands in the southern gate of Dinant, on the right bank of the Meuse river. It is completely separated from the rest of the cliff of which it obviously used to be a part. The *Rocher Bayard* was separated with an explosion to provide passage for the French troops of Louis XIV after they had taken Dinant. However, the popular beliefs say that the rock was split by the hoof of the giant *Bayard Horse*. *Bayard*, the legendary horse, was driven by the four *Aymon Brothers* when they were on the run for *Charlemagne King*. They were escaping the *Ardennes Forest*, sit on the back of the *Bayard Horse* when it jumped over the Meuse river and split the rock from the cliff and creating one of the most legendary rock of Belgium.

## STOP D2-5 - CHANSIN "LES NUTONS" QUARRY (DURNAL)

### References

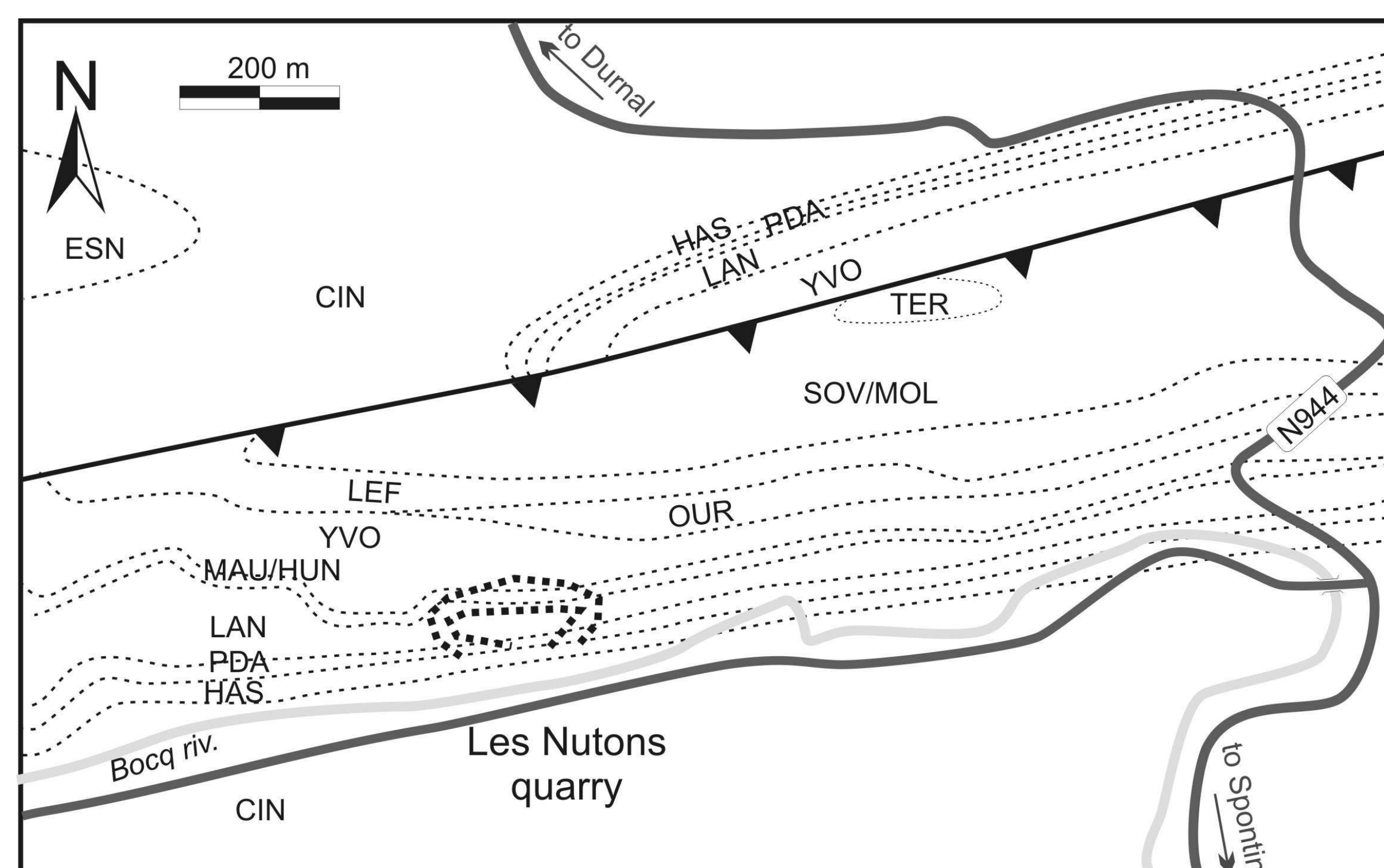
TOURNEUR et al. 1989  
POTY et al. 1991  
HIBO 1994  
POTY & BOLAND 1994

### Location and access

The quarry is open 800 m south of Durnal village, in the northern bank of the Bocq valley (Fig. 35). Centre part of the Dinant Synclinorium, transitional zone between Condroz sedimentation area (CSA) and Dinant sedimentation area (DSA).

### Lithostratigraphy and age

Hastièrre Fm (top of the middle member and upper member), Pont d'Arcole Fm, Landelies Fm ("Petit-Granit du Bocq" ornamental and building stone), Maurenne Fm, Yvoir Fm (lowermost part), Hastarian to Ivorian.



**Fig. 35:** Geological map of the Durnal area with the location of the Chansin "Les Nutons" quarry. Legend: ESN: Esneux Fm, CIN: Ciney Gp, HAS: Hastièrre Fm, PDA: Pont d'Arcole Fm, LAN: Landelies Fm (quarried as the "Petit Granit du Bocq" building stone), HUN/MAU: Hun Mbr and Maurenne Fm. YVO: Yvoir Fm, OUR: Ourthe Fm, LEF: Leffe Fm, SOV/MOL: Sovet and Mognée Fm, TER: Terwagne Fm. Modified after DELCAMBRE & PINGOT (in press) and BARCHY & MARION (in press, b).

### Description

The Hastièrre Fm crops out in the bottom of the quarry. The uppermost two metres of the middle member ( $\beta$ ) of the Hastièrre Fm is made of thick bedded bioclastic limestone with large gastropods (*Straparollus*). The contact with the upper member ( $\gamma$ ) of the Hastièrre Fm is sharp, corresponding to an erosion surface (Fig. 36). This last member (8 m) is made of decimetric beds of bioclastic, often argillaceous, grey limestone with many large solitary rugose corals (*Coniophyllum streeli*). Shaly interbeds are frequent and usually full of brachiopod shells. The boundary between the Hastièrre Fm and the overlying Pont d'Arcole Fm is not clearly cut but gradual (Fig. 36), and marked by the increase of shale layers (in thickness and frequency). The Pont d'Arcole Fm consists of brown grey to dark shale, often calcareous and silty, full of fossils (crinoids, brachiopods - among which small *Spiriferina peracuta* - small corals, bryozoans, trilobites, etc.). The upper part of the Pont d'Arcole Fm is marked by the increase of carbonate content. The last decimetre-thick shale bed marks the top of the Pont d'Arcole Fm and the transition to the overlying Landelies Fm.

The base of the Landelies Fm is made of a 20 m-thick alternation of 40 cm-thick limestone beds and centimetric argillaceous limestone layers. These alternations are very regular in thickness and facies (Fig. 37). The limestone is mainly wackestone-packstone more or less rich in crinoids (10-20 %) and brachiopods. The argillaceous layers are rich in bryozoan. The following 20 m are made



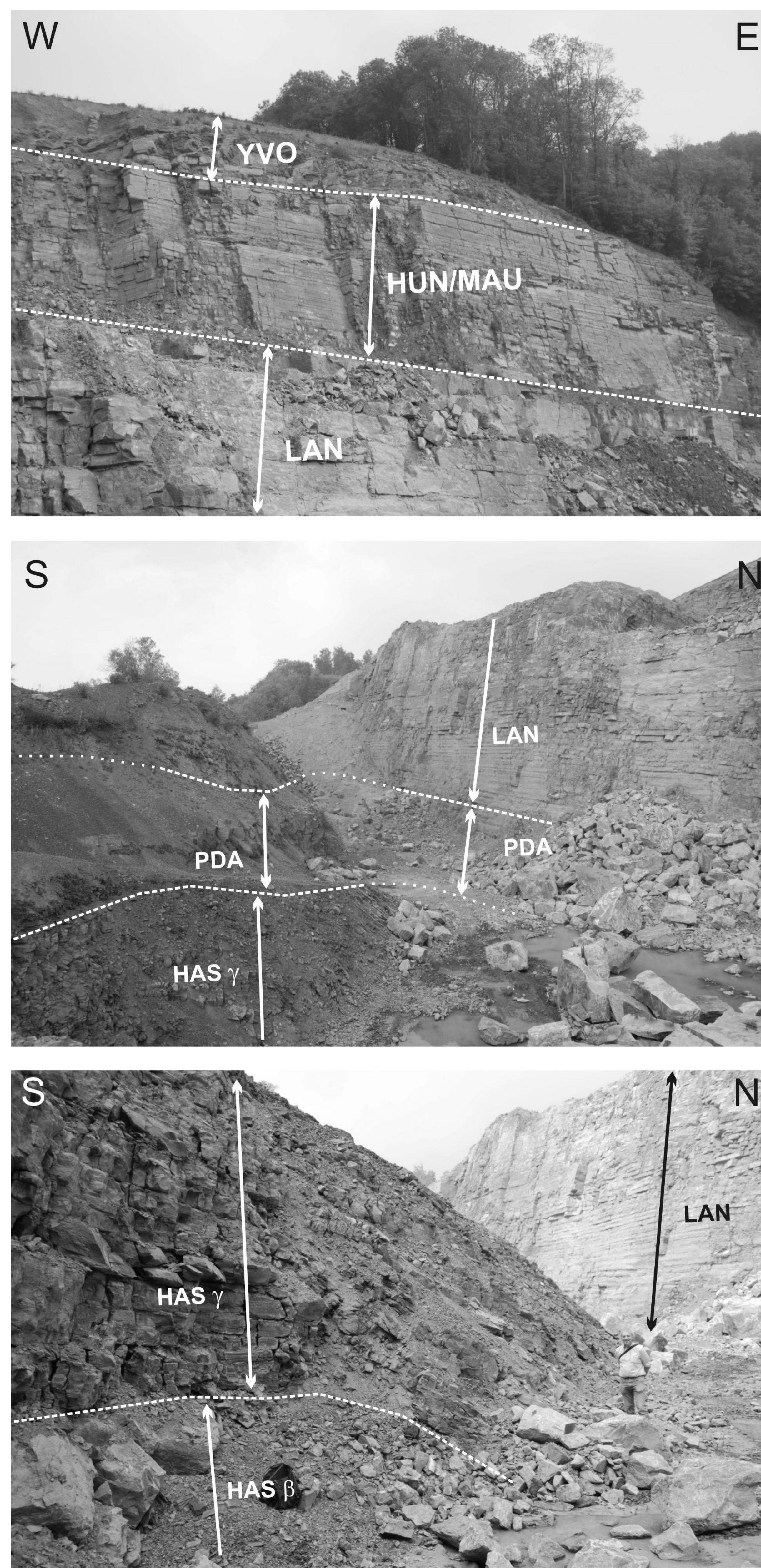


Fig. 36: From top to bottom; a: Upper floors of the Chansin "Les Nutons" quarry exposing the top of Landelies Fm (LAN), the transitional package of the Hun Mbr and Maurenne Fm (HUN/MAU), and the base of Yvoir Fm (YVO). b: Western side of the quarry exposing the upper Mbr of Hastière Fm (HAS $\gamma$ ), Pont d'Arcole Fm (PDA) and Landelies Fm (LAN). c: limit between the middle (HAS $\beta$ ) and upper (HAS $\gamma$ ) members of Hastière Fm. Eddy Poty for scale.

of decimetre to meter-thick beds, among which the most massive are quarried as "Petit Granit du Bocq" as building and carving stone (Fig. 36). The facies are still wackestone and packstone but the crinoid content increases to 35-40 % (HIBO 1994)

Oblique and cross-stratification are common in these crinoidal limestones; however stratigraphic joints and/or stylolites can define 40 cm-thick beds

as those observed in the lower part of the formation. The macrofauna is common and comprises large solitary rugose corals (*Siphonophyllia*), tabulate corals (michelinids, *Yavorskia*, cladochonids) and brachiopods. The boundary with the overlying formation is transitional and marked by the decrease of crinoidal content and the increase of siliciclastics: clay and detrital quartz (up to 50 % in some beds), then the increase of the argillaceous content. This unit belongs to the Maurenne Fm and its lateral equivalent known as the Hun Mbr of the Yvoir Fm. It is composed of argillaceous limestone and carbonated shale forming pluridecimetre-thick sedimentary sequences, as in the Landelies Fm. These facies are very rich in macrofauna, especially in the upper part: small solitary rugose corals, michelinids, cladochonids, bryozoans, brachiopods, trilobites, crinoids, etc. Splendid silicified fossils can be found in the weathered debris of the rock. The Yvoir Fm s.s. is badly exposed in the uppermost part of the quarry and is not accessible. Its base is defined with the appearance of the first limestones with black chert layer.

### Interpretation

The sequential interpretation of the Hastarian and Ivorian Fm is the same than already described for the Rivage and Gendron-Celles sections. The most remarkable difference is shown by the well exposed "cyclic" characteristic of the Landelies and Maurenne Fm. The regularity and thickness of the sequences are very similar to those described as climatic cycles in the Cretaceous limestone-marls alternations. By comparison with the latter, they could correspond to 22.000 years climatic cycles.

### Biostratigraphy

Rugose coral associations yielded by the middle and upper members of the Hastière Fm are characteristic of the RC1 $\beta$  biozone. Corals from the Landelies and Maurenne Fm/Hun Mbr indicate RC2 biozones. The upper Mbr of the Hastière, Pont d'Arcole Fm and Landelies Fm belongs to the MFZ2, and the Maurenne Fm to the MFZ3 foraminifers biozone of POTY et al. (2006).

### Main faunal component

#### Hastière Fm (upper Mbr), Hastarian, RC1 $\gamma$ :

*Conilophyllum streeli*  
*Siphonophyllia cylindrica*  
*Groessensia ambigua*  
 syringoporids

#### Landelies Fm, Hastarian, RC2:

*Siphonophyllia cylindrica*



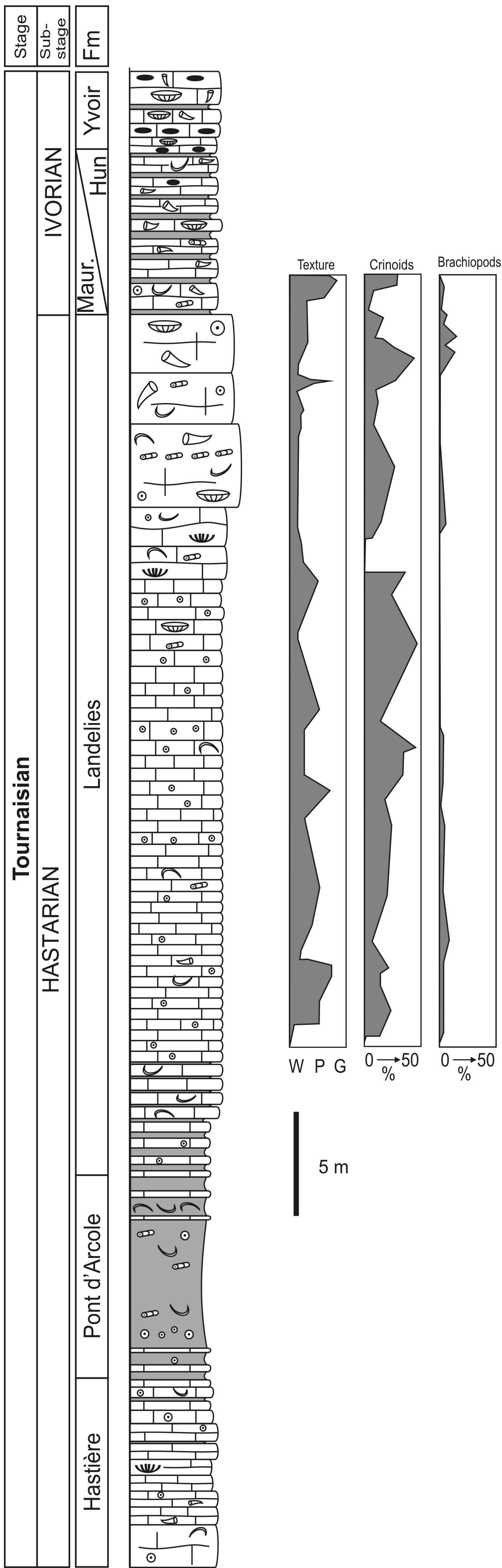


Fig. 37: Lithostratigraphical log of the Chansin "Les Nutons" quarry. The microfacies textures (W: wackestone, P: packstone, G: grainstone) and content in crinoids and brachiopods are given for the quarried levels. Modified after HIBO (1994).

- Siphonophyllia rivagensis*  
*Cyathaxonia cornu*  
*Zaphrentites* sp.  
*Eostroton* sp.  
*Saleelasma delepinei*  
*Uralinia lobata*  
*Yavorskia* sp.  
*Cladochonus* sp.
- Maurenne Fm and Hun Mbr (Yvoir Fm),  
Hastarian, RC2:  
*Caninia cornucopiae*  
*Caninia* sp.  
*Eostroton tortuosum*  
*Siphonophyllia* sp.  
*Amplexus coralloides*  
*Zaphrentites delanouei*  
*Saleelasma delepinei*  
*Michelinia* sp.  
*Cladochonus* sp.

STOP D2-6 - LIVES ROCK AND QUARRY

References

- HANCE (1979)  
POTY et al. (1991)  
LAUWERS (1992)  
CHEVALIER (2004)  
POTY & HANCE (2006a)  
CHEVALIER et al. (2006)

Location and access

The natural exposures at Lives (Lives Rock) and a disused quarry are situated on the southern bank of the Meuse River, 4 km east of Namur (Fig. 38). Northern limb of the Namur Synclinorium, central part of the Namur sedimentation area (NSA).

Lithostratigraphy and age

Top of the Neffe Fm, Haut-le-Wastia, Corphalie and lower part of the Awirs Mbr of the Lives Fm (Livian, Middle Viséan).

Description

The Lives Rock is the stratotype of the Lives Fm and also the Livian substage (CONIL et al. 1977, POTY & HANCE. 2006). The Neffe Fm is partly dolomitized and badly exposed. The Lives Fm begins with a 10-30 cm-thick conglomeratic bentonite known as the "Banc d'Or de Bachant" or "L1" of DELCAMBRE (1989). This horizon is an important marker bed that can be traced through the Namur-Dinant Basin and from the Aachen area (Germany) to the Boulogne-sur-Mer area (Northern France, HANCE et al. 2001). The Lives Fm is subdivided in three members: Haut-le- Wastia,



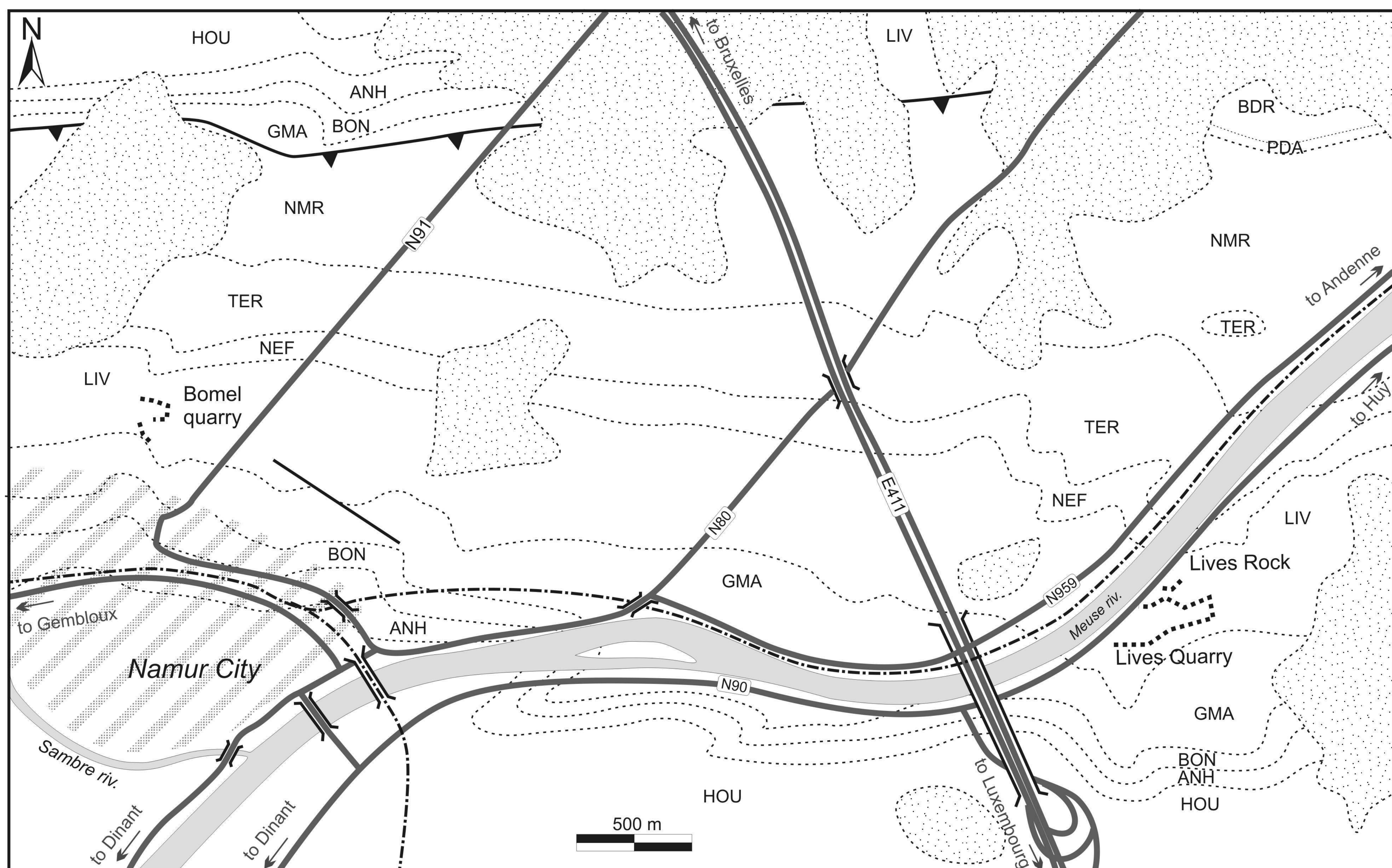


Fig. 38: Geological map of the Namur area with location of the Lives Rock and quarry, and the Bomel quarry. Legend: BDR: Bois de la Rocq Fm, PDA: Pont d'Arcole Fm, NMR: Namur Gp, TER: Terwagne Fm, NEF: Neffe Fm, LIV: Lives Fm, GMA: Grands-Malades Fm, BON: Bonne River Fm, ANH: Anhée Fm, HOU: Houiller Gp (Namurian-Westphalian coal measures group). Modified after DELCAMBRE (in press).

Corphalie and Awirs Mbr. The lower Haut-le-Wastia Mbr ("V2b $\alpha$ " of CONIL et al. 1977) is composed of 30 m of thick-bedded, pale to medium grey limestone arranged in parasequences, in which stromatolites and mudstones are dominant. These facies are locally brecciated, due to the dissolution of evaporitic layers. Bioclastic facies become more common in the upper part of the member and contains corals. The Corphalies Mbr ("V2b $\beta$ " of CONIL et al. 1977) is a massive 18 m-thick unit composed of thick-bedded, dark bioclastic limestone overlain by thin-bedded, dark mudstones containing small bioclastic levels (Fig. 39). The lower bioclastic unit contains numerous rugose corals and heterocorals. The Member includes two widely known marker beds: an argillaceous and bituminous layer containing *Lithostrotion araneum* colonies at the base of the member (POTY et al. 2006), and an argillaceous bed (bentonite "L3" of DELCAMBRE 1989) in the upper part of the member (Fig. 39). The Awirs Mbr ("V2b $\gamma$ ", "V2b $\delta$ ", "V2b $\epsilon$ ") is 35 m thick and made of plurimetre-thick parasequences mainly composed of dark grey, bioclastic limestone, sometimes cherty, rich in corals (*Siphonodendron*, *Clisiophyllum*, *Haplolasma*,

heterocorals), capped by micritic or stromatolitic layers. The colonial corals can be in living position, forming thin biostromes (ARETZ 2002), or broken and forming accumulations of debris.

### Interpretation

The "*Banc d'Or de Bachant*" is a bentonite that suffered pedogenetization during an emersion capping the falling stage system tract constituting the uppermost part of the Neffe Fm (sequence 6 of HANCE et al. 2001).

The entire Lives Fm represents the LST (Haut-le-Wastia Mbr) and the TST (Corphalie and Awirs Mbr) of the sequence 7. The formation is marked by parasequences known since the 1950' (GERARDS 1955, MICHOT et al. 1963). The Haut-le-Wastia Mbr counts 12 parasequences (numbered -12 to -1), mainly stromatolitic.

The Corphalie Mbr is made of one unique parasequence ("sequence 0" of MICHOT et al. 1963) beginning with a *Lithostrotion araneum* horizon that can be traced as far as the Bristol area in England ("*Lithostrotion basaltiforme* band" of VAUGHAN 1906). This sequence is by far the thickest of all sequences observed in the Lives Formation. The facies evolved from bioclastic grainstone to a cap of



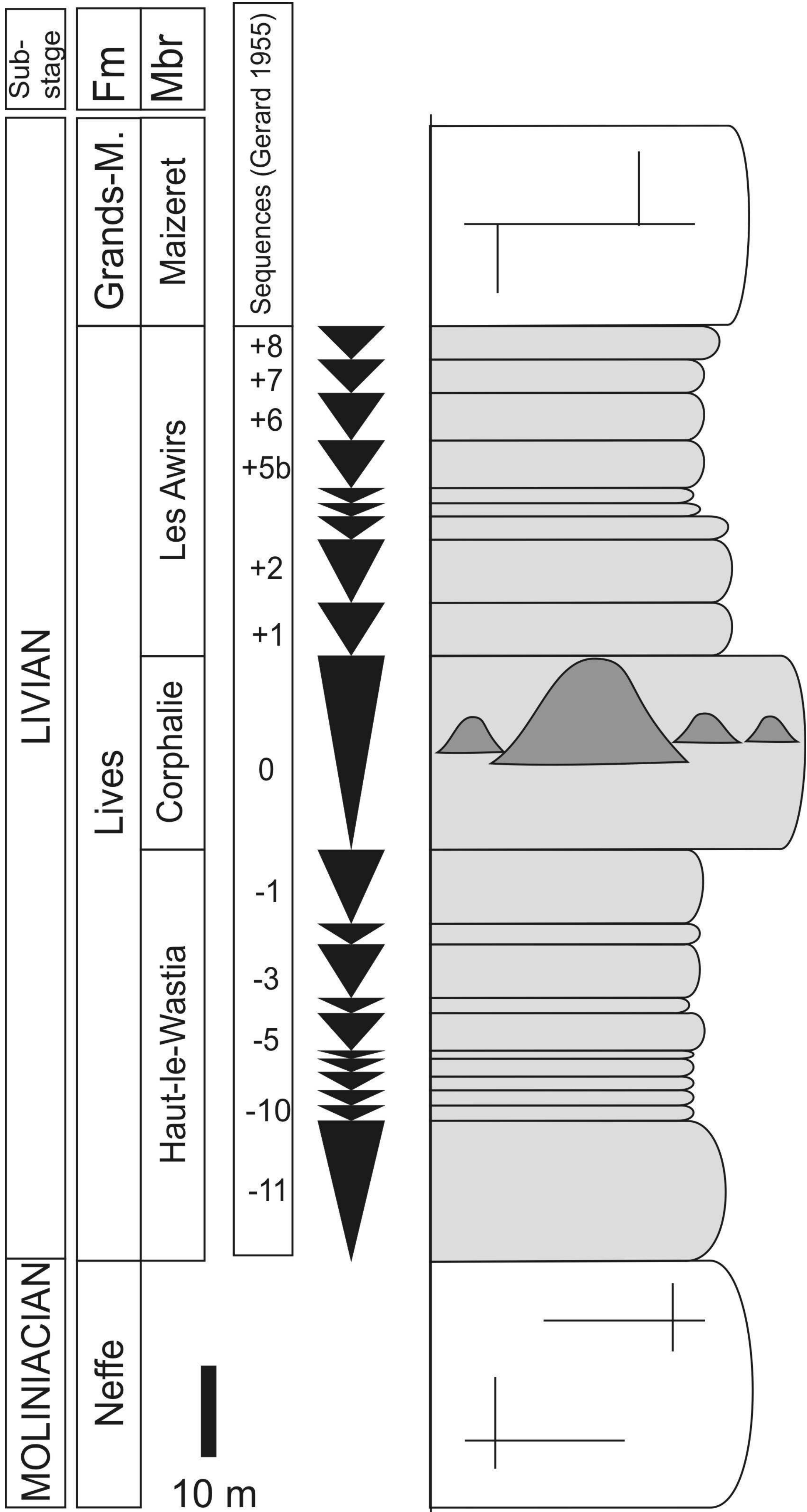


Fig. 39: Lithostratigraphic column of the Lives Mbr in the type area. The rythms "-11" to "+8" of PIRLET (1968) correspond to parasequences. The sequence "0" forms the middle Corphalie Mbr which contains small bryozoans-microbialites bioherms. Modified after LAUWERS (1992).

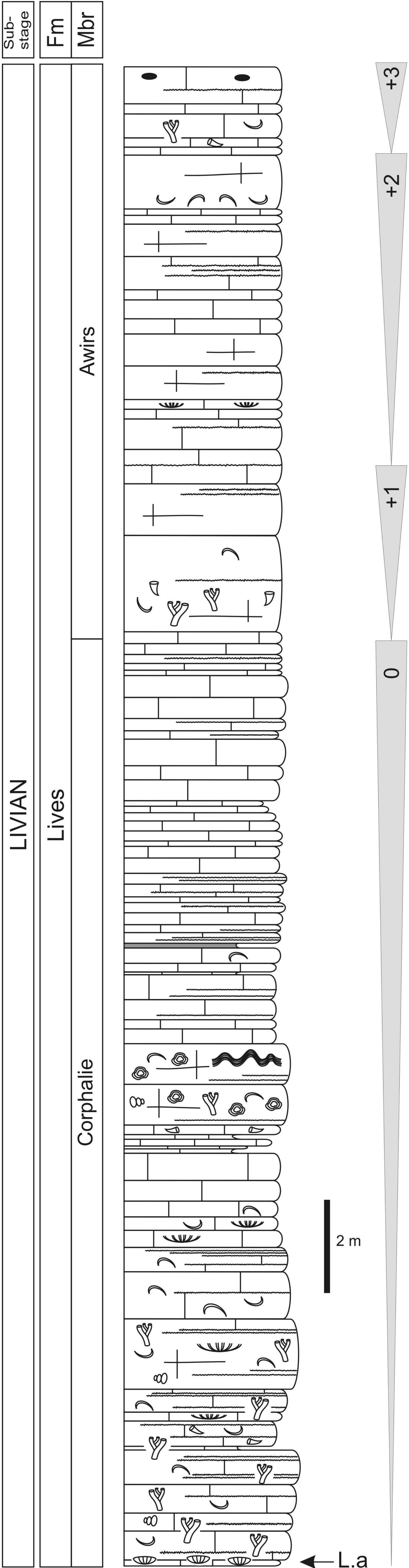


Fig. 40: Detail log of the Lives Fm at the Lives Rock. Parasequences are numbered, the Corphalie Mbr corresponds classically to sequence - or rythm - "0" (PIRLET 1968). Legend: L.a: *Lithostrotion araneum* layer, L2: cinerite L2 of DELCAMBRE (1989). Modified after CHEVALIER (2004).



micritic limestones (often peloidal) including thin bioclastic levels interpreted as storm deposits (CHEVALIER 2004).

The Awirs Mbr is made of eight parasequences (+1 to +8), mainly bioclastic, indicating a more open-marine environment resulting from the ongoing Livian transgression. The overlying Seilles Mbr of the Grands-Malades Fm is entirely bioclastic, light grey and more massive. Spectral analyses carried on the bathymetric curved extracted from the sedimentological studies of the Lives Fm (CHEVALIER 2004, CHEVALIER et al. 2006, ARETZ et al. 2011) show the record of four most important Milankovitch cycles (namely 413.000, 112.000, 34.000 and 21.000 years). The spectral results support the glacio-eustatic origin of the cyclicity observed in the sedimentary deposits.

### Biostratigraphy

The guide taxa for the Livian substage (MFZ12), the foraminifer *Pojarkovella nibelis* enters 15 m above the base of the Lives Fm in the stratotype but is known however from the very base of the Lives Fm, in the SE part of the DSA (DEVUYST et al. 2005). The Haut-le-Wastia Mbr contains the typical association of the rugose coral biozone RC5 $\gamma$  (*Siphonodendron martini*, *S. irregulare*, *Axophyllum vauhani*, *Clisiophyllum garwoodi*, *Caninophyllum archiaci*). The appearance of *Lithostrotion araneum* at the base of the Corphalie Mbr defines the base of the RC6.

### Main faunal component

#### Lives Fm, Corphalie Mbr, Livian, RC6:

*Siphonodendron martini*  
*Siphonodendron irregulare*  
*Lithostrotion araneum*  
*Clisiophyllum garwoodi*  
*Clisiophyllum* sp. nov. A  
*Axophyllum vauhani*  
*Axophyllum nanum*  
*Heterophyllia ornata*  
*Hexaphyllia mirabilis*  
syringoporids  
cladochonids

#### Lives Fm, Awirs Mbr, Livian, RC6:

*Siphonodendron martini*  
*Siphonodendron irregulare*  
*Siphonodendron sociale*  
*Caninophyllum archiaci*  
*Haplolasma conili*  
*Axophyllum nanum*  
*Axophyllum vauhani*  
Heterocorals  
syringoporids  
cladochonids

## STOP D2-7 - BOMEL (NAMUR)

### References

POTY et al. (1991)  
LAUWERS (1992)  
ARETZ (2002)  
ARETZ & CHEVALIER (2007)

### Location and access

The disused quarry of Bomel and the discontinuous section along the eastern side of the road leading to the quarry (Fig. 38) are situated in a northern suburb of town, 300 m north of the Bomel church. Northern limb of the Namur Synclinorium, eastern part of the Namur sedimentation area (NSA).

### Lithostratigraphy and age

Corphalies and Awirs Mbr of Lives Fm (Livian, Middle Viséan).

### Description

The west-facing wall of the quarry exposes four of the parasequences of the Lives Fm, namely "sequence -1" (uppermost sequence of the Haut-le-Wastia Mbr), "sequence 0" (corresponding to the Corphalie Mbr), "sequence +1" and "+2" (base of the Awirs Mbr) (LAUWERS 1992, Fig. 39, 41).

The middle part of the Corphalie Mbr contains small microbes-bryozoan reefs (2 m thick, up to 5 m in diameter). All are rooted in the same 1.8 m-thick bed made of bioclastic packstone with corals and brachiopods fragments. Abundant brachiopods and *Siphonodendron martini* colonies in life position are present in this bed, under the buildups. Although LAUWERS (1992) stated that at Bomel the small reefs are predominantly microbial ("algal") and skeletal organisms are lacking, CHEVALIER & ARETZ (2005) and ARETZ & CHEVALIER (2007) documented abundant bryozoans in reefs of these sizes in other localities. At Bomel these small reefs comprise a massive core facies, dark in its lower part, lighter upward. The upper surface of the buildups, as well as the lateral equivalent beds, is undulating ("hummocky surface") and overlain by a 60 cm-thick stromatolitic level thickening up to 120 cm in lateral position to the buildups. The stromatolitic bed is capped by a thin (5 cm) bed rich in coral fragments.

The road section shows a very large buildup (at least 8 m thick, up to 50 m in diameter) within the Corphalie Mbr (Fig. 41). Its base is not exposed but seems to be rooted in similar level that the smaller buildups. The core facies is mainly formed of fenestellid and ramose bryozoans encrusted with



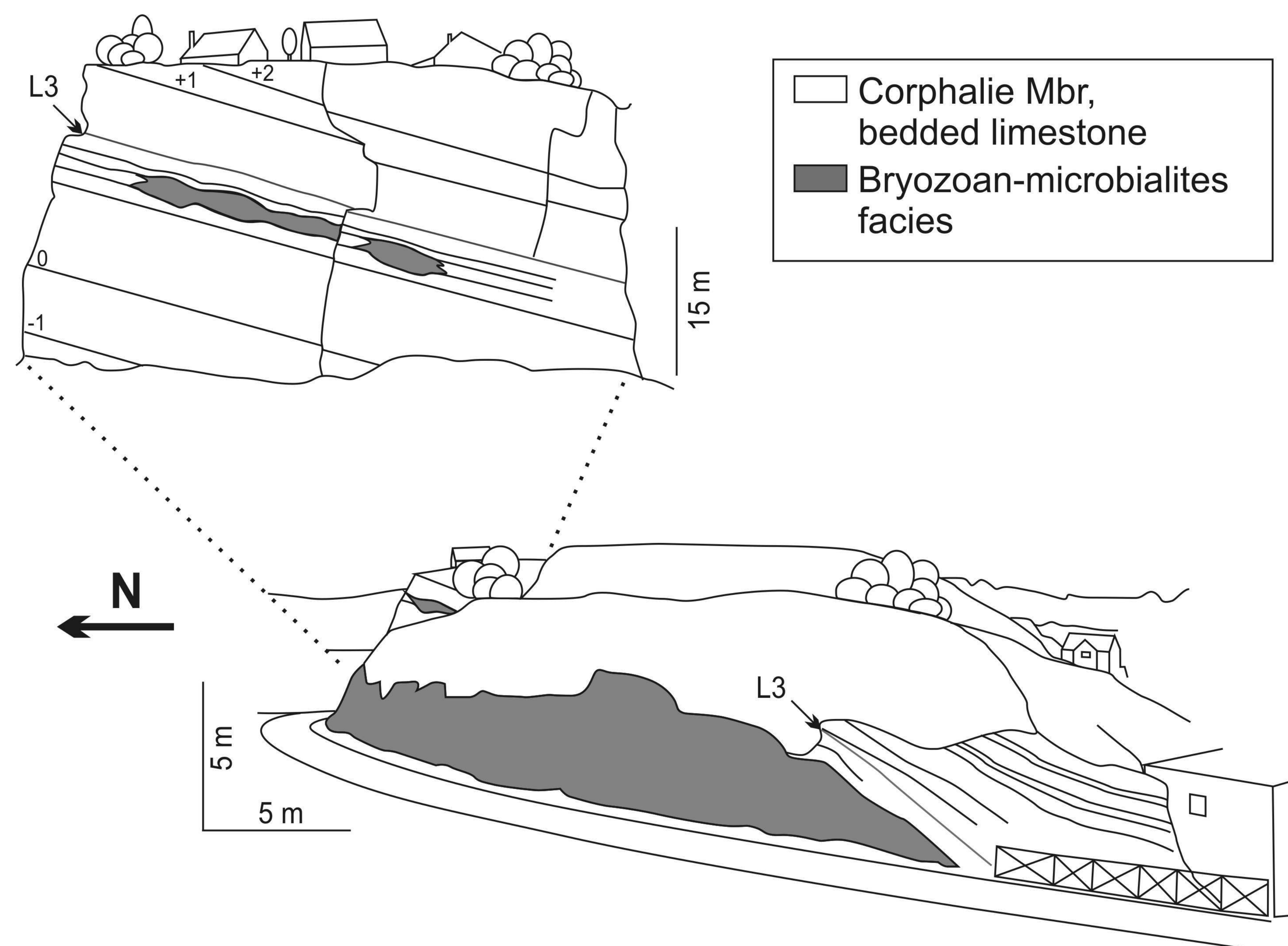


Fig. 41: Schematic sketch of the Bomel outcrops, (a) disused quarry and (b) embankment of the access road to the quarry. Legend: L3 cinerite of DELCAMBRE (1989), 1: bryozoan-microbialites facies of the bioherm, b: bedded facies of the Corphalie Mbr. Modified after LAUWERS (1992).

laminated microbial micrite. Microconchids are also very common, associated with microbial coating (LAUWERS 1992). Brachiopods and sponge spicules are locally abundant. Very rare tabulate and solitary rugose corals occur in the upper part of the core facies. These skeletal organisms coated and bound with microbial laminae form a framework in which cavities are filled by carbonate mud containing pellets, intraclasts and variegated bioclasts (Fig. 42). Some cavities show several generations of internal sediments and sparitic cements. The core facies are overlain by coral thickets composed exclusively of

*Siphonodendron martini* colonies. This coral thicket passes laterally to a fragmented coral bed, thinning progressively into a few centimetre thick level rich in coral fragments (ARETZ & CHEVALIER 2007). Thus, the coral colonies are in living position only on the top of the buildup and are displaced in the flanks. LAUWERS (1992) calculated a paleo-slope of 20° for the southern flank of the buildup and estimated its geometry as a dome more than a ridge. Laterally to the buildups, digitate and domal stromatolites occur. They can be traced up to several kilometres away in the Namur Synclinorium.

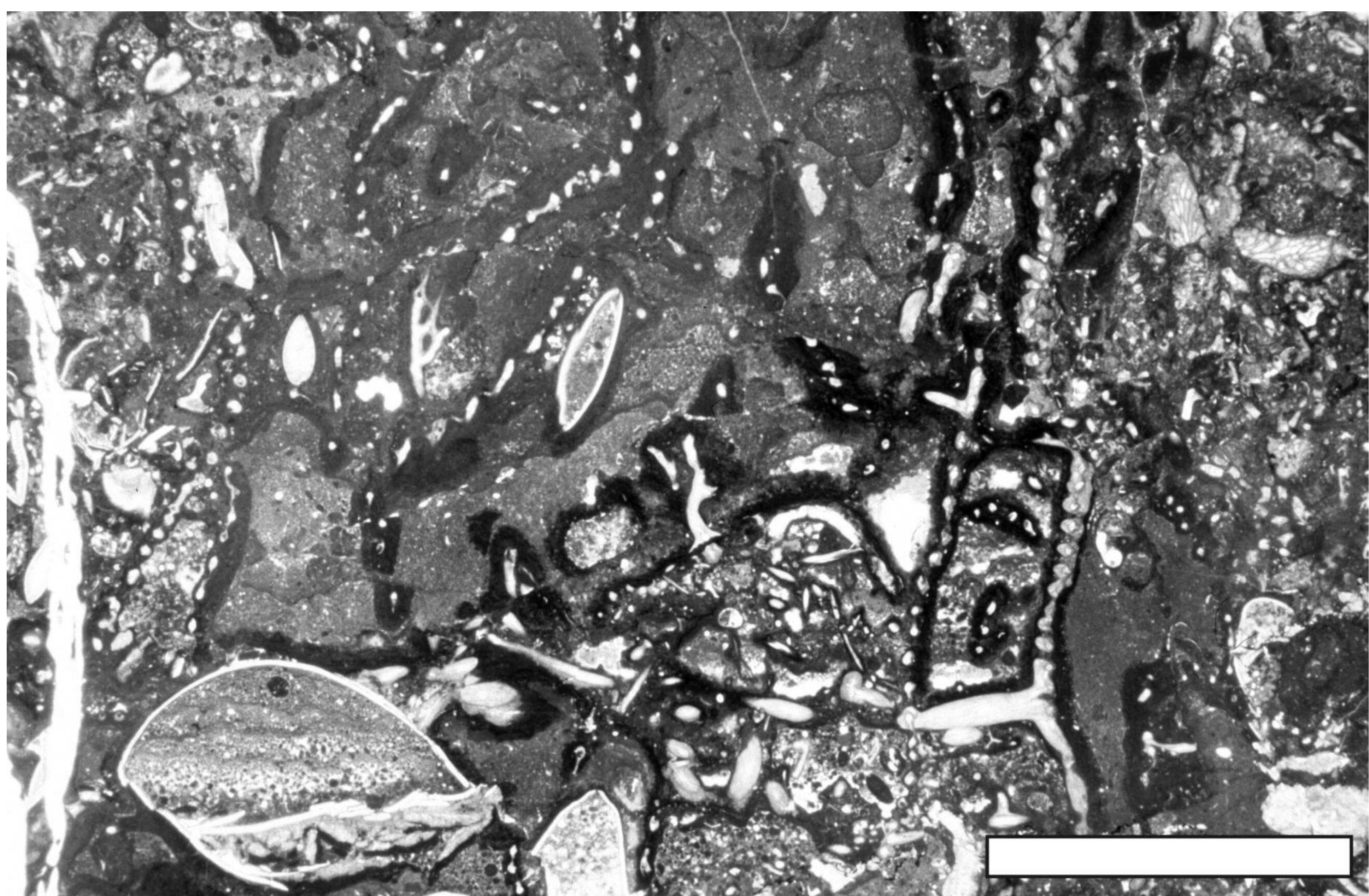


Fig. 42: Core facies of the large Bomel reef. Note the abundance of fenestellid bryozoans surrounded by dark microbial crusts forming the primary framework of these reefs. Scale bar is 10 mm (from ARETZ & CHEVALIER 2007)



### Interpretation

The sequence stratigraphical interpretation of the Lives Fm is given for the Lives section (STOP D2-5).

The lower part of the Corphalie Mbr was formed in an open marine and well-oxygenated environment in which *Siphonodendron martini* thickets grown. During the regressive part of the parasequence, the conditions changed, leading to a shallowing and more confined environment, favourable for the microbialite development. Locally, stromatolithic mounds of various sizes formed. In larger ones, bryozoans, brachiopods, sponges and microconchids played an important role in the construction of the build-up. Upward, these organisms decreased while microbial communities became dominant, probably due to increasingly restrictive environment conditions. The demise of the build-up is thought to be the consequence of a short-lived drop in sea level. Consequently, their top emerged and became exposed to aerial conditions, leading to the fractures and the subaerial weathering and dissolution of the build-up.

The following sea-level rise lead to the flooding of previously emerged parts of the build-up and its re-colonization by marine organisms. Among them, microbial communities built oncoids and columnar stromatolites, characteristic of agitated environments, rapidly replaced by quiet-environment laminar stromatolites on and around major build-ups. Large buildups became local shoal where corals colonies established (capping bed in sense of ARETZ 2010) and been partly destroyed

by agitation spreading their debris on the sea floor (LAUWERS 1992, ARETZ & CHEVALIER 2007). The following sequence filled the inter-mounds troughs of the platform where shallow-water deposits took place.

### Biostratigraphy

The buildup facies yielded no guide taxa, neither corals, nor foraminifers. However, the under- and over-lying beds contain typical Livian (RC6 and MFZ12) fauna.

### Main faunal component

Lives Fm, Corphalie Mbr, Livian, RC6:  
*Siphonodendron martini*  
*Lithostrotion araneum*  
 cladochonids

## STOP D3-1 - SOIGNIES QUARRY (GAUTHIER-WINCQZ)

### References

CONIL & GROESSENS (1975)  
 GROESSENS (1978a, 1978b, 1994)  
 TOURNEUR et al. (1989)  
 HIBO (1994)  
 DOREMUS & HENNEBERT (1995)

### Location and access

The Gauthier-Wincqz Quarry is located 1000 m south of the church of Soignies (Fig. 43). Northern flank of the Namur Synclinorium, central part of the Hainaut sedimentation area (HSA).

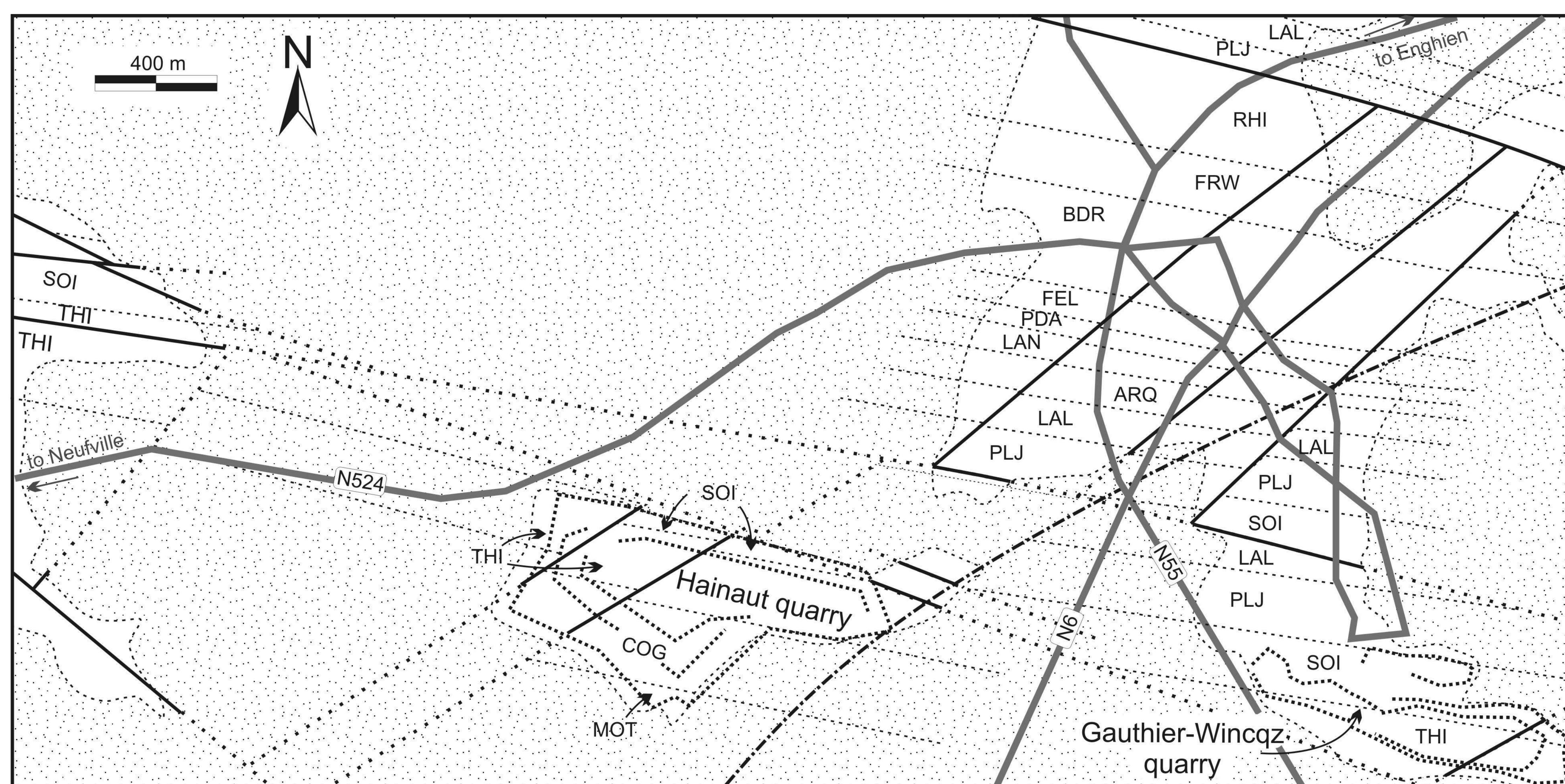


Fig. 43: Geological map of the Soignies area with location of the "classical" Hainaut quarry and Gauthier-Wincqz quarry. Legend: RHI: Rhisnes Fm, FRW: Franc-Waret Fm, BDR: Bois de la Rocq Fm, FEL: Feluy Mbr, PDA: Pont d'Arcole Fm, LAN: Landelies Fm, ARQ: Arquenne Fm, LAL: Lalaing Fm, PLJ: Perlonjour Mbr, SOI: Soignies Mbr, THI: Thiarmon Mbr, COG: Cognebeau Mbr, MOT: Montils Fm. Modified after DOREMUS & HENNEBERT (1995).



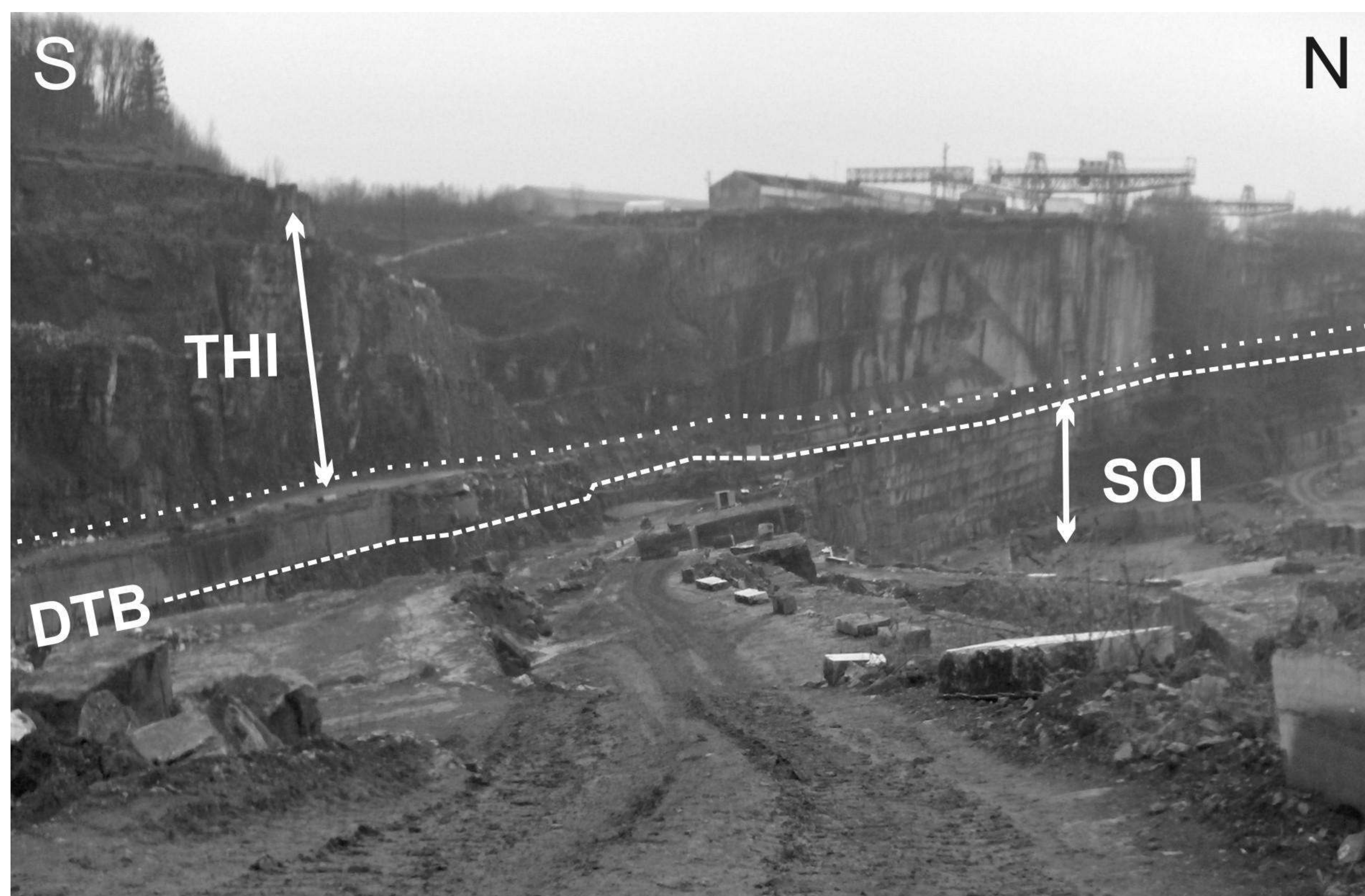


Fig. 44: Gauthier-Winqz quarry with the Soignies Mbr (SOI, "Petit Granit de Soignies" building stone) and Thiarmont Mbr (THI, "Raches sans chert"). DTB: "Delit à la terre bleue".

### Lithostratigraphy and age

The Ecaussinnes Fm and Malon-Fontaine Fm are exposed in the quarry. The first contains two members: the Perlonjour Mbr of which only the top is exposed in the quarry floor, named the "Cliquantès" by the quarrymen; and the Soignies Mbr, corresponding to the "Petit Granit de Soignies" or "Petit Granit", the building stone quarried in the Soignies vicinity (Fig. 44). The Malon-Fontaine Fm is formed of the Thiarmont Mbr overlying directly the "Petit Granit" and named "Raches sans chert"; and the Cognebeau Mbr, of which only the base is exposed corresponding to the "Raches à cherts". Both formations are supposed Ivorian.

### Description

The Perlonjour Mbr is composed of 20 m of argillaceous limestone often silicified (cherts), dolomitized in some place. The facies is mainly a bioclastic wackestone to packstone with crinoids and rare bryozoans and brachiopods. The upper part of the member is clearly a packstone with crinoids, brachiopods and some micritized grains. Foraminifers and moravamminids are abundant in rare thin levels.

The base of the Soignies Mbr, badly exposed in the quarry, is completely different of the underlying Perlonjour Mbr. The whole Soignies Mbr (= "Petit-Granit") is a 30 m-thick massive dark limestone in 70-200 cm-thick beds (Fig. 45). The bedding is mainly due to diagenetic stylolitic joints. Rare sedimentary-linked bedding surface are typically crowded with burrows (HIBO 1994). The facies varies from packstone to rudstone with crinoids (constituting 20-60% of the rock), with a rich macrofauna made of solitary rugose corals,

tabulate corals (syringoporids and michelinids), brachiopods, fenestellids and ramose bryozoans, trilobites, gastropods, pelecypods, sponges (*Asteractinella expansa*), echinid spines, fish remains, etc. The microfauna is very poor: moravamminids, rare ostracods and almost no foraminifers. The homogeneity of the rock is attributed to the intense bioturbation (horizontal and vertical, HIBO 1994). Two remarkable argillaceous levels are present: the "Delit à la Terre noire", 4.5 m above the base of the member, and the "Delit à la terre bleue", 4 m below its top.

The transition to the overlying Thiarmont Mbr is progressive: decrease of the crinoid and fenestellids, appearance of *Zoophycos* and foraminifers, proliferation of small solitary rugose corals, increase of the argillaceous content, decrease of the thickness of the beds and appearance of thin argillaceous interbeds (Fig. 45). The Thiarmont Mbr is 35 m-thick, the overlying Cognebeau Mbr is 28 m-thick. The latter is characterized by the presence of cherts molding the burrows, and by a decrease in the biodiversity. The microfacies changes to a wackestone with moravamminids, ostracods, aoujgaliids and sponge spicules (DOREMUS & HENNEBERT 1995).

### Interpretation

The transition between the Perlonjour Mbr to the Soignies Mbr is progressive; the quantity of crinoids also increases progressively. Contrarily, the proportion of bryozoan increases rapidly at the base of the Soignies Mbr (Fig. 45). The facies and bioturbation shown by the Soignies Mbr indicates a relatively low-energy depositional environment, below the fair-weather wave zone. The good preser-



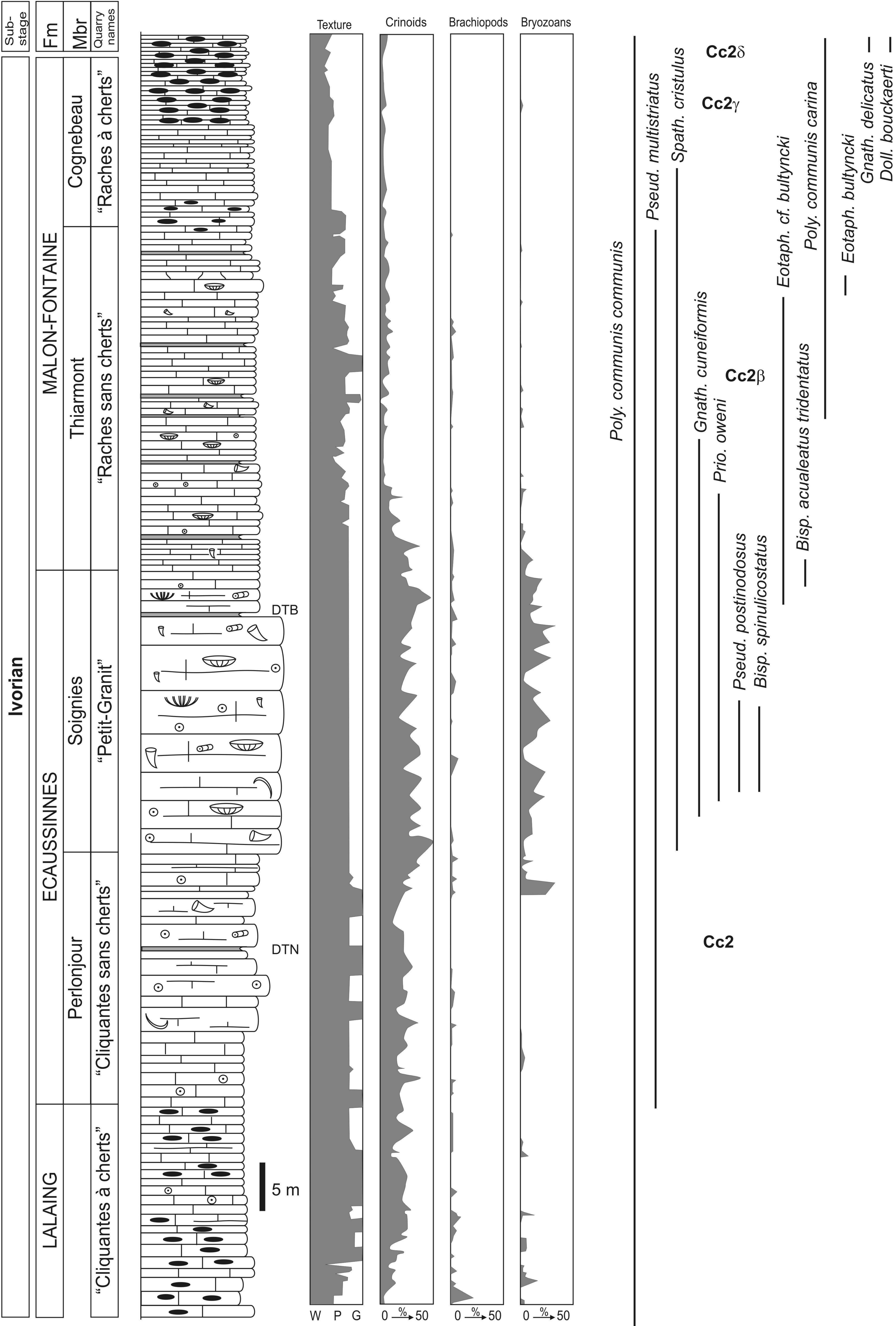


Fig. 45: Detail log of the different units quarried in the Soignies quarries. Microfacies textures (W: wackestone, P: packstone, G: grainstone), crinoids, brachiopods and bryozoans contents after HIBO (1994). Conodont distribution after GROESSENS (1978a). Legend: DTN: "Délit à la terre noire", DTB: "Délit à la terre bleue".



vation of the corals, crinoids and fenestellid bryozoans is probably due to an in-situ deposition, occasionally reworked by storm waves (HIBO 1994). In spite of similar facies and age, the "*Petit-granit de Soignies*" and the "*Petit-Granit de l'Ourthe*" (cf. STOP D1-5/6) deposited in different environments, the latter showing typically high-energy features. The local proliferation of sponges (*Asteractinella expansa*) could indicate a short-lasting deepening (subsidence or transgressive event?) or a climatic signal (HIBO 1994).

The two clay layers, "*Delit à la Terre noire*" and "*Delit à la terre bleue*", yielded heavy minerals (apatite, tourmalines, zircons) that allowed DELCAMBRE (1982) to interpret them as bentonite resulting of the weathering of volcanic ash layers.

### Biostratigraphy

The Ecaussinnes and Malon-Fontaine formations are Ivorian in age but precise dating are not available because the guide taxa (conodonts and foraminifers) are lacking. The occurrence of *Caninophyllum patulum* indicates the RC3 zone of POTY et al. (2006). Unfortunately, no other guide taxa is known in strata younger than the Thiarmon Mbr.

### Main faunal component

Ecaussinnes Fm, Soignies Mbr ("*Petit-Granit*"), RC3 s.l.:

*Cyathaxonia cornu*  
*Caninophyllum patulum*  
*Proheterelasma omaliusi*  
*Syringopora ramulosa*  
 michelinids ("*Turnacipora*" *favosa*)

Malon-Fontaine Fm, Thiarmon Mbr ("*Raches sans chert*") RC3 s.l.:

*Zaphrentoides omaliusi*  
*Hapsiphyllum delanouei*  
*Caninia cornucopiae*  
*Caninophyllum patulum tomiense*  
*Cyathaxonia cornu*  
*Michelinia favosa*  
*Michelinia megastoma*  
*Syringopora reticulata*  
*Syringopora* cf. *ramulosa*  
 michelinids ("*Turnacipora*" *favosa*)

## STOP D3-2 - LEMAY QUARRY (TOURNAI)

### References

LEGRAND et al. (1966)  
 MORTELMANS (1976)  
 COEN-AUBERT et al. (1981)

TOURNEUR et al. (1989)  
 POTY et al. (1991)  
 HENNEBERT (1996)  
 DOREMUS & HENNEBERT (1996, 1997)  
 GAILLARD et al. (1999)  
 CHANTRY (2001)  
 DEVUYST et al. (2005)

### Location and access

The Lemay Quarry is situated in Vaulx, approximately 5 km southeast of the center of Tournai, on the eastern flank of the Escaut valley (Fig. 46). It is one of the last active quarries in the Tournai area, where there were tens of them until the middle part of the 20<sup>th</sup> century. Northern limb of the Namur Synclinorium, western part of the Hainaut sedimentation area (HSA).

### Lithostratigraphy and age

The Tournai area exposes the historical type section of the Tournaisian. The Tournai Fm (Providence, Pont-à-Rieu and Vaulx members) and Antoing Fm (Calonne lower and upper members) are exposed. Both formations are considered as Ivorian despite the total absence of guide taxa. The classical fossils of Tournai were collected during the 19<sup>th</sup> century, mainly from weathered (karstic) zones affecting the limestone (see (W) on Fig. 48).

### Description

Only the top of the Providence Mbr (Tournai Fm) is visible. It is composed of cherty bioclastic wackestone and floatstone disposed in regular 30-40 cm-thick beds separated by cm-thick marly interbeds. The member is topped by a productid coquina bed ("*Banc à Moules*", BM on Fig 47) and by a thin argillaceous layer. The Pont-à-Rieu Mbr is a 22 m-thick homogeneous unit of crinoidal limestone often argillaceous and siliceous, usually fossiliferous (stemmed echinoderms, brachiopods, bryozoans, tabulate corals, trilobites, gastropods and pelecypods) and bioturbated. The texture is mainly wackestone but floatstone layers are common. Cherts and marly interbeds are uncommon. The Vaulx Mbr is a 32 m-thick package of argillaceous and siliceous limestone in massive irregular beds. It consists of bioturbated wackestone with fragments of stemmed echinoderms, brachiopods, rugose and tabulate corals, bryozoans and trilobites. The lower part of the member is particularly rich in chert ("*Carbonniaux*", CB on Fig. 47). The upper part is more massive and very rich in fossils ("*Bancs de Gris*", BG on Fig. 47) among which the "classical Tournai fauna". The member is topped by an erosive surface very rich in corals and overlain by the argillaceous layer known as the "Gras Délit".



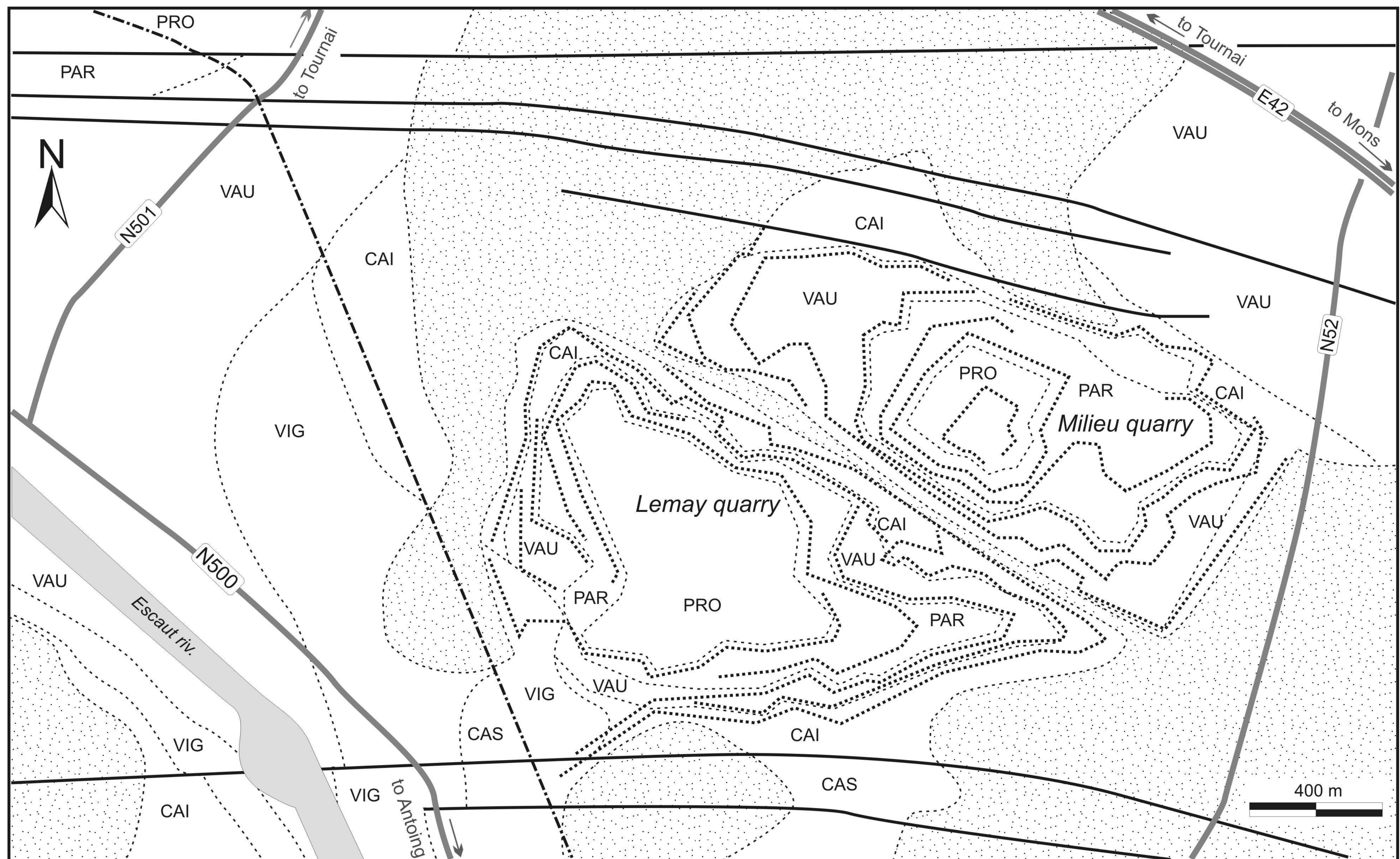


Fig. 46: Geological map of the Tournai area. Legend: PRO: Providence Mbr, PAR: Pont-à-Rieu Mbr, VAU: Vaulx Mbr, VIG: Vignoble Mbr, CAI: Calonne lower Mbr, CAS: Calonne upper Mbr. Modified after DOREMUS & HENNEBERT (1997).

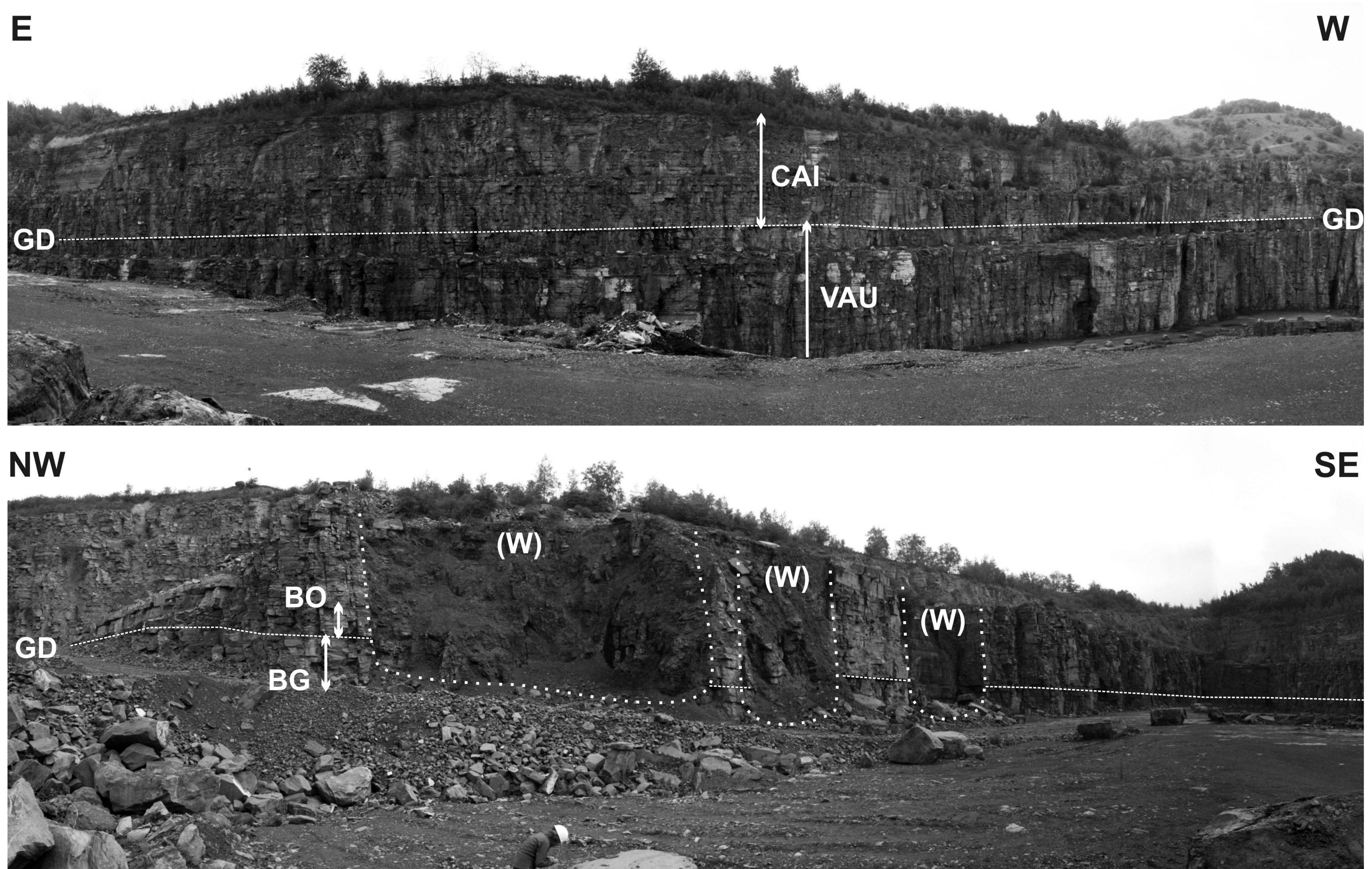


Fig. 47: Lemay quarry, (a) eastern cliff of the quarry showing the Vaulx Mbr, the "Gras Délit" layer and the Calonne lower Mbr, (b) northern cliff of the quarry showing the transition of the Vaulx Mbr (BG: "Bancs de Gris") and Calonne lower Mbr (BO: "Bancs à Chonetes"). (W): weathered karstic "pockets" from which the classic fossils of the Tournai quarry were extracted during the 19<sup>th</sup> century.



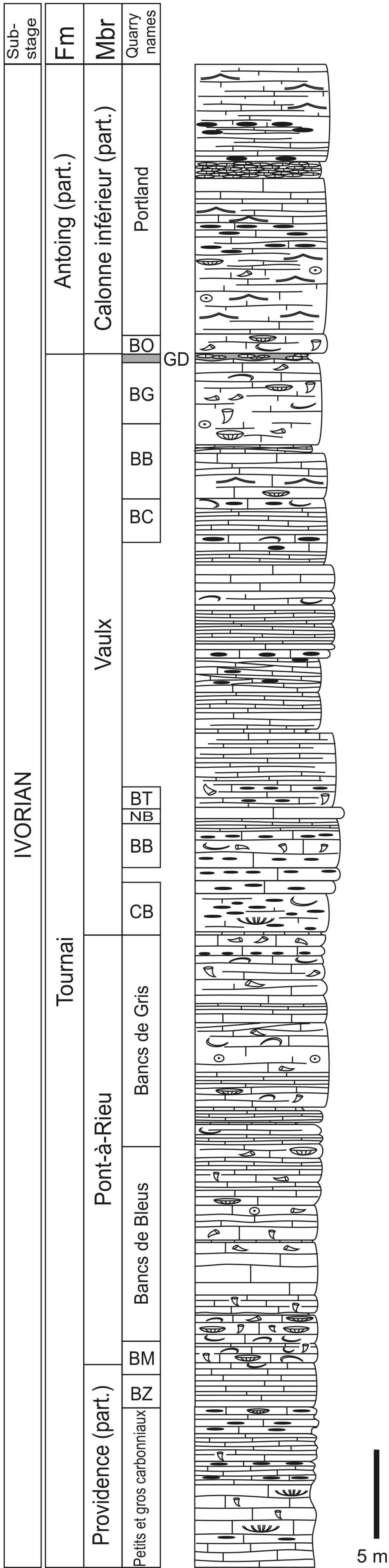


Fig. 48: Lithological log of the units quarried in the Tournai quarries. Legend: BZ: "Bleuzettes", BM: "Bancs à Moules", CB: "Carbonniaux", BB: "Bancs Bleus", NB: "Noirs Bancs", BT: "Bancs tigrés", BC: "Bancs à Carbonniaux", BB: "Bancs de Bleu", BG: "Bancs de Gris", GD: "Gras Délit", BO: "Bancs à Chonetes". Modified after MORTELMANS (1976).

The Antoing Fm begins with the lower Calonne Mbr (21 m) constituted of dark grey argillaceous and siliceous limestone usually poor in fossils, except its base that present the same facies and fossil association as the top of the underlying Vaulx Mbr ("Bancs à Chonetes", BO on Fig. 48). Upward, the beds are more regular in thickness and the fossil content decreases rapidly. The upper part shows only rare cephalopods and lingulid brachiopods. The facies evolved upward from wackestone to mudstone and the bioclasts become smaller. Bioturbations are particularly abundant: mainly the helicoidal *Zoophycos*, but also sinuous *Phycosiphon* (GAILLARD et al. 1999). Cherts are common through the whole member. The Vignoble Mbr (VIG on Fig. 46) is a lateral equivalent of the Calonne Mbr, with the same facies but showing large-scaled cross-stratifications. The upper Calonne Mbr is composed of bioturbated mudstone with rare brachiopods and bryozoans (DOREMUS & HENNEBERT 1997).

Interpretation

MORTELMANS (1976) explained the absence of algae and foraminifers by the siliciclastic input creating turbid waters unsuitable for these organisms. After GAILLARD et al. (1999), the sediments deposited within the aphotic zone as indicated by the lack of photosynthetic organisms and the presence of *Sphaerinvia*, a microorganism restricted to the deep environment in the Tournaisian. The floatstone layers common in the Tournai Fm corresponds to tempestites that reworked both bottom fauna and planctonic organism such as cephalopods.

MORTELMANS (1976) also highlighted that the macrofossils are almost never wear out nor broken, that they are size-sorted and rarely dislocated (pelecypods with two shells attached, rugose corals with protocorallite preserved, trilobites and pelamtozoan stems in anatomical connection). The faunal association results form an in situ accumulation in which the elements are autochthonous and not (or few) displaced.

The rugose coral fauna is composed entirely of solitary ceratoid and cylindrical forms among which many show rejuvenescence features and



radical changes in the direction of growth. These features are due to unstable environment, soft bottoms, occasional turbulences or the action of large benthic organisms that unbalance and tip over the corals. CHANTRY (2001) observed in the Antoing Fm numerous *Caninia* showing only juvenile stages that seem to have died prematurely in this unsuitable environment.

Nevertheless, the morphological variability of the *Caninia cornucopiae* and the resemblance of its juvenile stages with "zaphrentid" corals as *Proheterelasma*, *Zaphrentites*, *Sychnoelasma*, *Hapsiphyllum* and *Saleelasma*, as well as the presence of ubiquitous taxa as *Amplexus* and *Pentaphyllum* probably indicate that the environment was stable and the natural selection very weak.

The sedimentary and sequence stratigraphical analysis of the Tournai limestone is still poorly known, as well as the correlation of the Tournaisian units of Tournai with their equivalent in the Soignies area and the other sedimentation areas.

After DEVUYST et al. (2005), the Pont-à-Rieu and Vaulx Mbr correspond to the upper part of sequence 3 and the sequence boundary should correspond to the erosive base of the "Gras Délit", whilst the Antoing Fm should correspond to the TST of sequence 4. The "Gras Délit" corresponds most probably to a bentonite derived from weathered volcanic ashes (cf. "Délit à la Terre bleue" in Soignies, DELCAMBRE 1982, GAILLARD et al. 1999).

This alternation seems to correspond to climatic cycles. HENNEBERT (1996) analysed the couplet thin bed-thin interbed and thick bed-thick interbed by Fournier analysis and obtain a cyclicity close to 100 ka which correspond to eccentricity cycles (Fig. 49).

### Biostratigraphy

The facies of the Tournai and Antoing formations are usually unsuitable for both foraminifers and conodonts. The guide taxa are thus lacking and no precise dating available.

However, the rugose corals give an incomplete insight: typical Ivorian fauna are common (*Caninophyllum patulum*, *Sychnoelasma konincki*) and indicate RC3 subzone *s.l.* The Providence Mbr yielded the typical association of the RC3 $\alpha$  subzone. The Pont-à-Rieu and Vaulx members yielded an impoverished fauna dominated by *Caninophyllum patulum* and *Siphonophyllia cylindrica*. These members could be attributed to the RC3 $\beta$  subzone that is characterized by an impoverished coral fauna comparatively to the RC3 $\alpha$ . Unfortunately, no younger guide taxa could indicate the base of the RC3 $\gamma$  subzone.

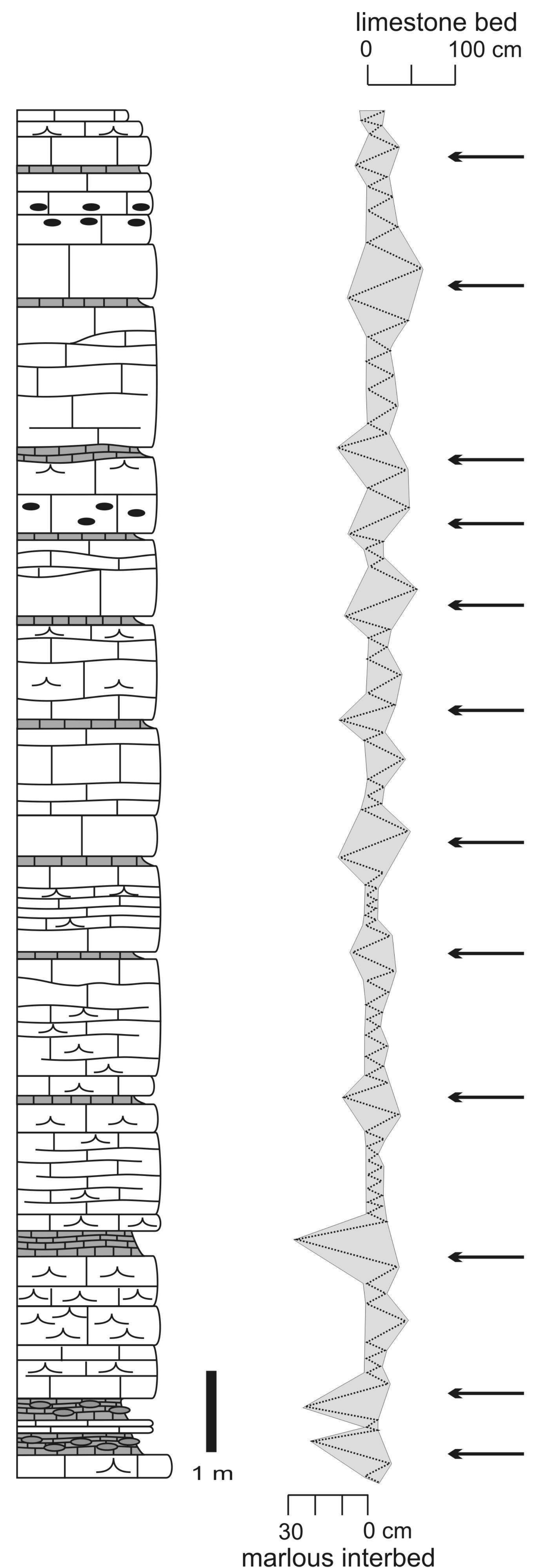


Fig. 49: Cyclostratigraphic analysis of the Providence Mbr based on limestone beds/marly interbeds couplets. Modified after HENNEBERT (1996).



**Main faunal component**Tournai Fm, Providence Mbr, Ivorian, RC3α:

*Cyathaxonia cornu*  
*Saleelasma* cf. *delepini*  
*Hapsiphyllum* sp. nov.  
*Zaphrentites delanouei*  
*Sychnoelasma konincki*  
*Caninia cornucopiae*  
*Caninophyllum patulum*  
*Proheterelasma omaliusi*  
*Syringopora* sp.  
*Cladochonus michelini*  
*Michelinia favosa*

Tournai Fm, Pont-à-Rieu Mbr, Ivorian, RC3β?:

*Cyathaxonia cornu*  
*Hapsiphyllum* sp. nov.  
*Zaphrentites delanouei*  
*Caninia cornucopiae*  
*Siphonophyllia cylindrica*  
*Siphonophyllia* sp. nov.  
*Caninophyllum patulum*  
*Eostrotion tortuosum*  
*Aulokoninckophyllum* sp.  
*Proheterelasma omaliusi*  
*Syringopora* sp.  
*Cladochonus michelini*  
*Michelinia favosa*  
*Michelinia megastoma*

Tournai Fm, Vaulx Mbr ("Bancs de Gris"), Ivorian, RC3β?:

*Amplexus coralloides*  
*Cyathaxonia cornu*  
*Proheterelasma omaliusi*  
*Zaphrentites delanouei*  
*Sychnoelasma konincki*  
*Caninia* sp. nov. B  
*Caninia cornucopiae*  
*Siphonophyllia* sp. nov. A  
*Siphonophyllia cylindrica*  
*Caninophyllum patulum*  
*Syringopora* sp.  
*Cladochonus michelini*  
*Cladochonus* sp.  
*Michelinia favosa*  
*Michelinia tenuiseptata*  
*Lophophyllum konincki*  
*Paleacis* sp.  
*Paleacis* cf. *smithi*  
*Beaumontia konincki*

Antoing Fm, Calonne lower Mbr, Ivorian, RC3β?:

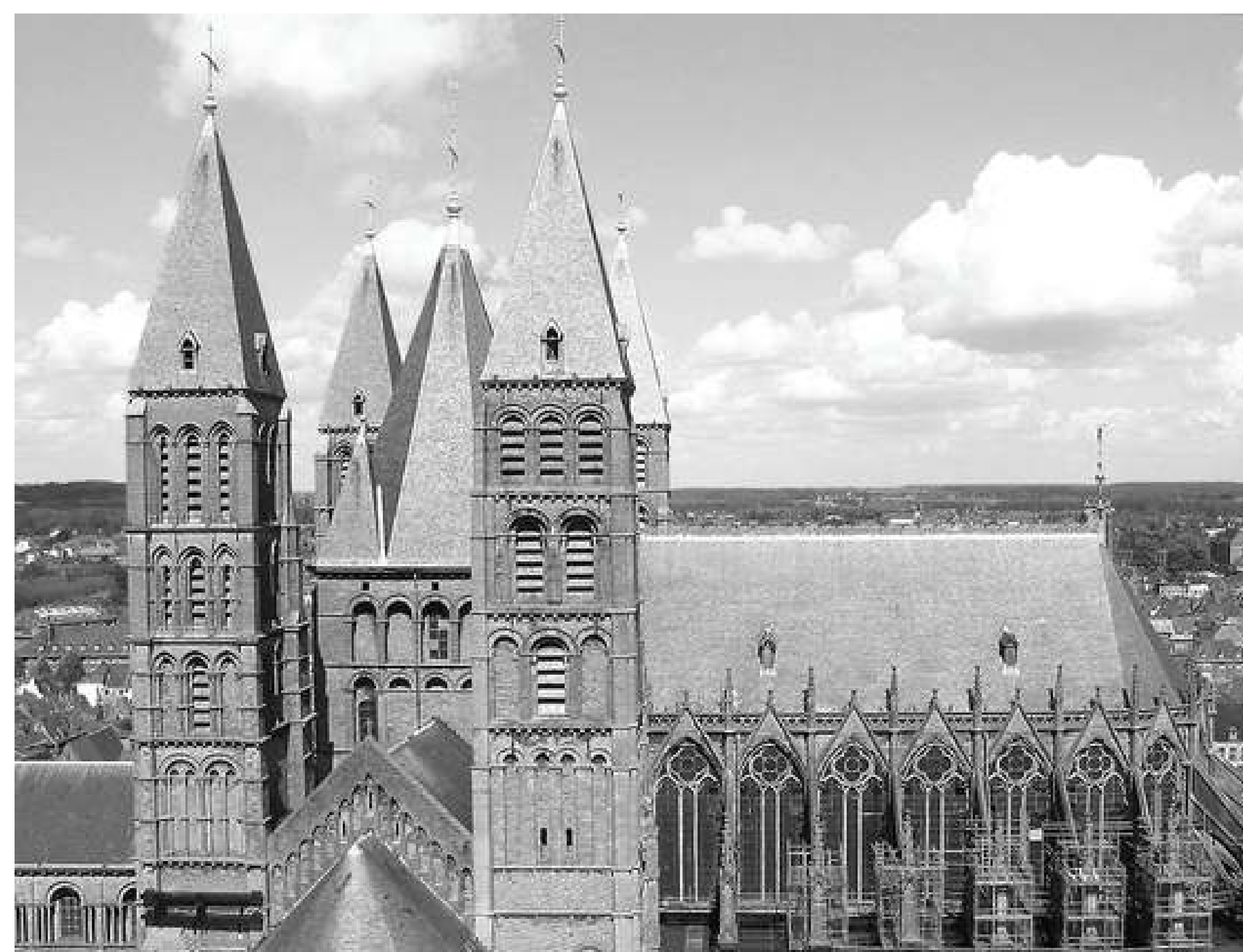
*Amplexus coralloides*  
*Proheterelasma omaliusi*  
*Caninia cornucopiae*

Antoing Fm, Calonne upper Mbr, Ivorian, RC3β?:

*Pentaphyllum* sp.  
*Caninia* sp.

Classical collection, from indetermined level in the classical Tournai quarries

*Rhizopora tubaria*  
*"Michelinia megastoma"*  
 cf. *Microcyathus konincki*  
*Stratophyllum tenue*  
*Squameophyllum spumans*  
*Yavorskia compressa*  
*"Aulopora" campanulata*



**Cultural notice:** Notre-Dame Cathedral in Tournai is one of the most impressive medieval construction of Europe, combining the Romance style nave and the central part with the towers and the Gothic choir. The Cathedral of Tournai succeeded to many small churches built since the premises of the Christian tradition. The building of this architectural masterpiece lasted from approximately 1146 until 1325, with additions and modifications in later centuries. Around 1198 the transepts and the vaults were added in a style tinged with Norman and Rhenish influences, then 5 towers were constructed above the transept. In 1242 the original eastern absis of the church is replaced by a Gothic choir with extraordinary dimensions: 58 m long and 47 m high. Among the other important art treasures inside the church are several paintings by some of the most important artists of their times, including the "Purgatoire" supposed to be painted by Rubens. In the transepts several Romanesque wall paintings can be seen. On the front of the church and the porch a lot of important Romanesque sculptures can still be admired. Furthermore, the cathedral is home to Shrine of Notre-Dame and the Shrine of Saint Eleutherius, two of the most beautiful art treasures in Belgium. Since December 2000, the Cathedral of Tournai is classified as UNESCO World Heritage.



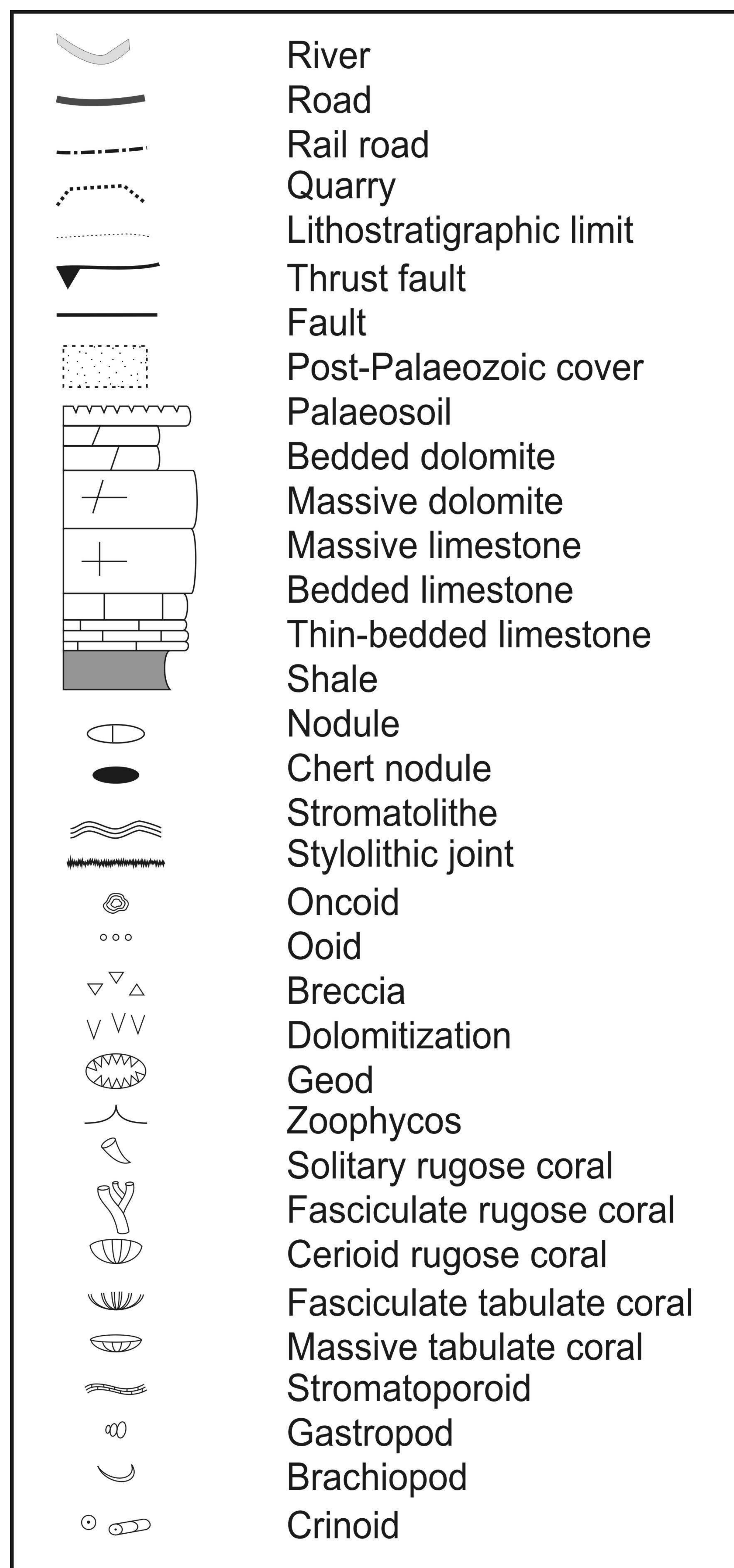


Fig. 50: Key for symbols used in Fig. 5–49.

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