SUPERSEDIMENTOLOGICAL EXPOSURES

FRASNIAN CARBONATE MOUNDS OF THE FRASNES AREA, BELGIUM

Around Frasnes (southern Belgium), in an area less than 20 km from the village centre, spectacular outcrops of different types of Frasnian carbonate mounds can be found. All of them can easily be reached by car.

Among the various Palaeozoic carbonate mounds known throughout the world, the Frasnian 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. Consequently, several hundred square meters of sawn sections are accessible for examination.

In the Dinant Synclinorium (Fig. 1), a major structure of the Rheno-Hercynian fold and thrust belt, three stratigraphic levels bear Frasnian carbonate mounds (Fig. 2). These are, in stratigraphic order, the Arche, the Lion and the Petit-Mont Members. In the Philippeville Anticlinorium, only the upper level contains mounds (Petit-Mont Member). The other carbonate mound levels are replaced laterally by bedded limestone, locally with back-reef character. At the northern border of the Dinant Synclinorium and in the Namur Syncline, the entire Frasnian consists of bedded limestone and argillaceous strata.

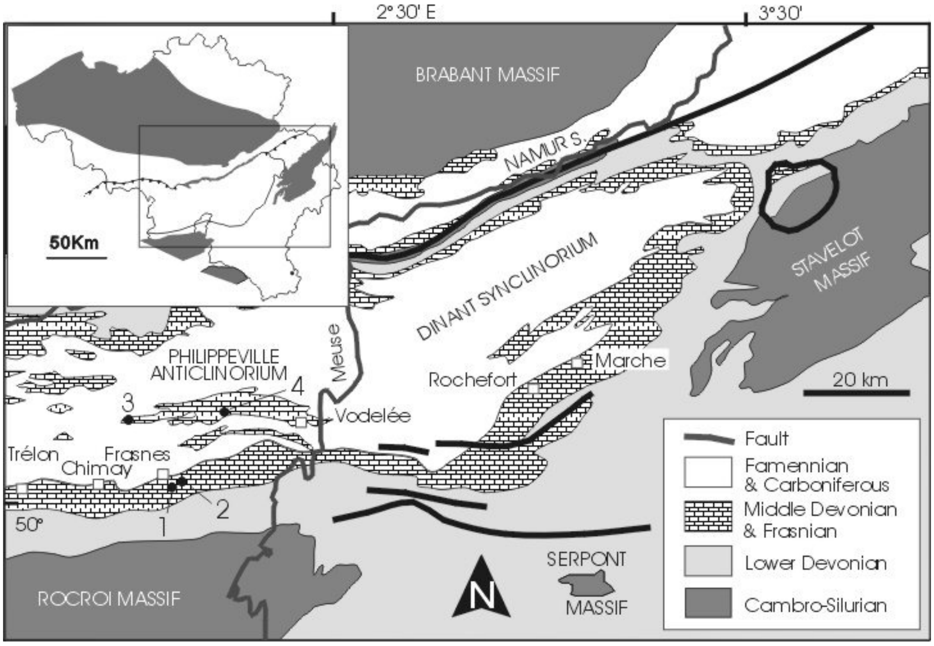

Fig. 1.- Schematic geological map of southern Belgium with location of stops.

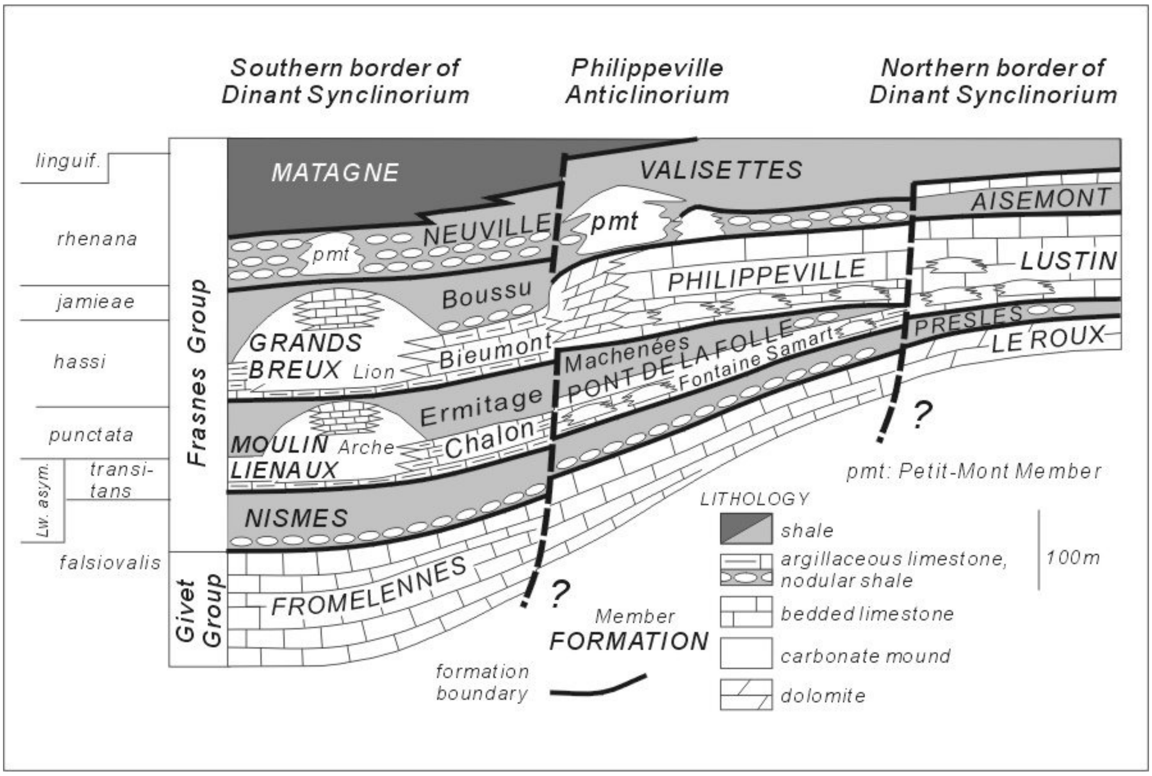

Fig. 2.- N-S section in the Dinant Synclinorium before Variscan tectonism. Conodonts, after Bultynck et al. (1998).

The Petit-Mont mounds (stop 3 and 4) are 30 to 80 m thick and 100 to 250 m in diameter. They are embedded in shale, nodular shale and argillaceous limestone. Based on facies mapping of buildups and related off-mound sediments, these mounds typically started from below the photic and storm wave base zones and built up into shallow water environments (Fig. 3). Above an argillaceous limestone substrate, the first carbonate mound facies consists of spiculitic wackestone with stromatactis (Pm1), which becomes progressively enriched in crinoids and corals (Pm2), then in peloids, stromatoporoids and cyanobacteria (Pm3). Pm4 consists of algal-coral-peloid wackestone and packstone with green algae and thick algal coatings. A core of algal and microbial bindstone (Pm5) sporadically occurs within large mounds. The uppermost part of these mounds may show a recurrence of facies Pm2 and Pm1. Pm1 to Pm3 are coloured red by hematite derived from microaerophilic iron bacteria; Pm4 and Pm5 are grey. The transition from the aphotic to the cyanobacterial photic zone is recorded in the succession Pm2-Pm3; the transition from the cyanobacterial to the green algal photic zone is recorded by Pm3-Pm5. Storm wave base was reached within Pm3 and fair-weather wave base within Pm5. This paleobathymetric interpretation suggests a depth of 100-150 m during initial establishment of Pm1. Hypoxic conditions are indicated by the sponge and iron-bacteria consortium in lower parts of the mounds. This is in agreement with the general assumption of stratified water masses during Late Frasnian, preceding the prominent Lower Kellwasser crisis.

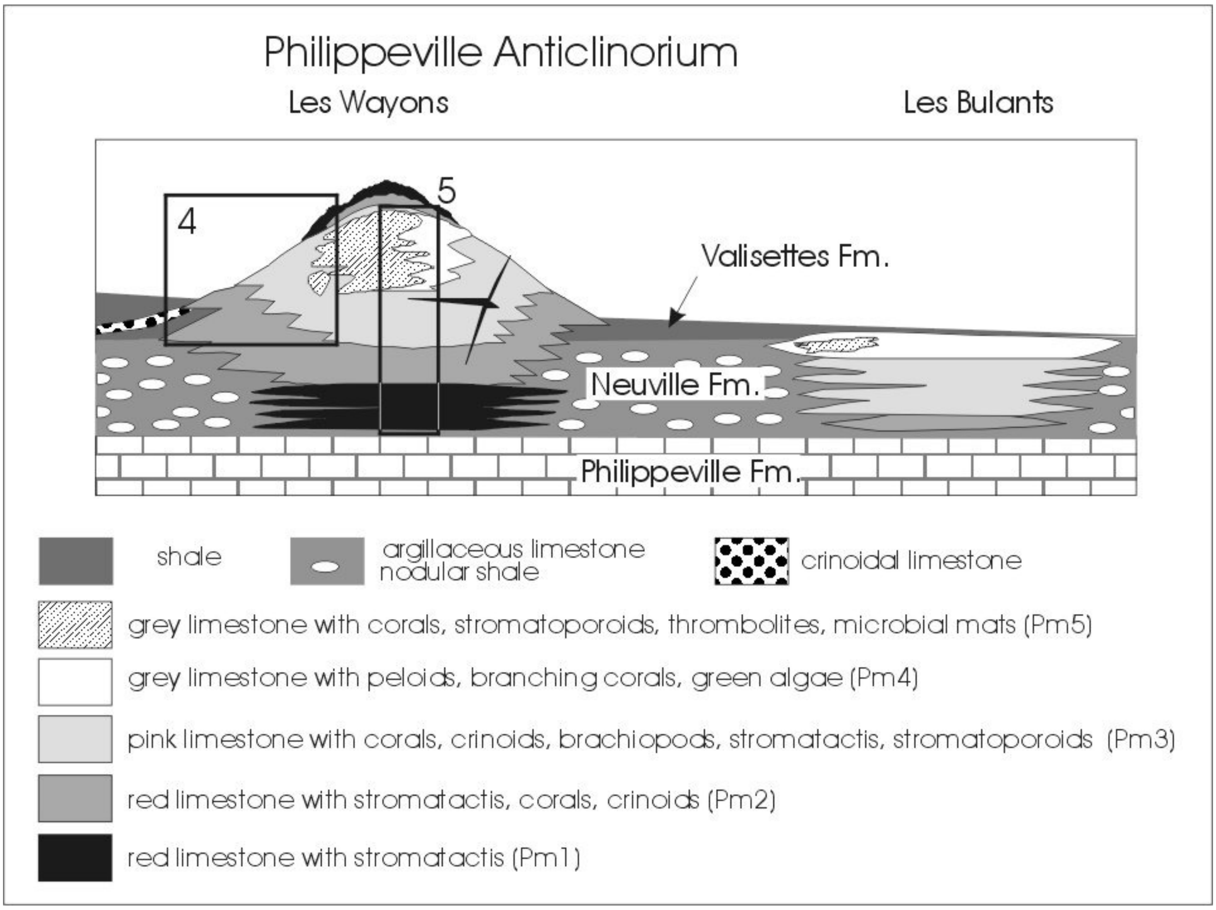

Fig. 3.- Sedimentological model of Petit-Mont Member carbonate mounds, with situation of stops 4 and 5.

The older Arche and Lion mounds (stops 1 and 2) are larger buildups, 150 to 200 m thick and 600 to 1000 m in diameter (Fig. 4). Seven mound facies, each characterized by a specific range of textures and associations of organisms were defined: pink limestone with stromatactis, corals and crinoids (A2-L2); grey, pink or green limestone with stromatactis, corals and stromatoporoids (A3-L3); grey limestone with corals, peloids and dasycladales (A4-L4); grey microbial limestone (A5-L5); this first 4 facies are relatively similar to Petit-Mont ones, with less iron-bacteria. However, shallower facies are different: grey limestone with dendroid stromatoporoids (A6-L6); grey laminated limestone with birdseyes (A7-L7); grey bioturbated limestone (A8-L8). Lateral time-equivalent sediments include a high amount of reworked material from the surrounding buildups. The sedimentological interpretation suggests that A2-L2 and A3-L3 facies developed close to the storm wave base, in a subphotic environment. Facies A4-L4, occurring near the fair weather wave base in the euphotic zone, includes A5-L5 lenses with stromatolitic coatings and thrombolitic bushes. A6-L6 corresponds to a slightly restricted environment and shows a progressive transition to the loferites of A7-L7. This facies was deposited in a moderately restricted intertidal area. A8-L8 developed in a quiet lagoonal subtidal environment.

The buildups started with A3-L3 in which microbial lenses and algal facies A4-L4 became progressively more abundant upwards. Following 20 m of laterally undifferentiated facies, more restricted facies occur in the central part of the buildups. This geometry suggests the initiation of restricted sedimentation, sheltered by bindstone or floatstone facies. The interpretation of the sedimentary dynamics shows that after the construction of the lower part of the buildups during a transgression, an essential element is the occurrence of a lowstand which forces reef growth along the edge of the buildups, starting the development of atoll crowns during the following transgressive stage. The persistence of restricted facies is then the consequence of the balance between sea level rise and reef growth.

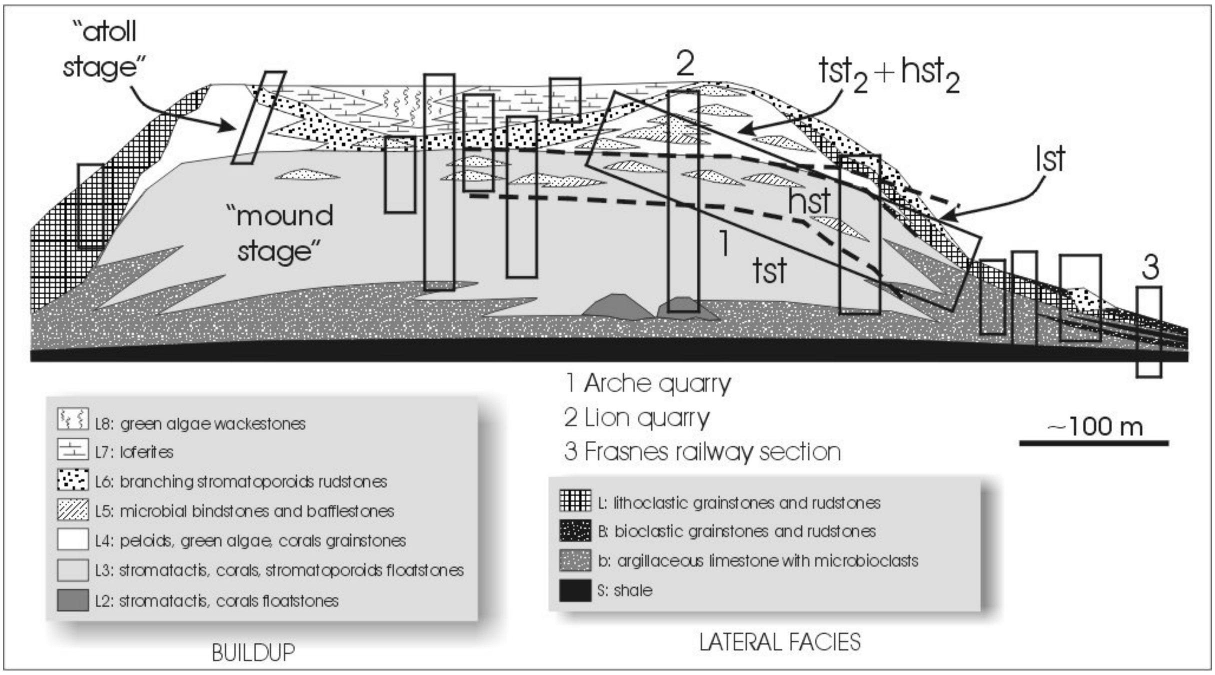

Fig. 4.- Sedimentological model of Arche and Lion Members carbonate mounds, with situation of stops 1 and 2. Other sections used for modelling are represented by rectangles.

Selected outcrops to be visited

Stop 1: Arche quarry (Arche Member, Frasnes)
Location: Fig. 5.

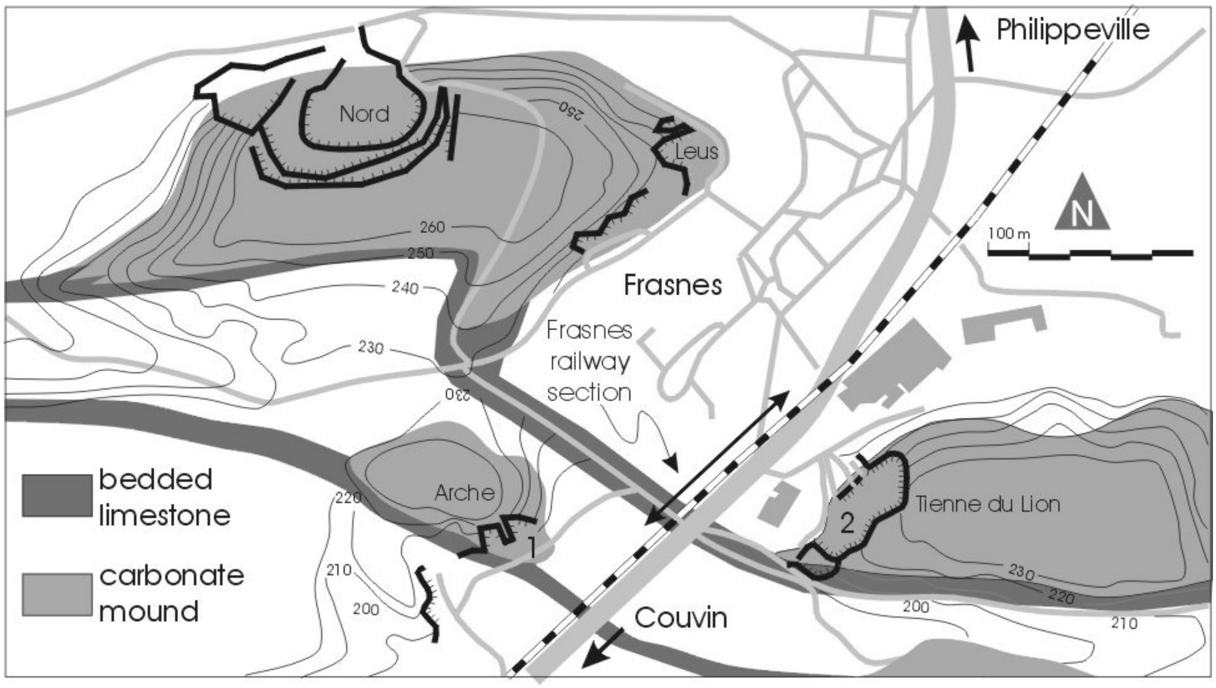

Fig. 5.- location of stops 1 and 2 in Frasnes (Dinant Synclinorium). Time-equivalent lateral sediments crop out in the Frasnes railway section, between the Lion and Nord mounds.

This abandoned marble quarry exposes a very complete section of an Arche Member mound, from pink coverstones with stromatactis, corals and crinoids (A2) with some beautiful receptaculites and zebra to grey microbial limestone (A5) forming the upper part of the quarry. Less than 50 m north of the main quarry downhill, it is possible to have access to the base of the mound, characterized by a transition from shale with abundant rugose corals to limestone with sponges, corals, crinoids and iron-bacteria.

Stop 2: Lion quarry (Lion Member, Frasnes)
Location: Fig. 5.

This abandoned quarry exposes a very nice section in a Lion Member mound, from prograding bioclastic fore mound facies (SW) to loferitic back mound facies (NE). A small wire-cutted section close to the entrance of the quarry shows lenses of grey limestone with dendroid stromatoporoids (L6) and microbial bafflestones (L5). A meter-thick neptunian dyke with parietal encrustations of iron-bacteria cuts this unit. The main access trenches to the quarry expose a very interesting section in the Boussu-en-Fagne Member shale, deposited during the drowning of the mound.

Stop 3: Beauchâteau quarry (Petit-Mont Member, Senzeille)
Location : Fig. 6.

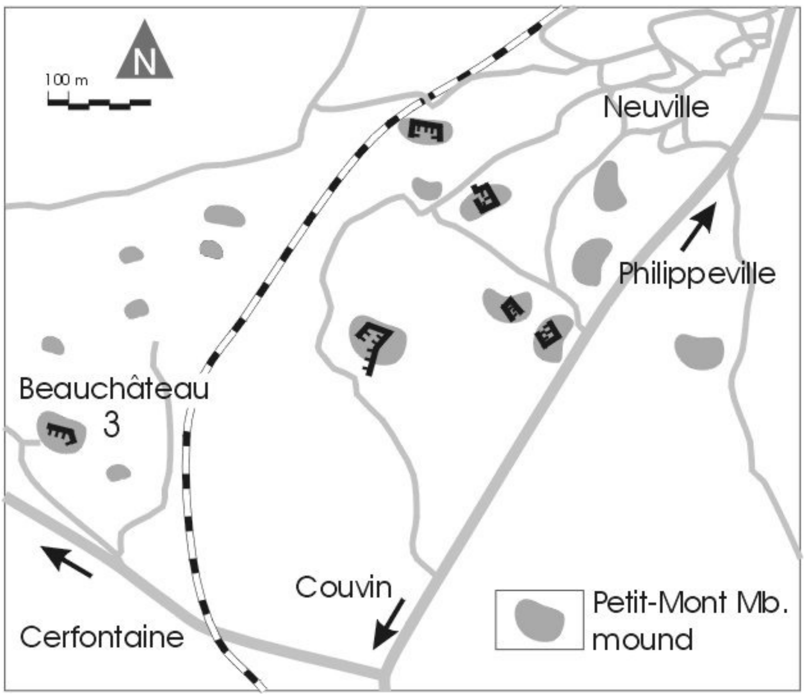

Fig. 6.- Location of stop 3 (Philippeville Anticlinorium). Note the abundance of Late Frasnian mounds in the vicinity of the Neuville village.

This abandoned marble quarry is the most spectacular outcrop of a Late Frasnian carbonate mound in Belgium. The mound is standing in subhorizontal position and large sawn sections expose facies ranging from the middle part of the mound (Pm3) to its top (Pm 4 and 5). The upper central panel shows interfingering between grey massive microbial facies and pink bedded bioclastic flank sediments. Dipping of mound flanks is partly the result of differential compaction: sedimentary slopes rarely exceed 30°. The left part of the quarry shows crinoid-rich argillaceous flank sediments.

Stop 4 : Les Wayons quarry (Petit-Mont Member, Merlemont)
Location : Fig. 7.

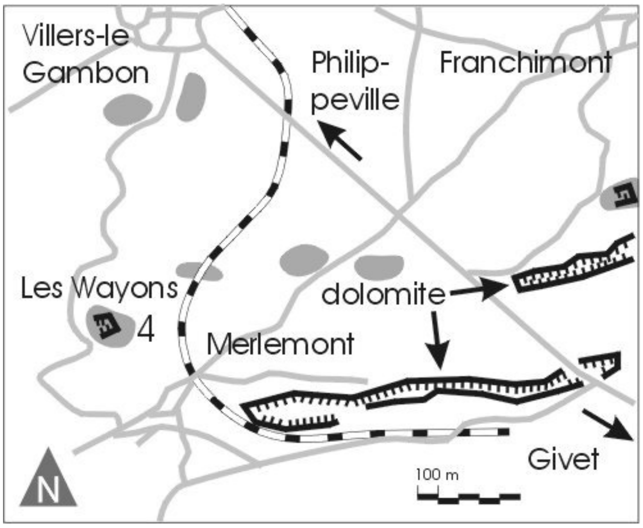

Fig. 7.- Location of stop 4 (Philippeville Anticlinorium). The large dolomite quarries of Merlemont work the Middle Frasnian Philippeville Formation (see Fig. 2).

This abandoned marble quarry, now used as a training area for speleology, complements the Beauchâteau section, as it exposes the lower part of a Late Frasnian mound. Stratification is nearly vertical and the base of the mound is visible in the NW part of the quarry. Some 20 m of red stromatactis limestone (Pm1) forms the lower part of the mound. Red colour is related to high amounts of microaerophilic iron bacteria in the sediment and stromatactis are derived from collapse of sponges whose spicules are very abundant in this facies.

References

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