

Triassic and jurassic lithostratigraphic units (Belgian Lorraine)

Frédéric BOULVAIN¹, Isabelle BELANGER², Dominique DELSATE³, Pierre GHYSEL²,
Pascal GODEFROID⁴, Martin LALOUX², Roger MONTEYNE⁵ & Marc ROCHE².

(2 figures)

1. *Géologie-Pétrologie-Géochimie, B20, Université de Liège, Sart Tilman, 4000-Liège.*

2. *Service géologique de Belgique, 13 rue Jenner, 1000-Bruxelles.*

3. *Laboratoire de Paléontologie-Géologie, C.R.S. du Musée national d'Histoire naturelle de Luxembourg, 25, rue Münster, L-2160 Luxembourg.*

4. *Département de Paléontologie, Institut royal des Sciences naturelles de Belgique, 29 rue Vautier, 1000-Bruxelles.*

5. *23, chemin des Sources, 1330-Rixensart.*

ABSTRACT. A multidisciplinary study of some extensively cored boreholes together with the new 1/25,000 geological mapping of Wallonia led us to propose a new lithostratigraphic canvas for Belgian Lorraine. This area is located on the NE border of the Paris Basin, south of the Ardennes; the studied stratigraphic interval covers the Late Triassic to the Bajocian.

KEYWORDS: Mesozoic, stratigraphy, Belgium, Lorraine, Triassic, Jurassic, Paris Basin.

REFERENCE TO THIS VOLUME. Boulvain, F., Belanger, I., Delsate, D., Ghysel, P., Godefroid, P., Laloux, M., Monteyne, R. & Roche, M., 2001. Triassic and Jurassic lithostratigraphic units (Belgian Lorraine). In Bultynck & Dejonghe, eds., Guide to a revised lithostratigraphic scale of Belgium, *Geologica Belgica*, 4/1-2: 113-119.

1. Introduction

The Mesozoic formations of Belgian Lorraine, outcropping on approximately 800 km² (fig. 1), are a north-eastern dependence of the Paris Basin, forming the so-called Gulf of Luxemburg. The nature and the complex geometry of sedimentary bodies indicate a littoral environment characterized by a mixed sedimentation with a siliciclastic predominance. The sequential evolution of deposits was integrated in a globally retrograding sedimentary prism.

Except for some famous sections, mainly located in the sandy Sinemurian, boreholes constitute the principal geological data source for Belgian Lorraine. Detailed lithological descriptions are provided in the following publications:

– Arlon borehole 219E254: Gulinck *et al.* (1973);

– Latour borehole 225E189: Boulvain and Monteyne (1993), Boulvain *et al.* (1995);

– Neulimont borehole 222W253, Saint-Mard borehole 225W145, Toernich borehole 219E614, Aubange borehole 223E493: Boulvain *et al.* (1995);

– Villers-devant-Orval borehole 221E87: Boulvain *et al.* (1996).

Since Dumont's (1842) precursory report and the synthesis by Maubeuge (1954), studies in Belgian Lorraine have been almost exclusively devoted to lithostratigraphy and biostratigraphy. Recent works concern sedimentological studies of the Sinemurian sandy body and the Aalenian "Minette" (i.e. Berners, 1983; Teyssen, 1984; Mergen, 1984; Muller & Steingrobe, 1988; Guérin-Franiatte *et al.*, 1991). Boulvain *et al.* (2001) propose a progress report on lithostratigraphy, sedimentology, mineralogy and palaeontology of Belgian Lorraine.

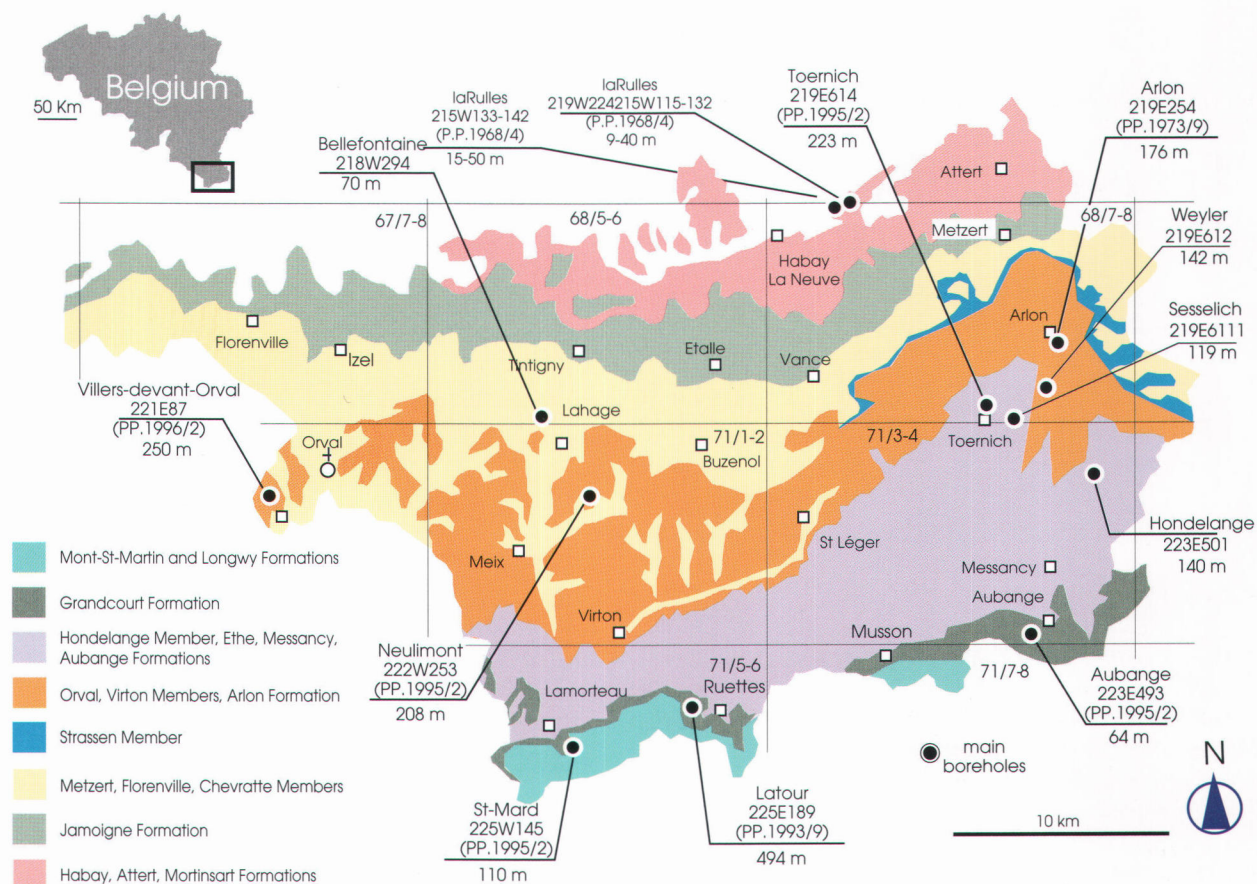


Figure 1. Simplified geological map of Belgian Lorraine.

This paper successively deals with the Habay, Attert, Mortinsart, Jamoigne, Luxembourg, Arlon, Ethe, Messancy, Aubange, Grandcourt, Mont-Saint-Martin and Longwy Formations (fig. 2).

2. Areas and formations

2.1. Habay Formation - HAB

Authors: Boulvain *et al.*, 2001.

Description: Alternation of conglomerate, sand, argillaceous sand, conglomeratic dolomite and clay, generally brick-red, sometimes greenish. This unit, with a marked continental character, rests unconformably on the Devonian basement. Its thickness is, consequently, locally variable.

Stratotype: Latour borehole.

Area and thickness: The formation outcrops in the north of Belgian Lorraine. It still appears westerly of the Rossignol meridian, down to the Chiny Forest. Its thickness increases gradually towards the east and the south to reach about 30 m at the meridian of Attert. Near the French border, the formation displays about the same thickness in subsurface (Latour borehole).

Age: Until now, no dating method has provided a specific age of the formation. Depending on the authors, it is assigned a Permian or a Triassic age.

2.2. Attert Formation - ATT

Authors: Boulvain *et al.*, 2001.

Description: Greenish or purplish marl and dolomitic marl ("marnolithes"), interbedded with decimetric white dolomitic lenses, some clay, conglomeratic argillaceous sandstone, and occasionally conglomerate with dolomitic cement. In boreholes, gypsum layers.

Stratotype: Access to the N4 road, close to Attert.

Area and thickness: The formation outcrops in the north-eastern part of Belgian Lorraine. Its thickness seems to increase regularly from west to east and from north to south, to reach a maximum of some 50 m in the neighbourhood of Attert. In the central area, at Habay, the formation is only 30 m thick. It disappears then west of Marbehan. In subsurface, in the Latour borehole, the Attert Formation reaches a hundred meters, bearing increasingly conglomeratic facies.

Age: The Attert Formation is dated from Late Triassic. The first miospore-rich bed below the Rhaetian Sand-

stone shows a Carnian assemblage as described in the "Grès à roseaux" (Biard, 1963; Van der Eem, 1974 in Schuurman, 1977). The vertebrate fauna discovered in the upper Bunte Mergel at Medernach favors a Late Triassic age (? Late Norian), as this assemblage closely resembles those found in the Knollenmergel in Germany (Duffin, 1993; Cuny *et al.*, 1995).

Remarks: In subsurface, in the Campine Basin, the Gruitrode, Bullen, and Bree Members consist of sandstone, conglomerate and siltstone with a continental facies. The "Muschelkalk" and the "Keuper" are characterized by limestone, dolomite and evaporite. Upwards, the Sleen and Aalberg Formations, dated from Rhaetian to Lias, consist of dark clay and marl with some argillaceous limestone levels (Dusar *et al.*, 1987; Wouters & Vandenberghe, 1994).

2.3. Mortinsart Formation - MOR

Authors: Dumont, 1842; Boulvain *et al.*, 2001.

Description: Alternation of grey to greenish sandstone, sand, silt and black or greenish clay.

Locally, some gravelly beds, bone-beds and lignite. This unit is capped in the east of Belgian Lorraine by wine-colour clays ("Argiles de Levallois") and in the western part of the area by a pebbly horizon.

Stratotype: Small stream close to Grendel (see Monteyne, 1969).

Area and thickness: North of Belgian Lorraine. The formation is a dozen m thick near Habay and Attert (central area). In the western area, west of Rossignol, it is transgressive on the Palaeozoic basement and is characterized by a reduced thickness. Thickness does not increase strongly towards the south since, close to the French border, in the Latour borehole, it remains less than 20 m. The Argiles de Levallois disappear westwards of a NNE-SSW line passing through Lischert.

Age: The formation is dated from Rhaetian *sensu lato*, on the basis of the presence of bivalve *Rhaetavicula contorta*, a characteristic fossil of the Mortinsart Formation. Rhaetian *sensu lato* on the basis of palynomorphs (Schurmann, 1977; Adloff & Doubinger, 1982; Roche, 1994; Rauscher *et al.*, 1995) and of vertebrates. The marine components of the vertebrate assemblage discovered in the Mortinsart Formation at Habay-la-Vieille (Duffin *et al.*, 1983) and Attert (Duffin & Delsate, 1993) closely resemble the typical Rhaetian vertebrate fauna from Holwell (Duffin, 1980) and Aust (Storrs, 1994) in England.

2.4. Jamoigne Formation - JAM

Authors: Dumont, 1842; Boulvain *et al.*, 2001.

Description: Bioturbated dark grey marl with decimetre-thick argillaceous-sandy limestone or sandstone beds (increasingly frequent towards the top of the unit). The Warcq Member, capping the formation at the contact with the Luxembourg Formation, consists of light grey argillaceous sand or sandstone. Locally, mica-

ceous sandstone and gravel beds are observed at the base of the Jamoigne Formation. Fauna and bioturbation are quite abundant.

Stratotype: Latour borehole.

Area and thickness: The formation outcrops in Belgian Lorraine, with a rather constant thickness of about 45 m. The thickness gradually increases towards the south to reach 70 m in boreholes close to the French border. In the west, the Jamoigne Formation is transgressive on the Rhaetian (Rossignol Member) and on the Palaeozoic basement (Muno Member) with a more arenaceous and fossiliferous facies.

Age: The Jamoigne Formation is only Hettangian in age in eastern Belgian Lorraine, covering the *Psiloceras planorbis*, *Alsatites liasicus* and *Schlotheimia angulata* ammonite Zones; in the western part, the formation also includes the Warcq Member (*Arietites bucklandi* Zone) and thus extends into the Lower Sinemurian (Maubeuge, 1954; Mergen, 1984; Guérin-Franiatte & Muller, 1986).

Remarks: This formation was subdivided as various "Assises" by Dumont and later authors on a biostratigraphic basis: namely the Helmsingen or Helmsange, Ansart, Jamoigne ss. and Warcq Assises. Some are not included here because of criteria for their definition; the Member of Warcq is redefined on a purely lithostratigraphic basis.

2.5. Luxembourg Formation - LUX

Authors: Steininger, 1828; Guérin-Franiatte *et al.*, 1991; Boulvain *et al.*, 2001.

Description: Alternation of sandy limestone and sand with cross-bedded stratifications; locally, homogeneous sand, sandstone and coquinas ("lumachelles").

Stratotype: Large quarry along the N4 road, at Côte rouge.

Area and thickness: Belgian Lorraine and Luxembourg. The formation, a hundred metres thick, comprises five members: at the base, the Metzert Member, a grey to yellow sandy unit (locally sandstone: "Clairefontaine facies"); then, above a slight angular unconformity, the Florenville, Orval and Virton Members, consisting of alternating yellow to orange sand and sandy limestone. These members are differentiated from one another only when separated by marl horizons (respectively, the Strassen and Posterie Members). West of the meridian of Prouvy, these marl horizons become thin layers very difficult to correlate. Near Virton, a third marl horizon (Trite Member) occurs near the base of the formation, separating Florenville and Chevratte Members. On the other hand, at the east of the meridian of Arlon, the same marl horizons thicken quickly and grade into the Arlon Formation. The Stockem Member which consists of clear sand is probably a weathering facies of Virton or Hondelange Members.

Age: The Luxembourg Formation is clearly diachronic (Maubeuge, 1965; Guérin-Franiatte & Muller, 1986;

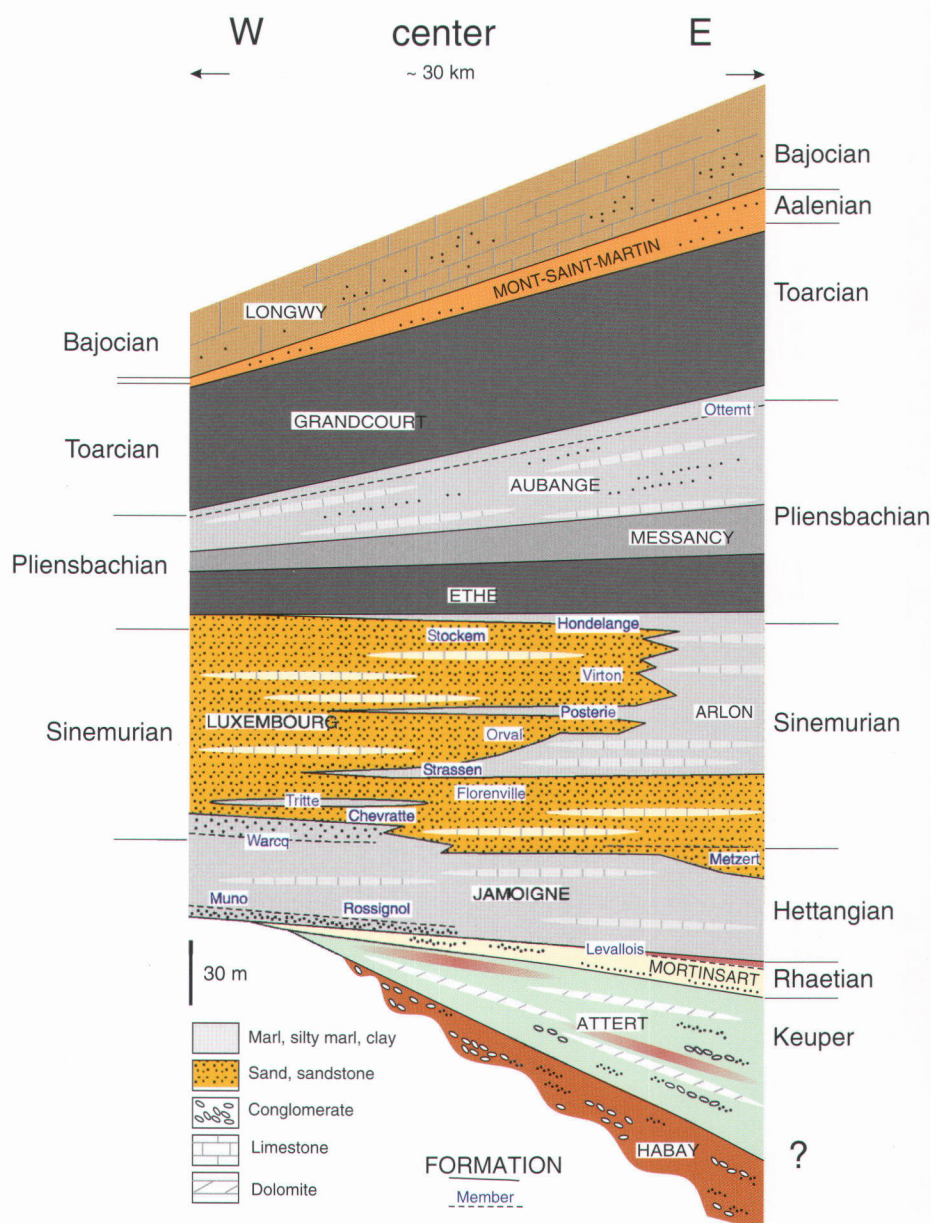


Figure 2. E-W schematic lithostratigraphic section of Belgian Lorraine.

Guérin-Franiatte *et al.*, 1991). In eastern Belgian Lorraine, it encompasses the Upper Hettangian and the base of the Sinemurian, from *Schlotheimia angulata* to *Arietites bucklandi* ammonite Zones; in the western part of the area, this formation extends from the Lower to the Uppermost Sinemurian, from *Arietites bucklandi* to *Echioceras raricostatum* ammonite Zones.

Remarks: This formation was introduced in Belgium by Dumont (1842). Because of its diachronic character, it was later subdivided in various “Assises” on a biostratigraphic basis. The unitary character of the formation was redefined by Guérin-Franiatte *et al.* (1991). Some units, corresponding partially to old “assises”, were redefined as members with new lithostratigraphic limits (Members of Metzert, Florenville, Orval, Virton, Stockem). The other “assises” are abandoned.

2.6. Arlon Formation - ARL

Authors: Dewalque, 1902; Monteyne, 1958; Boulvain *et al.*, 2001.

Description: Grey marl, silty marl, bioturbated argillaceous-silty to sandy limestone. Abundant fauna.

Stratotype: Toernich borehole.

Area and thickness: Belgian Lorraine. The formation has a thickness of about 60 m close to Arlon. More to the west, its thickness decreases very quickly, the formation being represented only by marl beds in the Luxembourg Formation (corresponding successively to Trite, Strassen and Posterie Members). A late western extension of the marly-sandy facies constitutes the Hondelange Member, which overlies the Luxembourg Formation.

Age: In eastern Belgian Lorraine, in the Arlon area, the Arlon Formation extends from the Lower Sinemurian (*Arnioceras semicostatum* ammonite Zone) to the top of the Lower Pliensbachian (*Prodactylioceras davoei* Zone) (Maubeuge, 1954; Mergen, 1984). In the western part of the area, the Trite Member is in the *Arietites bucklandi* Zone, the Strassen Member in the *Arnioceras semicostatum* Zone and the Posterie Member in the *Asteroceras obtusum* Zone.

Remarks: All authors have highlighted the difficulty to establish, east of Arlon, in this sandy-argillaceous-limestone unit (Lorraine facies), other subdivisions than biostratigraphic ones. We thus use the name of Arlon Formation here as a global unit and subdivide it into members whenever possible to do so on a lithostratigraphic basis (see intercalations in the Luxembourg Formation)

2.7. Ethe Formation - ETH

Author: Dewalque, 1854.

Description: Grey marl and silty clay, often laminar. Locally, limonitic nodules.

Stratotype: Latour borehole; good outcrop in a old brick-factory, Toernich street, Arlon.

Area and thickness: Belgian Lorraine. The thickness of the formation varies between 20 and 25 m in the west of the Belgian Luxemburg. In the eastern area, it can reach about 50 m.

Age: Ethe Formation is limited to Pliensbachian, and generally corresponds to the *Prodactylioceras davoei* Zone (Maubeuge, 1954).

2.8. Messancy Formation - MES

Author: Dormal, 1894.

Description: Grey silty or silty-sandy laminar marl. The boundary between Ethe and Messancy Formations corresponds to the first sandy bed.

Stratotype: Latour borehole.

Area and thickness: Belgian Lorraine. In the area of Messancy, the formation reaches approximately 35 m in thickness. In the west of Belgian Lorraine, Messancy and Aubange Formations together total between 35 and 40 m. In Latour borehole, Messancy Formation has a thickness of 8 m.

Age: Messancy Formation is dated from Upper Pliensbachian *Amaltheus margaritatus* ammonite Zone (Maubeuge, 1954, 1971).

2.9. Aubange Formation - AUB

Authors: Dumont, 1842; Dewalque, 1854; Boulvain *et al.*, 2001.

Description: Grey sandy marl with centimetric to pluri-decimetric lenses of limestone and argillaceous-sandy

limestone. Locally, limonitic crusts or conglomerate. Fauna is relatively abundant and bioturbation generally high. A pluri-decimetric coquina bed is almost always present near the top of the formation, under the Ottemt Member. The extreme top of the formation is locally constituted by bluish marls with blue-grey limestone nodules (Ottemt Member, see Boulvain *et al.*, 1995), or by blue-grey marly limestone beds (Saint-Mard), towards the west.

Stratotype: Latour borehole.

Area and thickness: In the western part of Belgian Lorraine, the thickness of Aubange and Messancy Formations varies between 35 and 40 m. It reaches approximately 45 m for Aubange Formation alone towards the east.

Age: Aubange Formation is dated from Upper Pliensbachian to Lower Toarcian *Pleuroceras spinatum* Zone to *Dactylioceras tenuicostatum* Zone (Maubeuge, 1954, 1971; Delsate, 1990).

2.10. Grandcourt Formation - GRT

Author: Dumont, 1842.

Description: Generally bituminous grey clay and marl with a thin silty-calcareous lamination, and laminar limestone nodules ("Schistes Cartons" Member), passing toward the top to sandier laminated marl, rich in septaria. Occurrences of centimetric to decimetric limestone beds.

Stratotype: Latour borehole.

Area and thickness: The formation outcrops in the south of Belgian Lorraine, with a thickness of approximately 40 m in the western area. It thickens towards the east to reach about 60 m near the Luxemburg border.

Age: The Grandcourt Formation is dated from Toarcian, from *Harpoceras falciferum* Zone to *Grammoceras thouarcense* Zone (Delsate, 1990; Laenen, 1991).

2.11. Mont-Saint-Martin Formation - MSN

Authors: Dumont, 1842; Boulvain *et al.*, 2001.

Description: Argillaceous sandstone ("Supraliasic Sandstone"), followed by ferruginous marl including several iron oolite beds, and ending with sandy marl. Locally, coquina beds.

Type area: Bois de Musson, to the west of Mont-Saint-Martin.

Area and thickness: The formation crops out in the extreme south of Belgian Lorraine. It presents a thickness of approximately 40 m in the eastern area but is strongly reduced towards the west.

Age: Mont-Saint-Martin Formation is dated from Upper Toarcian to Lower Bajocian *Grammoceras thouarcense* Zone to *Hyperlioceras discites* Zone (Maubeuge, 1947, 1972).

2.12. Longwy Formation - LGW

Authors: Dumont, 1842; Boulvain *et al.*, 2001.

Description: Orange yellow sandy limestone, followed by shelly limestone with locally conglomeratic layers with bioclastic limestone clasts. The base of the formation corresponds to the first limestone deposit superposed on Mont-Saint-Martin or, towards the west, on Grandcourt Formation. Its top coincides with the base of the "Marnes de Longwy".

Stratotype: Old quarries near the village of Tellancourt and road Ruelle-Tellancourt, close to the French border.

Area and thickness: Longwy Formation crops out in the extreme south of Belgian Lorraine and the north-east of French Lorraine. The formation is about 50 m thick in the eastern area. Its thickness gradually thins towards the west, with no possibility of giving any value.

Age: Longwy Formation is dated from Lower Bajocian *Hyperlioceras discites* Zone to *Stephanoceras humphriesianum* Zone (Maubeuge, 1951, 1954).

3. Conclusions

The Habay Formation is a fluvial unit, with immature channel conglomerate and paleosoils. The Attert Formation (dolomitic marl with gypsum and pseudomorphs) exhibits an evaporitic trend. The Mortinsart Formation (sand and marl) corresponds to a restricted marine unit, evolving towards an alluvial plain (Levallois Member). The Jamoigne Formation (bioturbated marl and limestone) is a marine subtidal restricted unit, evolving towards a more sandy series (Metzert Member). The Luxemburg Formation corresponds to a superposition of sand waves. The Ethe Formation (laminar clay and marl) marks a deepening of the basin, and the outset of marine dysaerobic conditions. The Aubange Formation (bioturbated marl with sandstone and limestone) is characterized by the reappearance of a normal benthic fauna. The Grandcourt Formation (laminar clay and marl) marks a return to open marine dysaerobic conditions. The Mont-Saint-Martin Formation (marl, sandy marl and oolitic ironstone) is a highly regressive unit, while the Longwy Formation (limestone) marks the initiation of a carbonate platform.

4. References

- ADLOFF, M. C. & DOUBINGER, J., 1982. Etude palynologique du Rhétien et de l'Hettangien de cinq sondages situés dans les environs de Mers (Luxembourg). *Bulletin d'Information des Géologues du Bassin de Paris*, 19, 2: 9-20.
- BERNERS, H.P., 1983. A Lower Liassic offshore bar environment, contribution to the sedimentology of the Luxemburg sandstone. *Annales de la Société géologique de Belgique*, 106: 87-102.
- BIARD, A. H., 1963. Contribution à l'étude palynoplantologique du Permo-Trias en France et en Afrique du Nord. Université de Dijon, *Publication du Centre de Recherche S.N.P.A.*, Pau: 187 p.
- BOULVAIN, F., BELANGER, I., DELSATE, D., DOSQUET, D., GHYSEL, P., GODEFROIT, P., LALOUX, M., ROCHE, M., TEER-
LYNCK, H. & THOREZ, J., 2001. New lithostratigraphical, sedimentological, mineralogical and palaeontological data on the Mesozoic of Belgian Lorraine: a progress report. *Geologica Belgica*, 3 (1-2), 3-33.
- BOULVAIN, F., DELSATE, D., GULINCK, M., LAGA, P. & MAUBEUGE, P.L., 1996. Description lithostratigraphique et pétrographie du sondage 221E87 de Villers-devant-Orval (Trias, Lias de la Gaume, Belgique). *Belgian Geological Survey Professional Paper*, 1996 (2), n°281: 26 pp.
- BOULVAIN, F., DELSATE, D. & MAUBEUGE, P.L., 1995. Description et interprétation stratigraphique de quatre sondages dans le Secondaire de la Gaume (Neulumont, Aubange, Saint-Mard et Toernich). *Belgian Geological Survey Professional Paper*, 1995 (2), 277: 51 pp.
- BOULVAIN, F. & MONTEYNE, R., 1993. Colonne lithologique du sondage de Latour (494 m). Une coupe de référence pour le Secondaire de la Gaume. *Belgian Geological Survey Professional Paper*, 267: 35 pp.
- CUNY, G., GODEFROIT, P. & MARTIN, M., 1995. Microrestes de vertébrés dans le Trias supérieur du Rinckebierg (Medernach, G.-D. Luxembourg). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, 196 (1): 45-57.
- DELSATE, D., 1990. Deux nouveaux horizons à Vertébrés (*Chondrichthyes-Elasmobranchii* et *Osteichthyes-Actinopterygii*) dans le Toarcien belge et limitrophe (Lorraine): synthèse stratigraphique et profils nouveaux. *Belgian Geological Survey Professional Paper*, 242: 53 pp.
- DEWALQUE, G., 1854. Note sur les divers étages qui constituent le Lias moyen et le Lias supérieur dans le Luxembourg et les contrées voisines. *Bulletin de la Société Géologique de France*, 11, pp. 234 & 546.
- DEWALQUE, G., 1902. Habay-la-Neuve-Arlon, carte géologique n°219 à 1/40.000, dressée sur ordre du gouvernement.
- DORMAL, 1894. Compte-rendu de l'excursion de la Société belge de Géologie, Paléontologie, Hydrologie dans les terrains triasique et jurassique des environs d'Arlon. *Bulletin de la Société belge de Géologie, Paléontologie, Hydrologie*, VIII (mém.): 102-129.
- DUFFIN, C.J., 1980. Marine vertebrates from the north west European Rhaetic. Ph.D. Thesis, University College, London, unpublished: 326 pp.
- DUFFIN, C.J., 1993. Mesozoic chondrichthyan faunas. I. Middle Norian (Upper Triassic) of Luxemburg. *Palaeontographica*, A, 229: 15-36.
- DUFFIN, C.J., COUPATEZ, P., LEPAGE, J.C. & G. WOUTERS, 1983. Rhaetic (upper Triassic) marine fauna from «Le Golfe du Luxembourg» in Belgium (Preliminary note). *Bulletin de la Société belge de Géologie*, 92, 4: 311-315.
- DUFFIN, C.J. & DELSATE, D., 1993. The age of the Upper Triassic vertebrate fauna from Attert (Province of Luxembourg, Belgium). In: HERMAN, J (Ed.): *Elasmobranchs and stratigraphie. Belgian Geological Survey Professional Paper*, 264: 33-44.
- DUMONT, A., 1842. Mémoire sur les terrains triasique et jurassique dans la province de Luxembourg. *Nouveaux Mémoires de l'Académie royale de Belgique*, XV: 1-36.
- DUSAR, M., BLESS, M.J.M., BORREMANS, G., BURGER, K., DE LOOSE, J., FAIRON-DEMARET, M., FELDER, P.J., GULLENTOPS, F., LIE SUN FAN, MUCHEZ, P., PAPROTH, E., PIERART, P., ROSSA, H.G., SMOLDEREN, A., SOMERS, Y., STEURBAUT, E., STREEL, M., VIAENE, W., WITTE, H., WOUTERS, L., 1987. De steenkoolverkenning boring Gruitrode-Ophovenderheide (Boring 172 van het Kempens Bekken). Kaartblad Opoeteren, 63E224. *Belgian Geological Survey Professional Paper*, 1987 n°3, n° 230: 235 pp.
- GUÉRIN-FRANIATTE, S., HARY, A. & MULLER, A., 1991. La Formation des Grès du Luxembourg au Lias inférieur: reconstitution dynamique du paléoenvironnement. *Bulletin de la Société géologique de France*, 162: 763-773.
- GUÉRIN-FRANIATTE, S. & MULLER, A., 1986. L'Hettangien dans le NE du Bassin de Paris: biostratigraphie et évolution sédimentaire. *Annales de la Société géologique de Belgique*, 109: 415-429.

- GULINCK, M., LAGA, P. & LEGRAND, R., 1973. Le sondage d'Arlon. *Belgian Geological Survey Professional Paper*, 1973 n°9: 14 pp.
- LAENEN, 1991. Ammonietenfauna en afzettingsmilieu van de basis van de formatie van Grandcourt te Aix-sur-Cloie (overgang Pliensbachiaan-Toarciaan van Belgisch Luxemburg). Licence in geology memoir, K.U.Leuven, unpublished: 79pp.
- MAUBEUGE, P.L., 1947. Sur quelques ammonites de l'"Aalénien ferrugineux" du Luxembourg et sur l'échelle stratigraphique de la formation ferrifère franco-belgo-luxembourgeoise. *Archives de l'Institut grand-ducal de Luxembourg*, Section des Sciences naturelles, physiques et mathématiques, nouvelle série, 17: 73-87.
- MAUBEUGE, P.L., 1951. Les ammonites du Bajocien de la région frontière franco-belge (bord septentrional du Bassin de Paris. *Mémoires de l'Institut royal des Sciences naturelles de Belgique*, deuxième série, 42: 96 pp.
- MAUBEUGE, P.L., 1954. Le Trias et le Jurassique du Sud-Est de la Belgique. In: *Prodrome d'une description géologique de la Belgique*, édité par P. Fourmarier, Société géologique de Belgique: 385-416.
- MAUBEUGE, P.L., 1965. Contribution à la géologie de la Province de Luxembourg et du Grand-Duché de Luxembourg: le problème du "Grès de Luxembourg". *Bulletin de la Société belge de Géologie, Paléontologie et d'Hydrologie*, 74 (2-3): 316-346.
- MAUBEUGE, P.L., 1971. Profils nouveaux dans le Pliensbachien et le Toarcien (Jurassique inférieur) de la Province de Luxembourg. *Belgian Geological Survey Professional Paper*, 1971 (8): 1-15.
- MAUBEUGE, P.L., 1972. Etudes stratigraphiques sur la formation ferrifère de Lorraine et ses morts-terrains. Edition privée: 487 pp.
- MERGEN, P., 1984. Données nouvelles et mise au point stratigraphique sur le Sinémurien en Lorraine belge. *Annales de la Société géologique de Belgique*, 107: 109-116.
- MONTEYNE, R., 1958. Recherches sur le Lias inférieur du Sud de la Belgique. Thèse Dr. Sc. Univ. Libre de Bruxelles, Fac. des Sciences, unpublished: 622 pp.
- MONTEYNE, R., 1969. Une coupe de référence dans le Rhétien du Bas-Luxembourg belge. *Belgian Geological Survey Professional Paper*, 1969/2 : 3 pp.
- MULLER, A. & STEINGROBE, B., 1988. Sedimentology of the Luxemburg sandstone Formation (Lower Lias) and the Minette oolitic ironstones (Upper Lias). IAS 9th European Regional Meeting Guidebook, Leuven. A. Herbosch ed.: 27-42.
- RAUSCHER, R., HILLY, J., HANZO, M. & MARCHAL, C., 1995. Palynologie des couches de passage du Trias supérieur dans l'Est du Bassin Parisien. Problèmes de datation du "Rhétien" de Lorraine. *Sciences géologiques Bulletin*, 48: 159-185.
- ROCHE, M., 1994. Palynologie et palynofaciès du Rhétien (Trias supérieur) du nord-est du Bassin de Paris. Ph. D. Thesis, Université de Liège, unpublished: 138 pp.
- SCHUURMAN, W. M. L., 1977. Aspects of late Triassic palynology. 2- Palynology of the grès et schiste à *Avicula Contorta* and argiles de Levallois (Rhaetian) of Northeastern France and Southern Luxembourg. *Review of Palaeobotany and Palynology*, 23: 159-253.
- STEININGER, J., 1828. Essais d'une description géognostique du Grand-Duché de Luxembourg. Imprimerie de l'Académie royale, Bruxelles.
- STORRS, G.W., 1994. Fossil vertebrate faunas of the British Rhaetian (latest Triassic). *Zoological Journal of the Linnean Society*, 112: 217-259.
- TEYSEN, T., 1984. Sedimentology of the Minette oolitic ironstones of Luxembourg and Lorraine: a Jurassic subtidal sandwave complex. *Sedimentology*, 31: 195-211.
- WOUTERS, L. & VANDENBERGHE, N., 1994. Géologie de la Campine. Essai de synthèse. ONDRAF: 208 pp.