TERRAIN avec la Société Géologique du Nord

SGN
SOCIÉTÉ GÉOLOGIQUE DU NORD

PROGRAMME DES SORTIES SUR HTTP://SGN.UNIV-LILLE1.FR

SAMEDI 13 MAI 2017 - 10h00

LE PHENOMENE RECIFAL AU GIVETIEN ET AU FRASNIEN EN WALLONIE

Thème :
Sédimentologie, Paléontologie,
Industrie extractive en carrière

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Programme prévisionnel :
- 10h-12h 30 : Carrière en activité de la Boverie à Rochefort : coupes multiples dans des récifs superposés du Frasnien moyen. Communautés récifales variées et variations du niveau marin, faciès récifaux et faciès de flanc. En introduction : usage industriel des roches exploitées et précisions techniques.
- 14h 30 – 15h 30 : Carrière abandonnée du Tiers Cocrai à Havrenne-Humain : récif à éponges du Frasnien supérieur. Bioconstruction à faible biodiversité, dominée par un consortium éponges-bactéries.
- 16h – 17h 30 : Carrière abandonnée de Resteigne : récif-barrière du Givetien et environnements associés : semelle récifale, avant-récif, récif à coraux et stromatopores, arrière-récif, lagon. Migrations de la barrière récifale en fonction des variations du niveau marin. Microbialites littorales

Rendez-vous : Départ à 7h45 depuis le bâtiment SN5, Université de Lille, Villeneuve d'Ascq (2h1/4 de route) ou rendez-vous à 10h près des bureaux de la société Lhoist Industrie S.A, Rue du Gerny 12, 5580 Jemelle, Belgique.

Durée : 10h00 - 17h30. Repas du midi pris dans un café. Boissons à acheter sur place. Casse-croûte à apporter.

Matériel : chaussures de terrain ou bottes (en fonction du temps), gilet réfléchissant, casque, parapluie ou imperméable, carnet de terrain, appareil photos, marteau, loupe.

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Université de Lille
1 SCIENCES ET TECHNOLOGIES

INSCRIPTION OBLIGATOIRE
avant le 22 avril 2017

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INTRODUCTION

Belgium shows surprising geological diversity over its small area (Fig. 1). Almost all types of sedimentary rocks crop out, and are generally preserved along well-described and easily accessible sections or in quarries (Boulvain & Pingot, 2015). Several sections are known worldwide and are visited for stratigraphic or sedimentological purposes. Magmatic rocks however are not abundant and metamorphic rocks are restricted to slates. The stratigraphic scale ranges from Cambrian to Quaternary, which translates to a half billion years of Earth history. Two orogenic phases shaped the Lower Paleozoic inliers and the Devonian-Carboniferous faulted and folded belt.

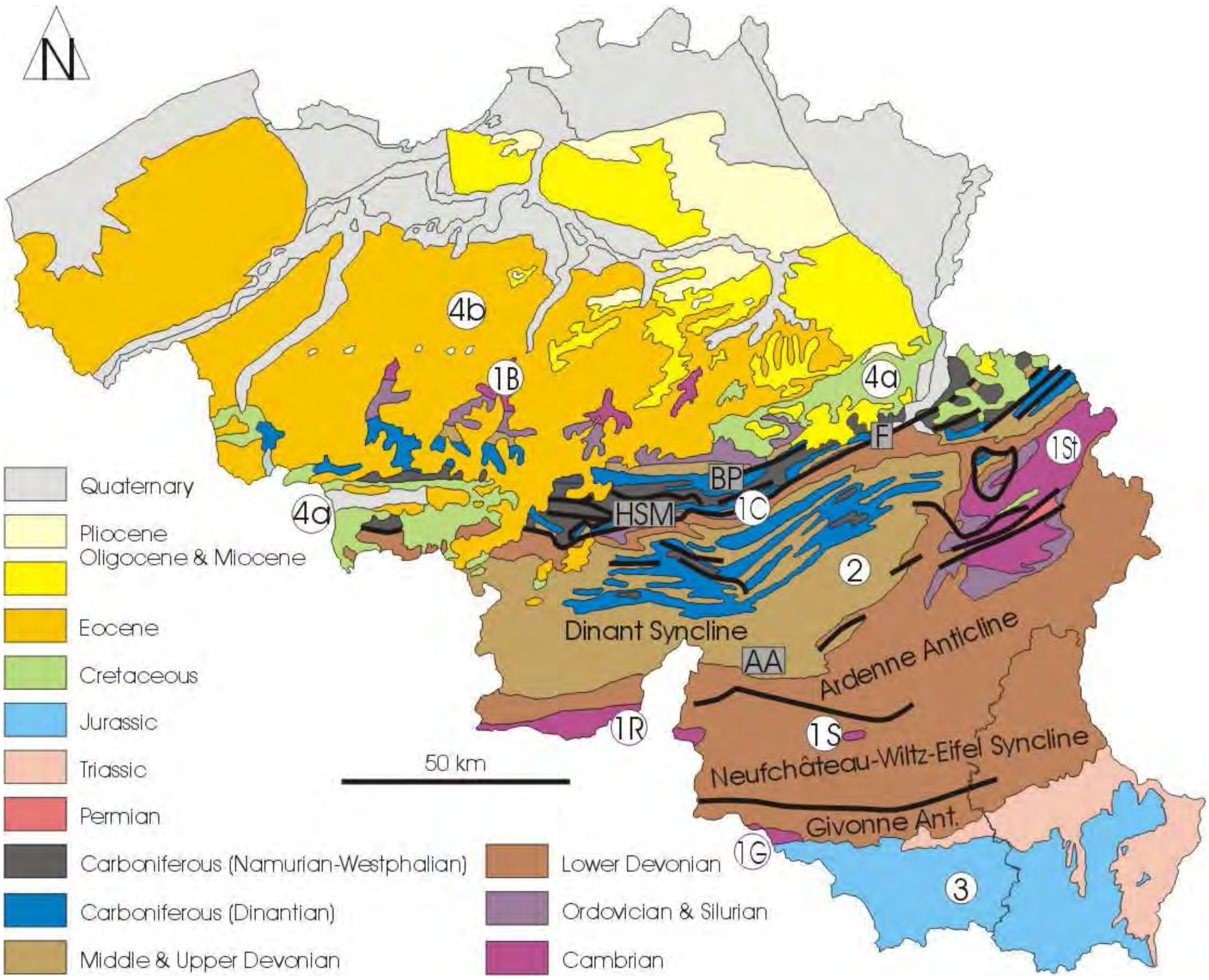

Fig. 1. Schematic geological map of Belgium and Luxembourg. (BP): Brabant parautochthon, (AA): Ardenne allochthon, (F): Midi-Eifel Fault, (HSM): Haine-Sambre-Meuse thrust sheets, (1B): Brabant Lower Paleozoic massif, (1C): Condroz LP inlier, (1St): Stavelot LP massif, (1R): Rocroi LP massif, (1S): Serpont LP massif, (1G): Givonne LP massif, (2): Devonian-Carboniferous faulted and folded belt, (3): monoclinal Triassic-Jurassic series, (4a): Cretaceous subhorizontal cover, (4b): Cenozoic subhorizontal cover.

The Middle Devonian formations crop out along the borders of the Dinant Syncline and eastern equivalents. Formations from this time also appear in the Haine-Sambre-Meuse thrust sheets and the Brabant parautochthon.

During the Middle Devonian, a drastic transgressive regime was aroused. The rising sea level is responsible for an extension of the Rheic ocean north of the future Midi-Eifel fault, up to the Brabant parautochthon and simultaneously, the Lower Devonian detrital facies gave way to argillaceous limestone and to the first carbonated platforms (Bultynck et al., 1991).

The Eifelian marks the transition between the old detrital and the new carbonate world. Facies are still mixed and carbonate platforms, laterally restricted, and still surrounded by shale. At the onset of the Givetian however, a huge carbonate platform is established over southern Belgium. The coast at this time was located near the Brabant massif. The spectacular development of carbonates was probably related to a warmer climate (Belgium was situated between the Equator and the Capricorn tropic) and to a dramatic decrease in detrital supply coming from the Old Red Sandstone Continent. Along the southern border of the Dinant Syncline, the Givetian platform is well developed and characterized by 450 m of limestone including fore-reef, reef and lagoon environments (Boulvain et al., 2009). This thickness decreases northerly to a hundred of meters, with typical littoral carbonates.

During the Frasnian, a transgressive phase brought the coastline farther to the north, perhaps flooding the entire Brabant massif. A shale unit, several tens of meters thick (Nismes Formation) concealed the entire drowned Givetian platform. After this episode, a carbonate platform redeveloped, shifted northward relative to the Givetian platform (Fig. 2). The southern border of the Dinant Syncline shows three stratigraphic levels bearing Frasnian carbonate mounds (Boulvain, 2007). These are, in stratigraphic order, the Arche, the Lion and the Petit-Mont Members. In the Philippeville Anticline, only the upper level contains mounds (Petit-Mont Member). The other carbonate mound levels are replaced laterally by bedded limestone or dolomite, with local back-reef character. At the northern border of the Dinant Syncline and in the Brabant Parautochton, the entire Frasnian consists of bedded limestone and argillaceous strata (Da Silva & Boulvain, 2004).

Among the various Palaeozoic carbonate mounds known throughout the world, the Frasnian Petit-Mont carbonate mounds of Belgium are probably the earliest studied. This remarkable interest carried by generations of geologists derives from the number and quality of outcrop: currently 69 carbonate mounds are known and the majority were actively quarried for "marble" (not in a strict petrographic meaning). Consequently, several hundred square meters of sawn sections are accessible for studies. The Petit-Mont mounds are 30 to 80 m thick and 100 to 150 m in diameter They are embedded in shale and nodular shale. The first carbonate mound facies consists of red limestone with sponges, and becoming progressively enriched in crinoids and corals, then in stromatopores (calcified sponges) and cyanobacteria. The red pigment is derived from microaerophilic iron bacteria.

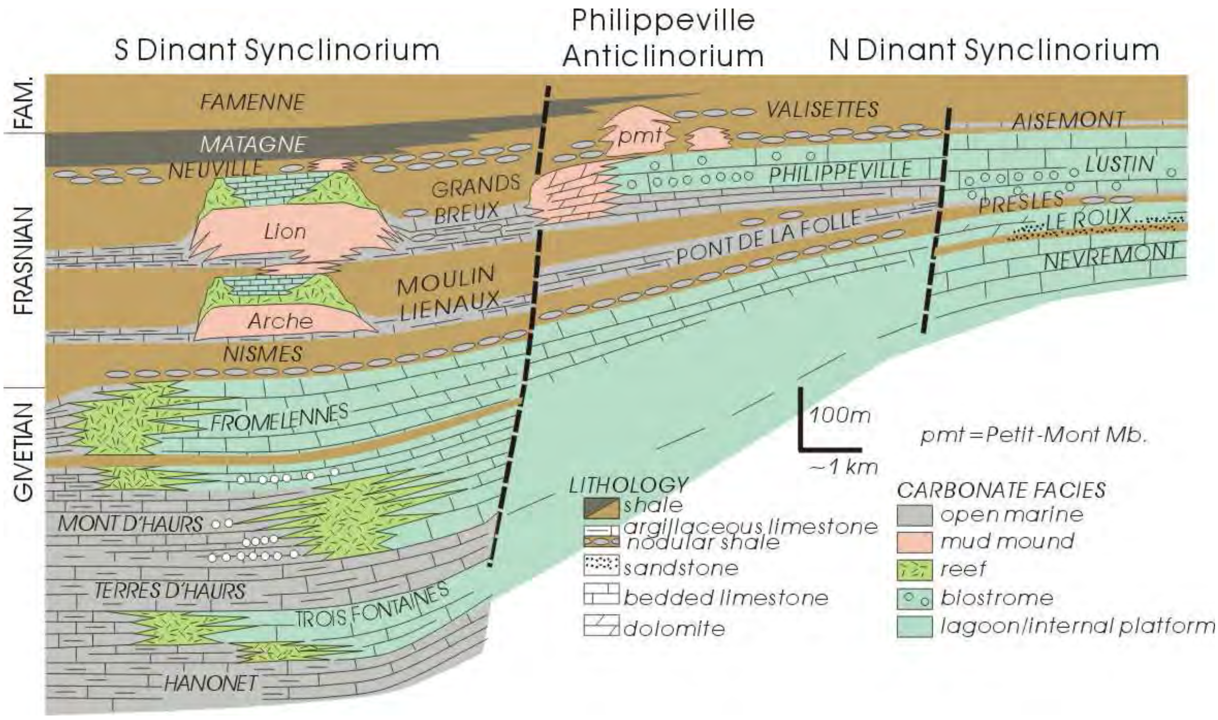

Fig. 2. North-south transect through the Dinant Syncline before Variscan tectonism showing the Givetian and Frasnian formations.

After the drowning of the Frasnian carbonate platform under transgressive shale, the Famennian Stage marked a complete renewal of seascapes. A clear regressive trend brought the coastline south of the Brabant massif and carbonates were replaced by detrital sediments.

STOP 1 – LA BOVERIE QUARRY (Rochefort)

References
Lecompte (1956)
Boulvain et al. (2004, 2005)
Boulvain & Coen-Aubert (2006)
Boulvain (2007)
Da Silva et al. (2011, 2014)

Location and access
Active quarry along the road from Marche-en-Famenne to Rochefort, near Jemelle. Southern border of the Dinant Synclinorium.

Stratigraphical units and age
Moulin Liénaux Fm., Grands Breux Fm., Neuville Fm. (Frasnian).

Highlights
La Boverie quarry is located at the south-eastern edge of the Dinant Synclinorium, on the Gerny plateau. From the ~3,5 km large Arche and Lion mounds, the La Boverie quarry

intersects about 1.1 km sediment, mainly corresponding to the central part of the buildups The series of buildups exposed in the quarry is nearly 220 m thick (Figs 3, 4, 6).

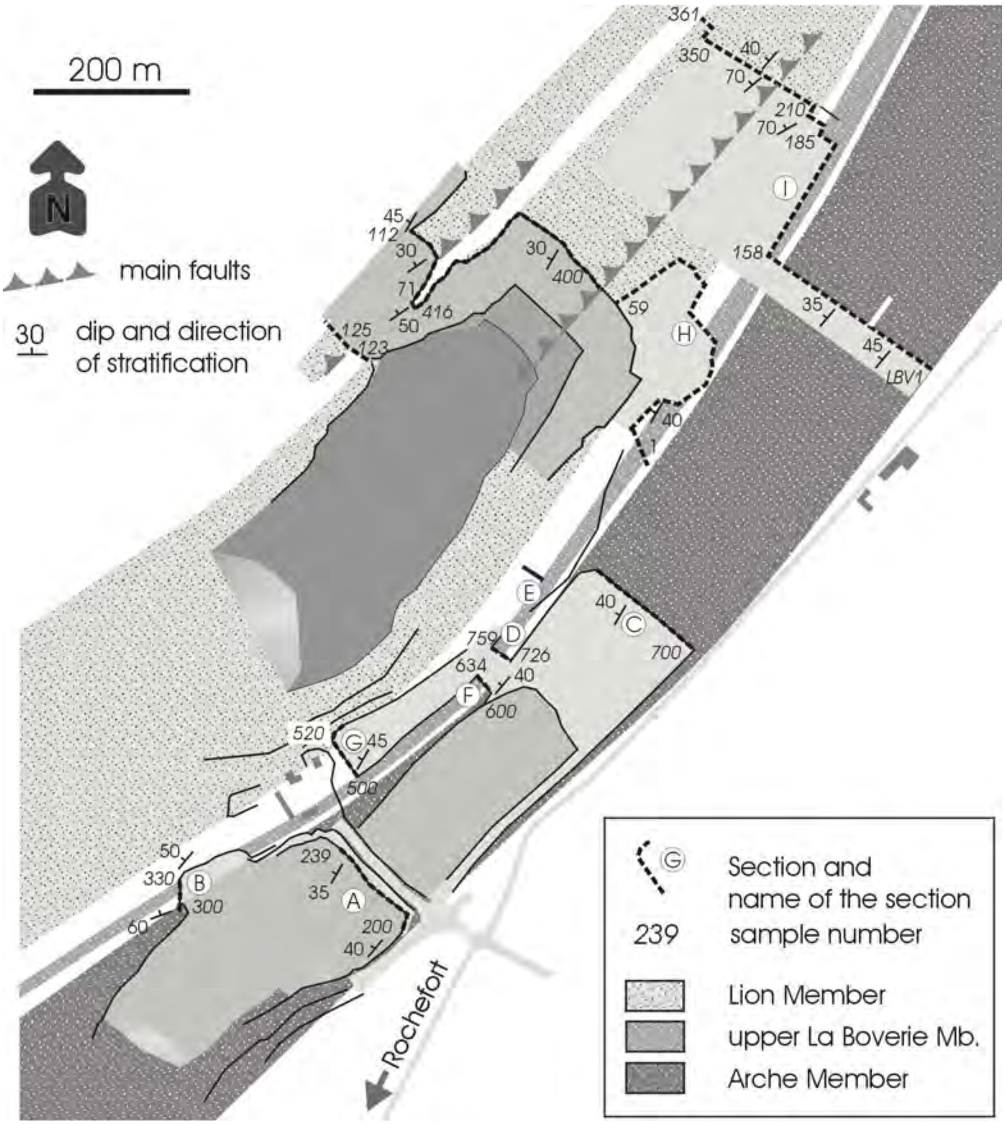

Fig. 3. Geology of the La Boverie quarry and studied sections (A-I).

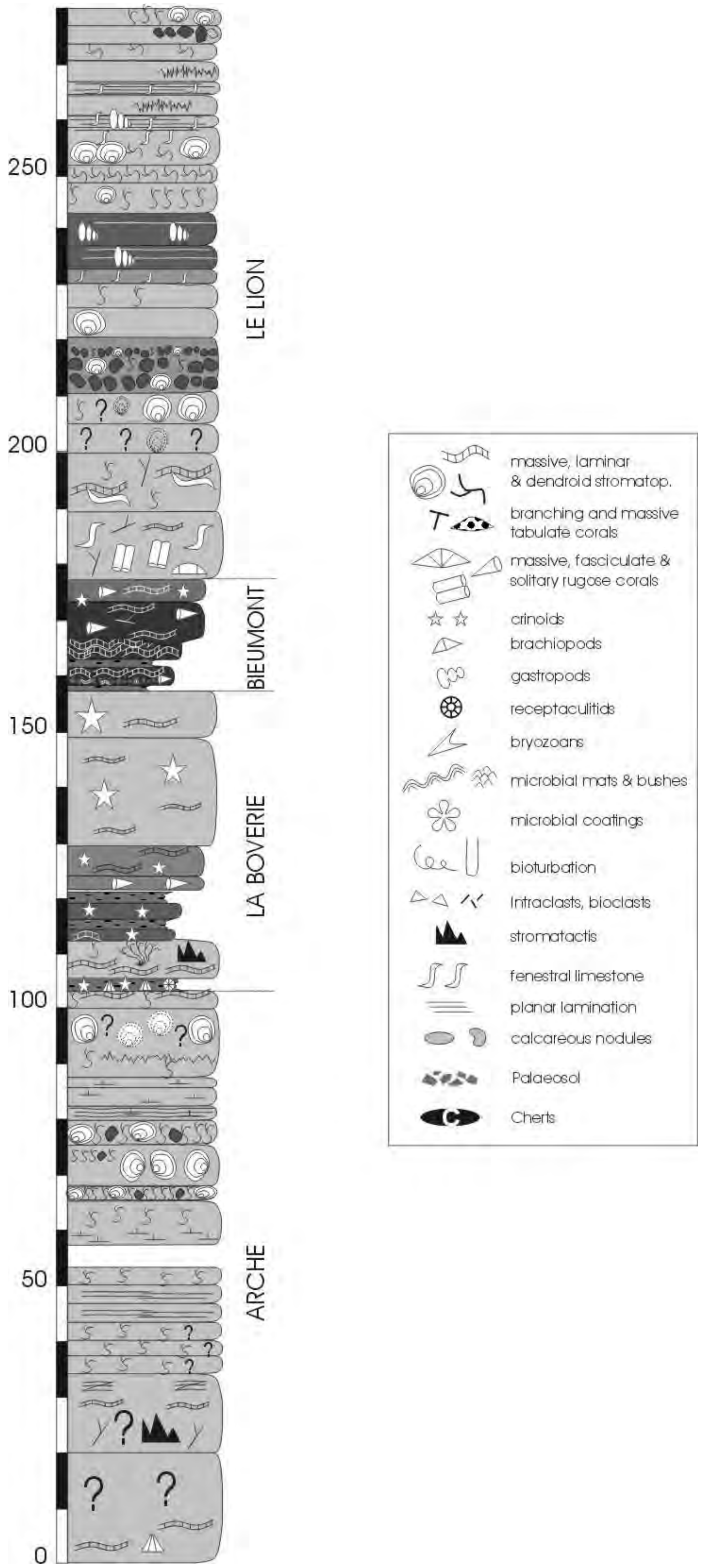

Fig. 4. Log of section I (see Fig. 3 for location) from the La Boverie quarry (Da Silva et al. 2011). Explanation of symbols.

Roughly, the two generations of buildup began with grey or pinkish floatstone containing stromatactis, corals and stromatoporoids (A-L3). After about 40 to 70 m of this facies forming the bulk of the mounds, the grey algal A-L4 facies began to develop, including microbial bindstone or bafflestone lenses (A-L5), which tend to coalesce upwards. More restricted facies (A-L6-7) developed in the central part of the buildups. Microbioclastic packstones (b) mainly occur in off-mound facies. In this facies, the influence of reefs on the sediment budget remains relatively low. On the other hand, the lithoclastic grainstones and bioclastic rudstones are facies where extensive supply of reefal debris is significant (B and L). This reefal input consists of bioclastic-lithoclastic sediment reworked from the mound and deposited by debris flows showing decimetre-deep basal erosion structures (Humblet & Boulvain 2001).

The top of the Arche Member is particularly well-exposed in this quarry. It consists of grey massive limestone with microbial mats and/or dendroid stromatoporoids (A-L5-6). This shallow facies forms usually the upper part of the Arche and Lion Members. Above this and with a sharp contact, there is dark shale including bioclastic lenses or beds (lower part of the La Boverie Member). This implies the collapse of the Arche mound carbonate factory with the deposition of relatively deep argillaceous sediments. Very locally, carbonate production is maintained, but shows a severe facies retrogradation and the replacement of a microbial mat-dendroid stromatoporoid assemblage by a sponge-coral-crinoid assemblage locally red colored by iron bacteria. Later, the carbonate accumulation increases and the shale is replaced upwards by argillaceous bioclastic limestones. Growing centres remain localized. This unit corresponds to the lower part of the intermediate buildup. The next unit is laterally homogeneous. It consists of a massive, generally light grey limestone rich in dendroid or massive stromatoporoids, tabulate corals and microbial mats. This is a shallow facies, close to that from the top of the Arche Member. This rapid transition and the lateral progradation of a relatively shallow facies over deeper bioclastic sediments or mound facies are obvious in all sections. It suggests a sudden restart of the shallow-water carbonate factory, probably related to a sea-level fall. This second unit corresponds to the upper part of the La Boverie Member. Hardgrounds are locally developed on the top of the buildup.

The transition to the Bieumont and Lion Members resembles that between the Arche and La Boverie Members. It is mainly characterized by the collapse of the carbonate factory with widespread deposition of shale and bioclastic limestone lenses, except in some local areas where buildup development keeps on. These isolated "survival" mounds show again a return to the deeper sponge-coral-crinoid assemblage (A-L2).

The more argillaceous facies which follow are ascribed to the Bieumont Member. The relatively thick Lion Member overlies these argillaceous-bioclastic facies. Above this mound, there are more or less nodular calcareous shale belonging to the Boussu-en-Fagne Member, which is succeeded by the Neuville Formation.

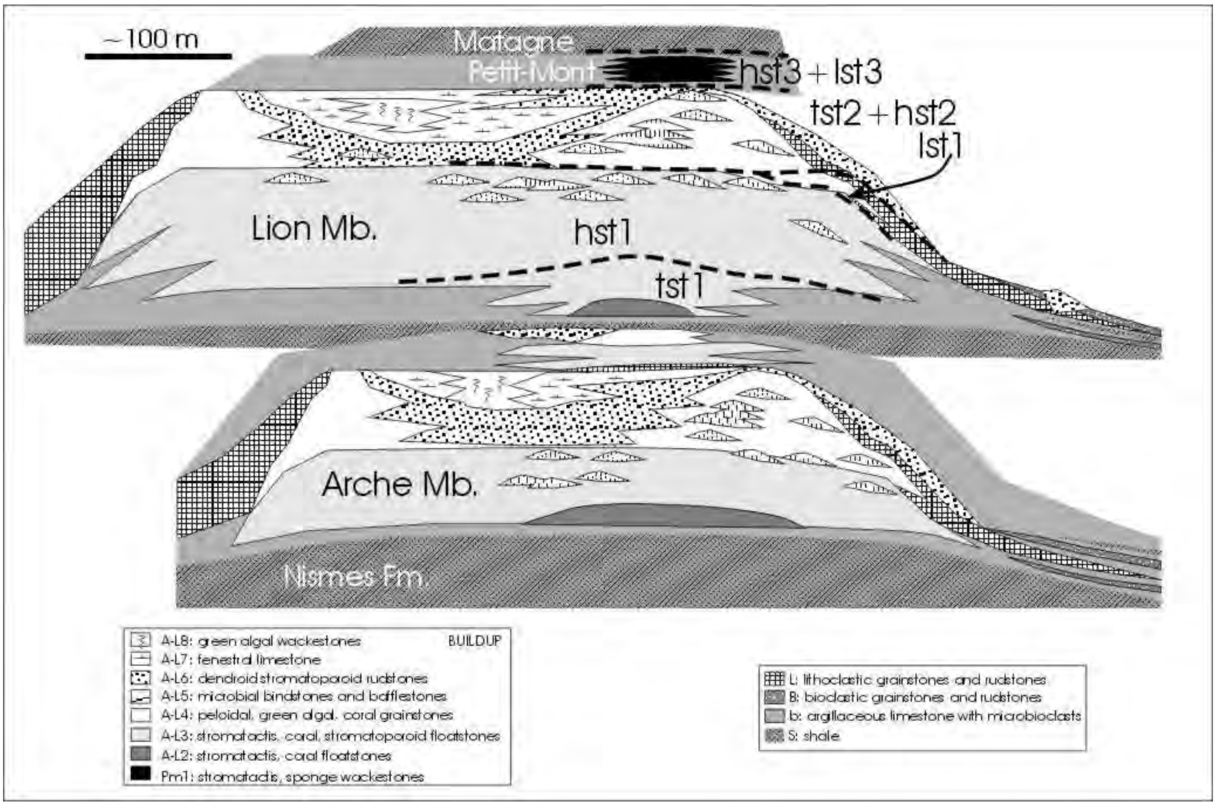

Fig. 5. Sedimentological model from the La Boverie quarry (Boulvain, 2007).

Short industrial information and history of the site (by Alain Lauwers)
The lime plant of Jemelle was built by Mr. Léon Lhoist along the main railway line Brussels-Luxembourg in the year 1924. At that time the lime kilns were fed by adjacent quarries mining the Givetian limestones. The natural market of the plant was the steel industry of Luxembourg.

In the mid-1950s however, the limestone quality proved insufficient to meet the more and more demanding steel specifications, especially in terms of silica and sulphur contents. Though the Léon Lhoist Co. was fortunate enough to find an alternative deposit of high quality limestone 4 km north of the Jemelle plant where the La Boverie Quarry could be developed. The quarry faces opened in the 2 purest mounds of Arche (F2d *auct.*) and Lion (F2h *auct.*) were progressively merged to form a 600 m-long single face, developed on five 15 m-high benches. The reef facies consist of high purity limestones with $CaCO_3$ contents over 98 wt%.

Today, the quarry raw output is around 2 Mt per year and the kilnfeed stone produced is feeding modern lime kilns with a combined capacity of 0.5 Mt of quicklime per year, *i.e.* 20-25 % of the lime produced in Belgium.

The main market still delivered today is the steel industry which exceeds 80 % of the production. Other markets served by the Jemelle plant are the environment, the chemical industry and construction (please refer to the Enclosure illustrating the lime applications at home and in the industry - in French).

The Jemelle plant benefits from a good logistics : its railway connection and the vicinity of the main roads E411 and N4.

Its difficulty however is the limited reserves offered by the deposit especially due to the major limitation in the deepening of the quarry : no mining under water is currently permitted due to the use of water by the nearby Saint-Remy Abbey (founded in 1230) where the famous "Rochefort" Trappist beer is brewed...

STOP 2 – TIERS COCRAI QUARRY (Havrenne/Humain)

References
Boulvain (1993, 2001, 2012)

Location and access
Disused quarry near Havrenne/Humain, between Rochefort and Marche-en-Famenne. Southern border of the Dinant Synclinorium.

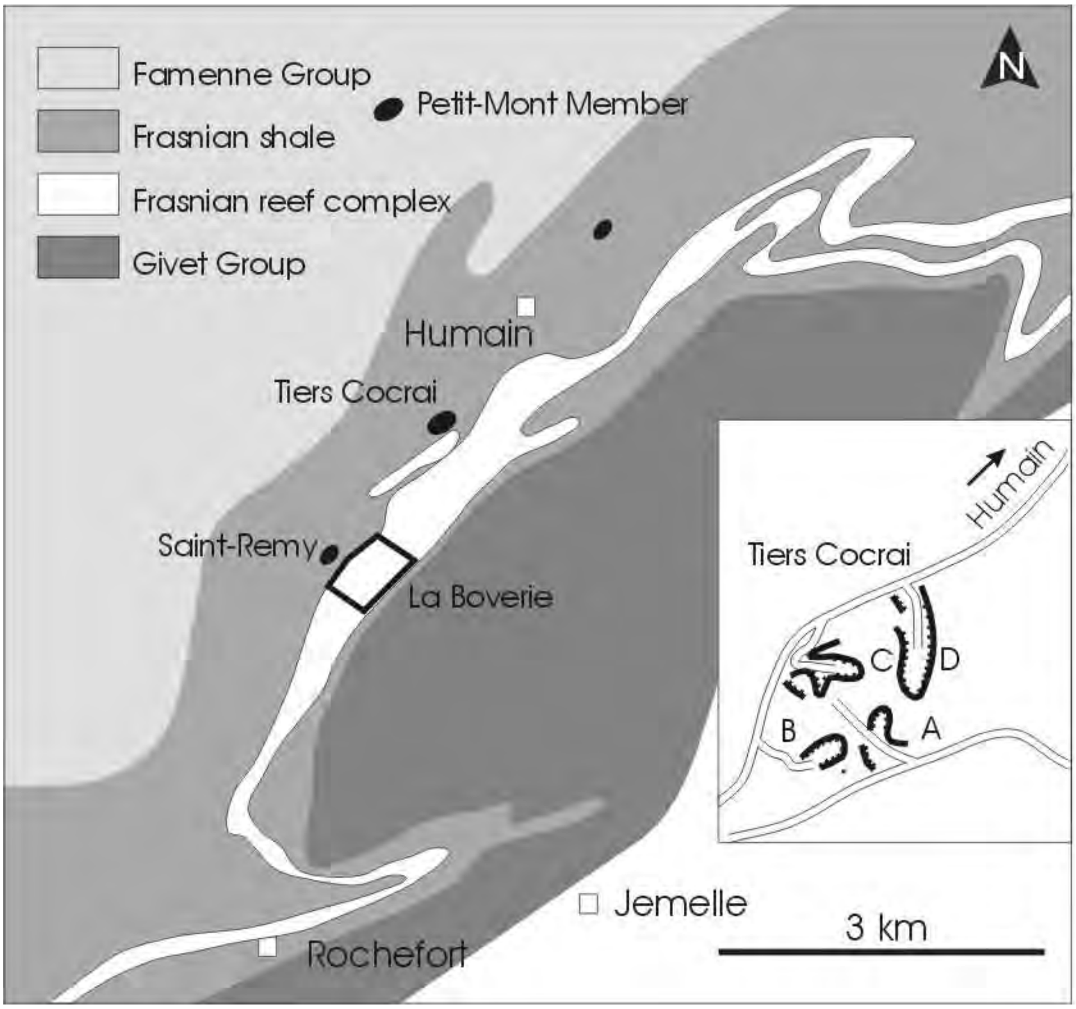

Fig. 6. Location of the La Boverie and Tiers Cocrai quarries.

Stratigraphical units and age
Petit-Mont Member (Frasnian).

Highlights
This quarry shows beautiful sections in one of the most famous facies from the Petit-Mont member mounds: spiculitic wackestone with stromatactis (facies Pm1, Fig. 6). This facies,

known as “Belgian red marble” or “Griotte” corresponds to iron bacteria–sponge-dominated communities, developing in a quiet aphotic and hypoxic environment (Boulvain, 2007; Boulvain et al., 2001).

The intense red pigmentation of this facies is the consequence of a hematite content up to 5% Fe_2O_3. The occurrence of stromatactis is variable. Stromatactis may be grouped in metre-scale beds forming a reticulate structure and exceeding 50% of the rock. Stromatactis may exceed 50 cm in length, but generally diminish in size towards more argillaceous zones. Stromatactis are cemented by inclusion-rich radiaxial calcite. The cement overlies various types of internal sediment. A strict geometrical relationship between spicular networks and stromatactis does not exist: spicules can overlie, penetrate or form concentrations below stromatactis. Bourque & Boulvain (1993) concluded that stromatactis formed from sponge degradation in a relatively coherent, gel-like sediment. Cavities left after degradation evolved within sediment by collapse of the upper part and internal sedimentation on the base. It seems noteworthy that, in spite of the presence of sponges in argillaceous limestone below the carbonate mounds, no stromatactis were observed.

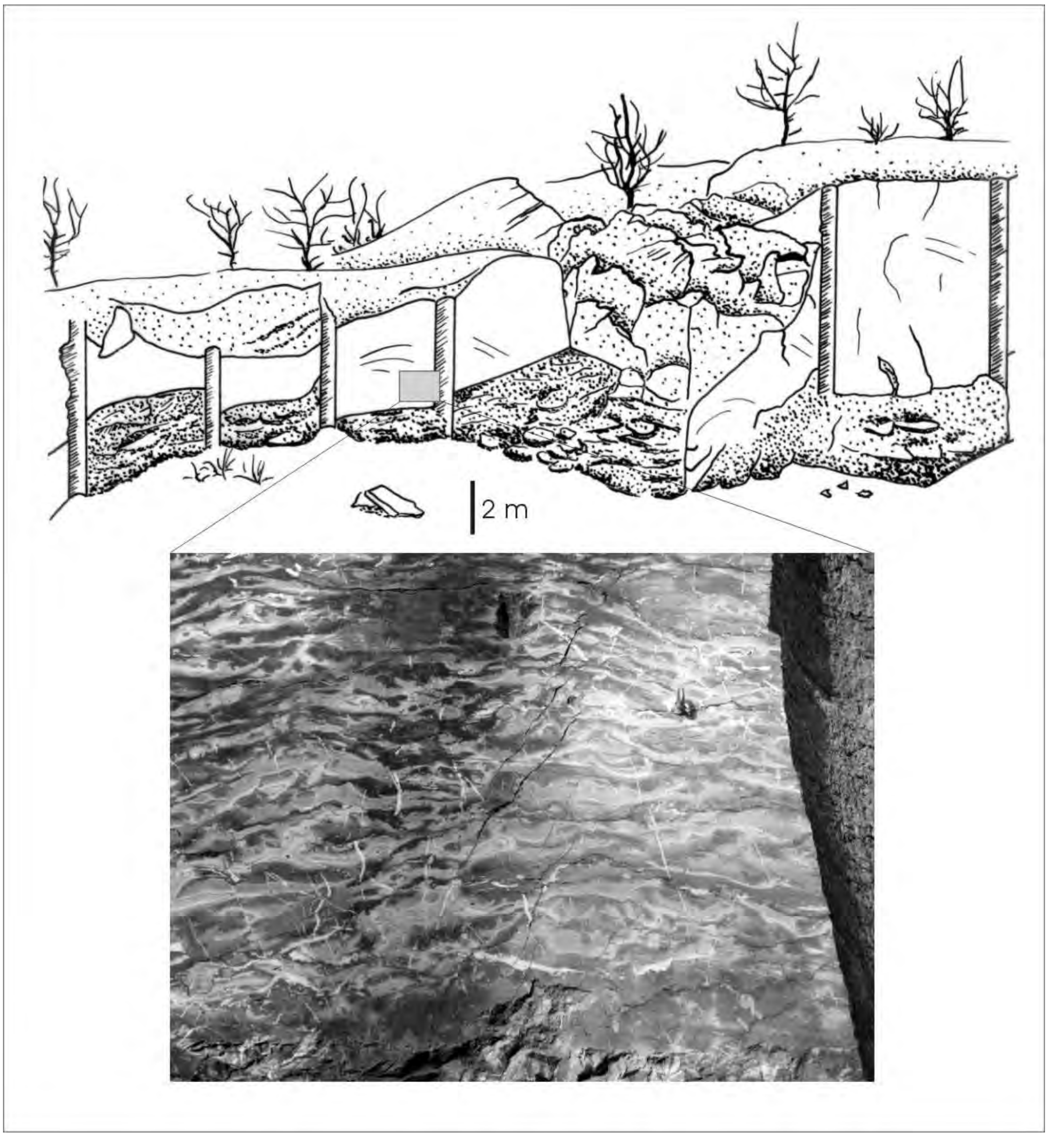

Fig. 7. Red marble with stromatactis in the Tiers Cocrai quarry.

STOP 3 – RESTEIGNE QUARRY

References
Coen-Aubert (1977, 2003)
Préat et al. (1984)
Coen-Aubert et al. (1986)
Casier & Préat (1990, 1991)
Boulvain et al. (2009)

Location and access
Disused quarry near the Lesse River in Resteigne. Southern border of the Dinant Synclinorium (Fig. 8).

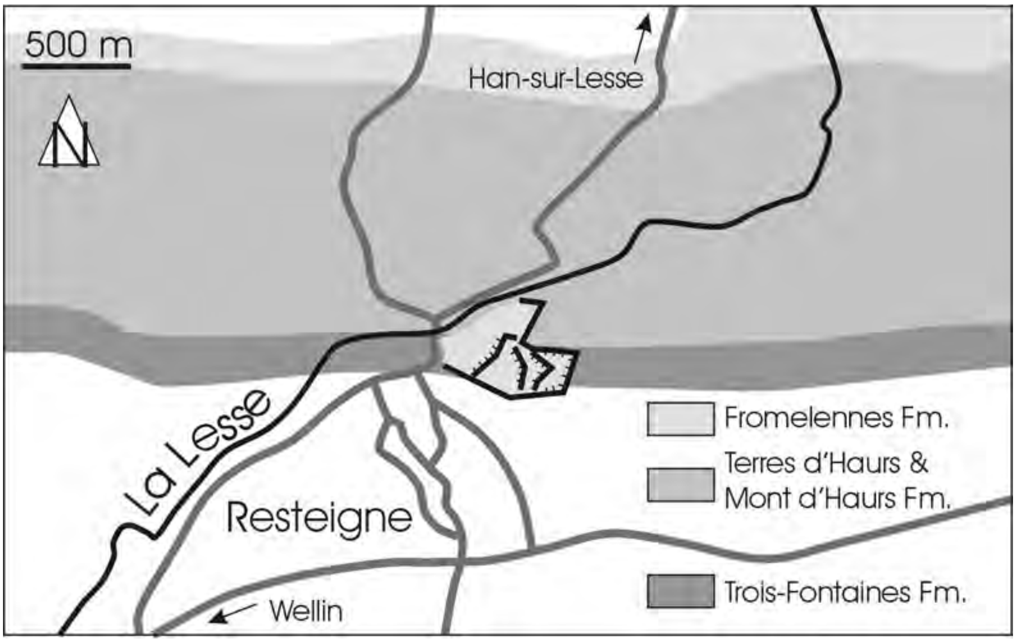

Fig. 8. Schematic geological map of the Resteigne area.

Stratigraphical units and age
Hanonet Fm. (Givetian), Trois-Fontaines Fm (Givetian), Terres d'Haurs Fm. (Givetian).

Highlights
This quarry shows the upper part of the Hanonet Fm, the Trois-Fontaines Fm. and the lower part of the Terre d'Haurs Fm. (Figs 8 & 9). The argillaceous limestone from the Hanonet Formation passes upwards into purer limestones, forming the base of the Trois-Fontaines Formation.

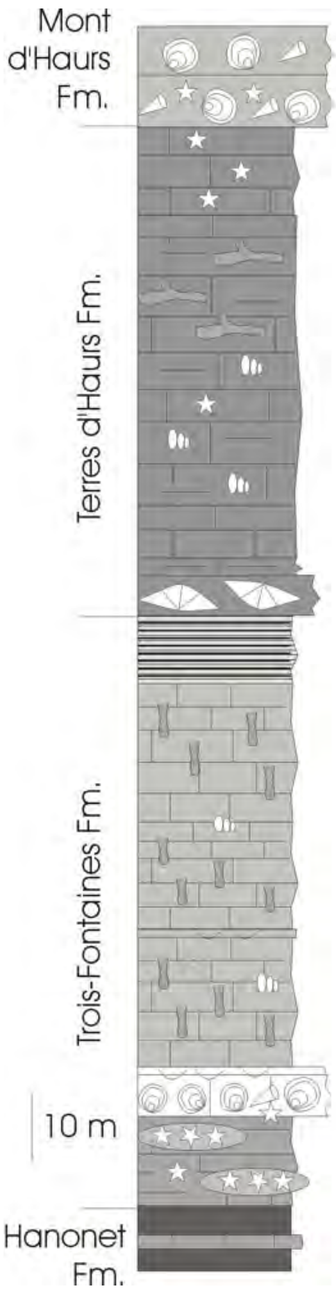

Fig. 9. Schematic log of the Resteigne quarry. Explanation of symbols, see Fig. 4.

Fig.10. The base of the Trois-Fontaines Formation (arrowed) in the Resteigne quarry.

The first meters of the Trois-Fontaines Fm. are storm deposits rich in crinoids, acting as a sole for reef initiation. Over the crinoidal sole grew lenses rich in lamellar and tabular stromatoporoids, solitary and fasciculate rugose corals, branching and massive tabulate corals. Progressively, massive stromatoporoids became more abundant, associated with some rugose and tabulate corals and brachiopods. Multiple coatings associating stromatoporoids, corals, cyanobacteria (*Girvanella, Bevocastria, Sphaerocodium*) are observed. The community became richer in calcareous algae as palaeosiphonoclads (mainly *Issinella*), phylloids (*Resteignella*) and dasyclads (*Givetianella*) (Mamet & Préat 1986). Peloids are abundant. Above the reef, dm-thick accumulations of brachiopods or gastropods ("coquina beds") with early marine cement are observed. These beds are storm deposits left on the shore.

After progradation of the reef barrier southwards, a lagoonal complex developed: it constitutes the upper half of the Trois-Fontaines Formation. This lagoonal complex is characterized by fine grained sediments with a relatively low diversified fauna: leperditids ostracods (Casier & Préat 1991), gastropods, burrowing organisms, and a flora dominated by calcispherids and palaeosiphonoclads (Préat & Boulvain, 1982).

After lagoon filling and final development of tidal flat complexes with algal-microbial mats, corresponding to the top of the Trois-Fontaines Fm., the sedimentation started again during a new marine transgression. The Terres d'Haurs Fm. is characterized by argillaceous limestone with horizontal burrows, locally rich in crinoids, brachiopods, gastropods and coral patch reefs. The base of the formation is underlined by a metre-thick lenticular reef with massive rugose (*Argutastrea*) or tabulate corals (*Thamnopora, Pachyfavosites*,…) (Préat et al. 1984 ; Coen-Aubert 1977, 2003; Coen-Aubert et al. 1986) (Fig. 11).

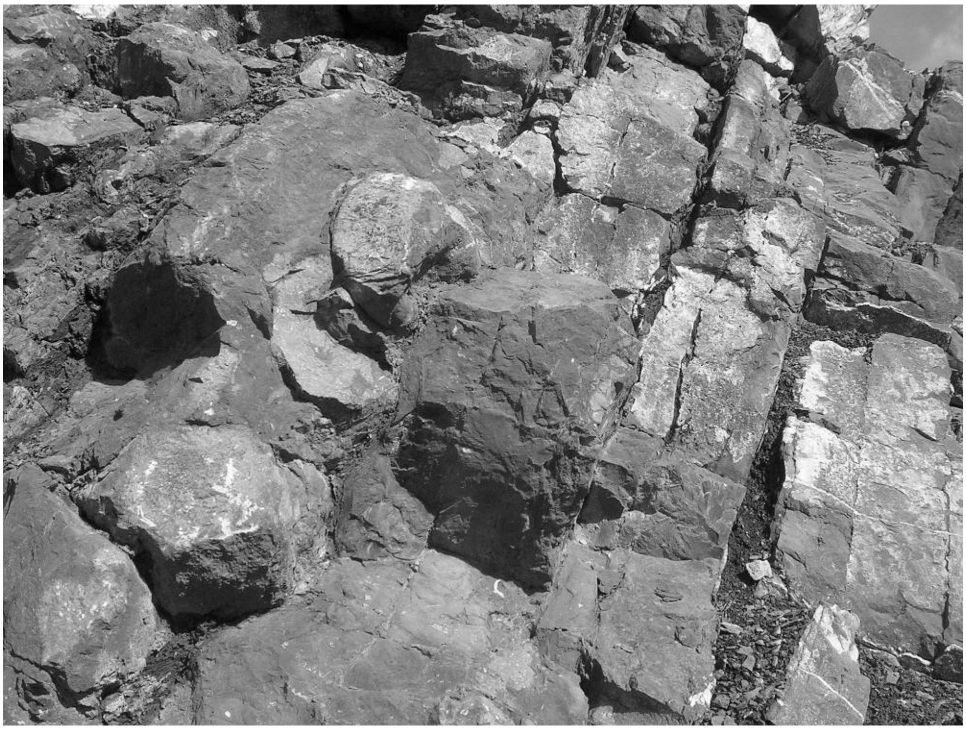

Fig. 11. Base of the Terres d’Haurs Formation in the Resteigne quarry. Isolated colonies of massive rugose corals (*A. quadrigemina)*.

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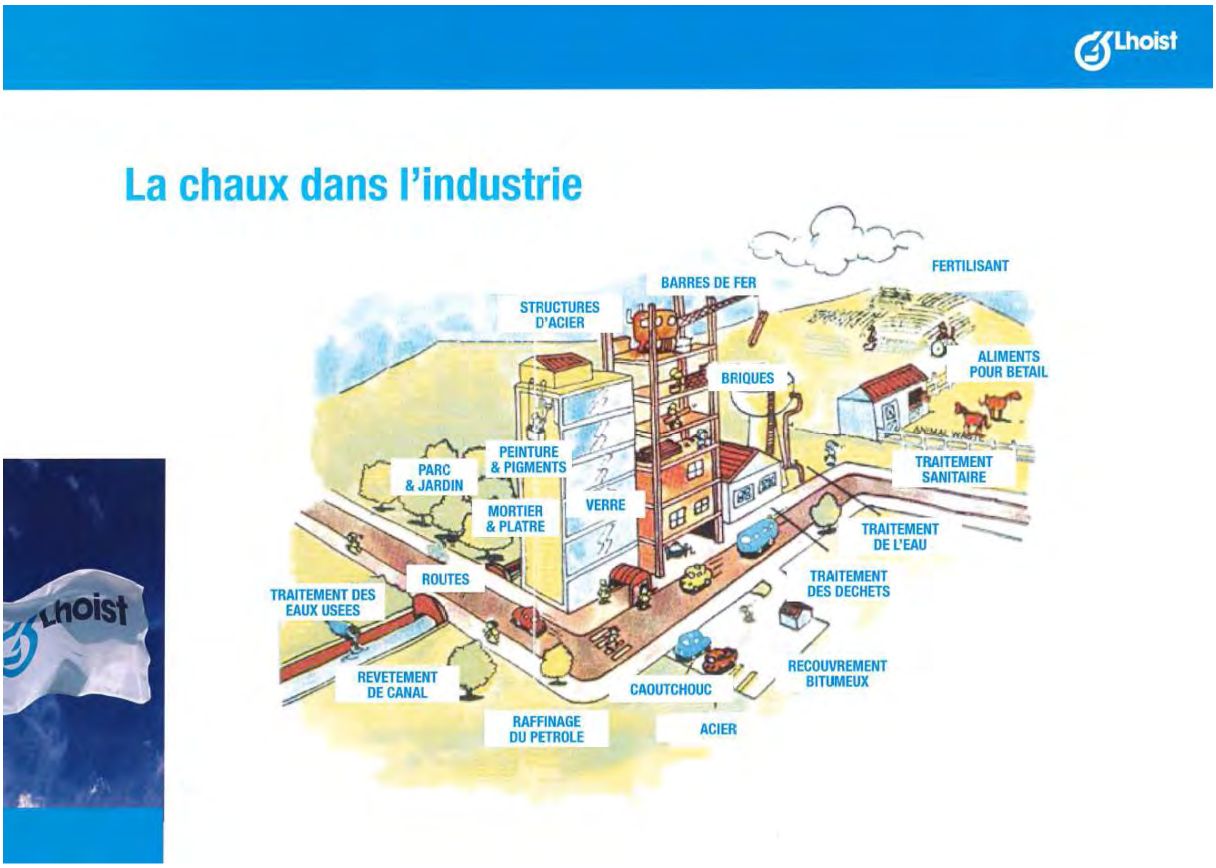
ENCLOSURE – Lime applications at home and in the industry



For more details, please refer to : http://www.lhoist.com/markets-products

Spectacular mudcracks exceptionally exposed in the upper part of the Lion mound (F2h *auct.*) in the La Boverie Quarry (Lhoist), Rochefort – Level 235 m ASL.