

## DINANTIAN

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(3 figures)

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**ABSTRACT.** The name “Dinantien” was introduced by A. de Lapparent in the third edition of his treatise of geology, to replace the ancient expression “terrains anthraxifères”. The Dinantian was at that time regarded as a stage and subdivided into three substages. The middle subdivision, the “Waulsortien”, having been recognised as a sedimentary facies, soon disappeared from the chronostratigraphical time scale.

As a result of the ballots taken by the Subcommission of Carboniferous stratigraphy in 2003, the Carboniferous System is now subdivided into two subsystems, Mississippian and Pennsylvanian, whose mutual boundary does not correspond to the top of the Dinantian. The term ‘Dinantian’ thus disappeared from use, after 111 years of existence as international stratigraphical unit. Its use remains however valid as regional subdivision.

**KEYWORDS:** Arundian, Asbian, Brigantian, lower Carboniferous, Chadian, Condrusian, Freyrian, Holkerian, Livian, Mississippian, Moliniacian, Strunian, Tournaisian, Viséean, Warnantian, Waulsortian.

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### 1. Name

Dinantian (English), Dinantiaan (Dutch), Dinant Stufe (German), Dinantien (French).

### 2. Age

According to Gradstein *et al.* (2004) the Dinantian extended from 359.2 (+/- 2.5) to 326.4 (+/- 1.6) Ma.

### 3. Author

The term ‘Dinantian’ was introduced by Albert de Lapparent (1893, p. 819) for the lowest of 3 subdivisions of the Carboniferous System:

“ Ce système (carbonifère) a d’abord été bien connu en Europe, où il est susceptible d’une triple subdivision. A la base est un étage où dominant les formations marines, et dont les représentants terrestres ou littoraux contiennent assez souvent des couches de houilles anthraciteuses. On l’a désigné sous le nom d’étage *anthraxifère*. Au-dessus vient ce qu’on appelle proprement le *terrain houiller* (...) se divisant lui-même en deux parties : le terrain houiller *inférieur* (...) et le terrain houiller *supérieur*, ... L’anthracite n’étant nullement caractéristique de l’étage inférieur, nous substituerons au mot *anthraxifère* celui de *dinantien*, pour marquer que cet étage a son type dans la vallée de la Meuse, aux alentours de Dinant. Le terme de *culm*, depuis longtemps classique, marquera le facies continental ou côtier de l’étage.”

Also in 1893, Munier-Chalmas and de Lapparent published a « Note sur la nomenclature des Terrains sédimentaires » in which (p. 448) they refer the creation



**Figure 1.** Albert de Lapparent (1839-1908) French Geologist, professor at the “Institut catholique de Paris” and perpetual secretary of the Academy of Sciences of France. He introduced in 1893 the term “Dinantian”.

of the name « Dinantien » to « de Lapparent and Munnier-Chalmas », in de Lapparent's *Traité de Géologie*, 3e éd., 1893, p. 819 (i.e. the reference cited above). In this paper, however, they provided further information : "C'est en Belgique seulement que les limites de l'étage inférieur peuvent être indiquées avec précision ; car il est permis de dire que l'étude stratigraphique détaillée du calcaire carbonifère d'Irlande et de l'Angleterre est encore à faire. Cette division est si bien développée dans la vallée de la Meuse, aux environs de Dinant (Dinandum), que nous proposeront de lui appliquer le nom de Dinantien assuré d'un bon accueil de la part des géologues belges. Le Dinantien, succédant au calcaire d'Etroeungt (Nord), comprendra les trois sous-étages créés par M. Dupont, *Tournaisien, Waulsortien, Viséen*"

#### 4. Historical type area

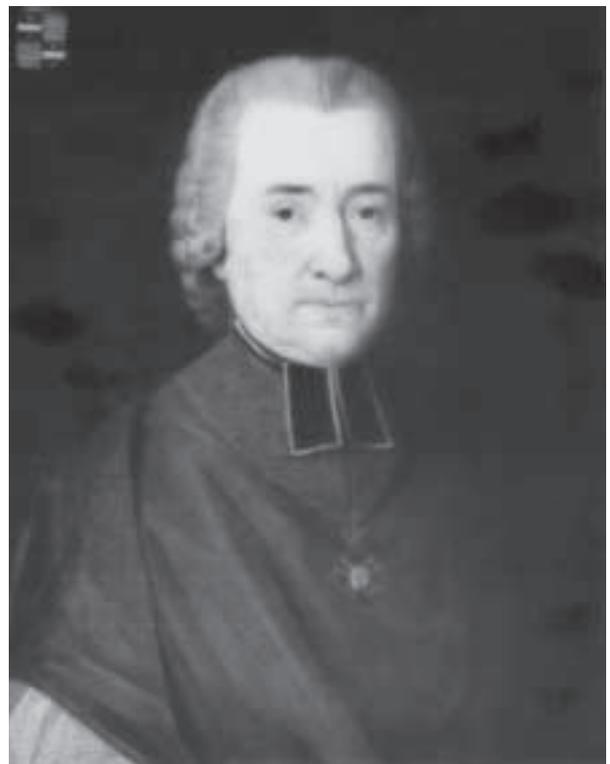
The name "Dinantian", to replace "Carbonifère inférieur", was given by de Lapparent because of the quality of outcrops along the River Meuse, around Dinant, but it was also to celebrate the pioneer work of Edouard Dupont. However, throughout the period during which the concept of the Dinantian has evolved, the type sections of the subsystem and its constituent parts have never been located at Dinant itself. Instead, they were scattered over the Dinant and Namur Basins (or Synclinoria), known now by structural geologists as the "Allochtonne Ardennoise" and "Parautoctone Brabançon" (Khatir *et al.*, 1992). In the early descriptions of Dupont, the only complete section of the Carboniferous limestones was said to be at Falmignoul, a locality south of, but administratively part of Dinant. The lowest "Assise" of E. Dupont (1863), and hence the base of the Dinantian, was defined both along the road to Anseremme at Falmignoul and at the Etroeungt quarry "where J. Gosselet (1860a) described a noteworthy fauna". The top of the Dinantian, in whose uppermost levels the limestones become darker and contain coal horizons can be seen at Anhee, north of Dinant.

When the official legend of the geological map was published in 1929, the base of the Dinantian was taken at the base of the Hastière limestone. Demanet amended this in 1938, to include the Calcaire d'Etroeungt or "Strunian" at the base (Tn1a). In 1935, the International Carboniferous Congress of Heerlen defined the base of the Carboniferous at the appearance of the goniatite *Gattendorfia subinvoluta*. Henceforth, the position of the base of the Dinantian was necessarily dependent on international efforts to refine the definition of the base of the Carboniferous System.

In 1967, Conil, Pirlet and Lys published a new Dinantian biostratigraphical column in which they defined reference sections. This work was based on that of Demanet (1958) which was amended, mainly using micropaleontological data. The base of the Dinantian, which included the

"Strunian s.s." (Tn1a), was defined by the appearance of the foraminifer *Quasiendothyra* at Etroeungt. The exact position of the first *Quasiendothyra*, as well as the recognition of the different subspecies, led to a long-lasting conflict within the Belgian geological community. The reference section for the top of the Dinantian was taken in the Dejaiffe quarry at Warnant (in the Molignée valley, near Yvoir). The upper Viséan beds contain *Martinia* aff. *glabra* as well as many conodonts. Between this level and the first occurrence of *Eumorphoceras*, characterizing the E2a1 zone of the overlying Namurian, there are five metres of unfossiliferous sandy shales. The E1 zone appears to be absent.

These boundaries were used until 1976 when Conil, Groessens and Pirlet subdivided the Dinantian into five stages based on the occurrences of conodonts and foraminifera in conformity with international rules. The Strunian was included in the Devonian. The base of the lowest Dinantian stage, the Hastarian, was defined at Hastière-Lavaux, along the "sentier des Vignes" (a footpath located NE of the village church, along the left bank of the River Meuse). The base was chosen as near as possible to the appearance of the first specimen of the conodont genus *Siphonodella*, the lineage from *Siphonodella praesulcata* to *S. sulcata* (see below) having



**Figure 2.** Louis-Hyacinthe d'Everlange-Witry (1719-1791) Physicist and mineralogist, curator of Charles of Lorraine private natural history collections, canon of the Tournai cathedral and member of the Royal Belgian Academy. He was the first to publish a paper, including four plates of fossils, on the Tournai limestones (Groessens, 1989).

never been found in Belgium. The base of the “Calcaire d’Hastière”, formerly labelled Tn1b, containing reworked (?) Devonian conodonts and ooids, was also excluded from the Dinantian. Some authors believe there to be a stratigraphic gap in that position. The Dejaille quarry at Warnant was retained as the top of the Dinantian, as represented by the top of the Warnantian stage.

## 5. Historical background

The first paper on “Carboniferous stratigraphy” was published in Belgium. On December 9th, 1777, Louis-Hyacinthe d’Everlange-Witry (1719-1791), a priest, presented a memoir on the fossils of Tournai at the Imperial and Royal Academy of Brussels. This paper (published in 1780) contains plates showing fossils among which is a “*Trilobos*”, identified by G. and R. Hahn (2003) as probably a *Cunningella* sp. ind. This was the first representation of a Carboniferous trilobite. (Groessens, 1989)

The “father of the Belgian geology”, J.B.J. d’Omalius d’Halloy, first referred the (Carboniferous) limestones to the “*Bituminiferous Formation*” (1808) and, later, to the “*Terrain Anthraxifère*” (1828).

In 1849, in the legend to the first geological map of Belgium, A.H. Dumont, included the “Houiller” in the “*Terrain Anthraxifère*” which he subdivided into three systems: Eifelian, Condrusian and “Houiller”. In 1856, A.H. Dumont published a new geological map of Belgium on which the Condrusian was described as being composed of crinoidal limestones, dolomites, and limestone with *Productus*, cherts and anthracite. The “Calcaire de Tournai”, characterized by crinoidal limestones, was identified as the lowermost stage of the Condrusian, while the “Calcaire de Visé”, the limestone with *Productus*, formed the uppermost stage. Four years later he replaced the term “Condrusien” by “Carboniferous”, introduced in Great Britain by Conybeare and Philips in 1822.

Alongside this terminological evolution, the publication of de Koninck’s many memoirs provided a major contribution to Lower Carboniferous paleontology. Already, in the first of them (1842), he stated that notable differences existed between the fossils he found at Tournai and those at Visé, but he nevertheless considered them to be contemporaneous. Then, in 1847, de Koninck argued that the Viséan limestones were older than those of Tournaisian, only to admit the opposite a few years later when he used the legend established by Dupont.

Gosselet (1860b) considered that the *dolomitic middle stage* of Dumont was a lateral equivalent of the limestones, and proposed a subdivision of the Carboniferous into three parts namely, from the top to the bottom: *étage Houiller*, *étage du calcaire de Visé*, and *étage du calcaire de Tournai*.

This scheme served as starting point for the work of Edouard Dupont who made a fundamental contribution to the stratigraphy of the Carboniferous limestones. Du-

pont, the first director of the Natural Sciences Museum of Brussels, was a bit of a character. Although he may be considered as one of the pioneers of archeology, geology, the study of fossil reefs, and geological mapping, his biography was not published until more than half a century after his death. Stockmans (1965) wrote that he was an authoritarian man, obstinate and sometimes even persisting in errors. His obstinacy in the geological field mapping (1/20,000 scale) that was ordered by the Government in 1878 caused what Vanpaemel (1996) called the “crisis of Belgian Geology at the end of the nineteenth century”. Dupont’s refusal to change his ways caused enormous damage to the Belgian geological world (Groessens & Groessens-Van Dyck, 2000).

Dupont started his career in 1860 as a disciple of J.B.J. d’Omalius d’Halloy. In 1863, he published his first essential contribution “sur le Carbonifère de la Belgique et du Hainaut français” in which he introduced 6 subdivisions of the Lower Carboniferous: the “*assises*” d’Etreoungt (I), Avesnelles (II), Tournai (III), Waulsort (IV), Namur (V) and Visé (VI).



**Figure 3.** Edouard Dupont (1841-1911) Director of the Royal Museum of Natural History of Belgium and author of the first geological maps of the Dinant area. The name “Dinantian” was given by de Lapparent, not only because of the quality of outcrops along the river Meuse, around Dinant, but also to celebrate the pioneer work of Edouard Dupont.

In Dupont's view, these units were not uniformly distributed. He interpreted the absence of any "assise" as resulting from a break in sedimentation, and he developed from this his "theory of lacunes" in which he neglected and/or ignored lateral facies changes. Between 1880 and 1885 Dupont and collaborators published a series of geological maps at the 1:20,000 scale, and three stages "Tournaisian", "Waulsortian" and "Visean" were introduced. Dupont positioned the base of the Visean at the "calcaire gris violacé et noir subcompacte avec des bandes de rognons de phtanites gris", later named the "Calcaire de Leffe" and designated as "Tn3c". He considered this limestone to have been produced by erosion of the Waulsortian reefs.

The great controversy which arose when Dupont's maps were published finally resulted in the creation, in 1896, of a Geological Survey separate from the Museum - and thus independent of Dupont.

In 1895, de Dorlodot established a new stratigraphic column for the Dinantian in which the Waulsortian stage was removed (for the subsequent history of the Waulsortian, see Lees, 1988) and the base of the Visean moved to the base of the "Marbre noir de Dinant". He made a new geological map of Dinant, at the scale of 1:40,000, published in 1919, twenty years after all the other maps and almost ten years after the death of Edouard Dupont.

The official legend of the geological map, published in 1929, retained Dinantian subdivisions similar to those of de Dorlodot. The base of the Dinantian was taken at the base of the Hastière limestone, (47) although Demanet (1929) had including the Calcaire d'Étroeungt or "Strunian" at the base (Tn1a).

In 1967, Conil, Pirlet and Lys published a new Dinantian biostratigraphical scale in which they defined reference sections. As already mentioned in section 4, the base of the Dinantian, which included the "Strunian s.s." (Tn1a), was defined by the appearance of the foraminifer *Quasiendothyra* at Étroeungt, and the top of the Dinantian was taken in the Dejaiffe quarry at Warnant.

During the 7th International Congress on geology and stratigraphy of the Carboniferous (Krefeld, 1971, p.142) it was decided that the Carboniferous should be divided into two or more subsystems. The Tournaisian and the Visean thus became series and had to be subdivided into stages. Conil *et al.* (1976) proposed five new stages: in stratigraphic order, *Hastarien*, *Ivorien*, *Moliniacien*, *Livien* and *Warnantien*, based on new data available on the occurrences of conodonts and foraminifera.

The Devonian-Carboniferous boundary was discussed at several field meetings in the period 1978-1989. In an attempt at close conformity with the existing defined position (dating from 1935) at the base of the *Gattendorfia* Zone, a new operational definition of the boundary was proposed by the Working Group chaired by E. Paproth. This placed the boundary at the first appearance of the

conodont *Siphonodella sulcata* within the evolutionary lineage from *S. praesulcata* to *S. sulcata* (Sandberg, 1972 and Sanberg *et al.*, 1978), and immediately preceding the entry of *Gattendorfia* in the Hönnetal. It was then important to search for a boundary stratotype best displaying this evolutionary lineage, as well as exhibiting adequate representation of other, zonally significant fossil groups. In Belgium, Bouckaert and Groessens (1976) had collected all available sections without significant results. Van Steenwinkel (1980), focussing on the Anseremme section, also failed to find the lineage, but did find *S. duplicata* and a stratigraphic gap at the boundary. This ended Belgian ambitions to keep the boundary stratotype in this part of the world.

Several candidate sections were proposed in 1988, two in South China and three in Europe (Austria, France and Germany). After much effort, a large majority of the Working Group voted for a global boundary stratotype at La Serre (Montagne Noire, France) and two auxiliary boundary stratotypes, at Hasselbachtal (Germany) and Nanbiacun (China). The final definition by the Devonian-Carboniferous Boundary Working Group of the base of the Carboniferous in the La Serre section was achieved late in 1989.

The Subcommittee of Carboniferous stratigraphy had formally agreed, at Krefeld in 1971, to place the Tournaisian - Visean boundary at the base of the first bed of *marbre noir* in the Dinant (Bastion) section as identified in Conil *et al.*, 1967 (see also Groessens and Noël, 1974). In 1988, while preparing the field-trip guidebook for a visit of the Palaeontological Association Carboniferous Group to the Belgian Dinantian (Conil *et al.*, 1988), Conil and his co-workers revised this Bastion section. They uncovered some exposures, never before examined, that yielded conodonts and foraminifera showing that the base of the Moliniacian stage did not correspond to the base of the Visean, as had been intended (Conil *et al.*, 1989), but was older - lying in the upper Tournaisian. Lees (1997) proposed that, until the question of redefinition of the stage boundary was resolved, the name "*Freyrian*" be applied, informally, to the interval between the base of the Moliniacian and the base of the Visean.

The Tournaisian-Visean Boundary Task Group, chaired by G. Sevastopulo, is currently putting the finishing touches to its proposal for the base of the Visean at the Penchong section in Guanxy, southern China. The task group internally approved the proposal and is now preparing a formal proposal for the SCCS ballot on the GSSP (Newsletter on Carboniferous Stratigraphy, vol. 23, 2005, p. 3).

In 1997, the chairman of Subcommittee of Carboniferous Stratigraphy received a draft revision of the IUGS Global Stratigraphic Chart in which the Carboniferous System was subdivided into two subsystems whose mutual boundary passed between the *Serpukovian* and *Bashkirian*, thus well above the top of the Dinantian.

## 6. The end of the “Dinantian Subsystem” as an international subdivision.

As a result of the ballots taken by the Subcommittee on Carboniferous Stratigraphy in late 2003 and ratified by the International Commission on Stratigraphy and the International Union of Geological Sciences in early 2004, the *Carboniferous System* has a new, official, global series and stage classification and nomenclature. The System, is now subdivided into two subsystems: the *Mississippian* and *Pennsylvanian*. Each subsystem has three series, called : *Lower*, *Middle* and *Upper*. In the Mississippian, each of the series comprises a single stage, from bottom to top : *Tournaisian*, *Viséan* and *Serpukhovian*. Thus, the Dinantian subsystem died officially at the age of 111 as international stratigraphical unit. Its use remains however valid as regional subdivision.

## 7. Acknowledgements

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