FAMENNIAN REGRESSION AND STRUNIAN GRABENS
IN THE ARMORICAN MASSIF. A KEY-AREA: WESTERN BRITTANY

by

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(3 figures)

ABSTRACT. - An updated lithologic and paleontologic analysis of the most important Upper Devonian and Lower Carboniferous sections in the western part of the Armorican Massif is presented and compared with the data from the eastern part of the same Massif. It helps to understand the tectono-sedimentary processes around the Devonian-Carboniferous boundary and provide the basis for a paleogeographic interpretation. (Abstracted by the editors).

RESUME. - Une mise à jour des données lithologiques et paléontologiques des plus importantes coupes du Dévonien supérieur et du Carbonifère inférieur de la partie occidentale du Massif Armoricain est présentée et comparées aux données de la partie orientale du même massif. Elle aide à comprendre les processus tectono-sédimentaires près de la limite Dévonien-Carbonifère et fournissent les bases d’une interprétation paléogéographique.

1. - INTRODUCTION

The western part of the Armorican Massif (Western France) is an excellent region for the study of Famen- nian sediments and their relationships with those of the Strunian and Dinantian. Three areas are discussed here: Morlaix, Châteaulin and Rade de Brest. The terms "Châteaulin Basin" and "Morlaix Basin" are used here in the more restrictive acceptation i.e. for the Dinantian period only.

The Rade de Brest in the western Châteaulin Synclinorium yields the most complete Devonian sections of the Armorican Massif. These consist of marine, apparently continuous, autochthonous sequences. They are well-dated by macrofauna and microfauna and range from the lowermost Gedinnean to the lower part of the Upper Famennian (Fa2a). The Devonian of Morlaix is very incomplete and/or poorly dated.

Paleontologically dated Strunian (Tn1a) deposits only occur in the western part of the central Armorican Massif (on the northeastern flank of the Châteaulin Basin and in the Morlaix Basin). These consist of subaqueous, autochthonous sediments with olistolites and/or pebbles, but without evidence of a marine environment.

Distinctly marine, autochthonous Dinantian rocks occur in the western part of the Châteaulin Basin. These lower Tn3c Quivit Limestones represent the south-westernmost extension of the Northern-European Dinantian sea.

2. - COMPARISON WITH EASTERN PART OF THE ARMORICAN MASSIF

A rather different succession is known from Ménéz Bélair in the eastern part of the Armorican Massif, where the marine Devonian sequence only ranges into the Lower Famennian (Fa1a), where the Strunian deposits are unknown, and where the marine Dinantian Quenon Limestone is of latest Tournaisian (Upper Tn3c) age (Paris et al., 1982). The eastern part

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of the Armorican Massif is also distinguished from the western area by the following aspects:

- vast areas without Devonian or Carboniferous sediments on top of the Lower Paleozoic rocks (Mancellia synclines to the South of Rennes);
- structural units with marine, autochthonous and continuous Devonian successions which are however not younger than Emsian (Cotentin, Laval Synclinorium; Houglatte et al., in press);
- relatively complete marine Devonian sequences (Gedinian to Famennian), but mainly recognized as olistoliths in the Dinantian deposits (Angers, St. Julien de Vouvantes, Ancenis; Dubreuil, 1980, 1985);
- isolated occurrences of precisely dated (autochthonous or allochthonous?) Givetian Ville-d'Ardin Limestones (Vendée);
- reddish autochthonous deposits (Hyenville, Cotentin) of presumed Upper Mesodevonian to Neodevonian age (Doubinger & Poncet, 1964);
- the already mentioned absence of Strunian sediments.

It should be noticed that there is no biostratigraphic evidence supporting the hypothesis of Poncet & Giresse (1972) that the Robillard Sandstone is of Upper Devonian or Tournaisian age. This idea is based on the fact that this sandstone occurs in between the Hyenville deposits of presumed Upper Mesodevonian to Neodevonian age and the Upper Tournaisian to Visean (Pelhâte & Poncet, 1970; Pelhâte, personal communication) Montmartin Limestones. Further-

more, since the age of the Hyenville deposits is questionable, there is no means for dating the lower limit of the Robillard Sandstone. This implies that there is a reasonable doubt about the existence of Strunian rocks in Normandy.

This brief review of the deposits around the Devonian-Carboniferous boundary shows that the most precisely dated sediments occur in the western part of the Armorican Massif. Moreover, a major structural event affected that area during the Famennian-Strunian period. Rocks showing the impact of the Bretonic phase (synclavage folding, overthrusting, syntectonic magmatism and granitisations; Darboux et al., 1977; Rollet, 1982) are unconformably overlain and reworked by the Strunian synchro-recumbent nappes of the Châteaulin (pull-apart) Graben (Rollet & Thonon, 1979; Guillochau & Rollet, 1982; Rollet, 1984).

3. - KEY-SECTIONS IN WESTERN BRITTANY

An updated lithologic and paleontologic analysis of the most important sections is presented here. These serve as a basis for paleogeographic reconstructions.

3.1. - WESTERN CHATEAULIN SYNCLINORIUM

Two sections are considered: the Porsguen section of the Rade de Brest and the Zorn section of the Crozon Peninsula.

The Upper Frasnian and Famennian are represented by the Porsguen and Zorn formations which form the top of an important sequence of marine shelf deposits ranging from the Pridoli into the Famennian. The Upper Frasnian to Lower Famennian (dol6 - dol8) Porsguen Formation (thickness some 50 m ?) consists of black (keratibuminous) shales with abundant fossiliferous nodules and without any detrital influx. Large calcareous spheroids and/or some carbonate layers occur in the lower portion, whereas silico-phyric nodules are found in the upper half (Babin et al., 1976, Morzadec, 1983). At Porsguen these nodules have yielded diverse fossil assemblages including bivalves (Posidonia venusta, Buchiola retrostriata), goniatites (Cheiloceras circumflexum, C. verneuii) and inflated plant debris (Protolepidodendropsis pulchra, P. frickei, Lepidodendropsis africanum, Leptophloeoideas rhombicum, Platycladulum brownianum). The reducing character of these sediments suggests a confined marine environment, probably near emerged areas and very shallow (Babin & Plusquellec, 1965). This period is marked by "un paysage à topographie molle où se trouvent délimitées des aires de sédimentation de petite taille, eux uniquement entre elles. Les reliefs ont disparu". (Guillochau, 1982). Although there are no hard facts proving the shallow environment, the analogy with the black, reducing sediments of the
Armorican Silurian (Guillocheau, 1982) supports this hypothesis. And thus, in our opinion the Porsgwen Formation marks the beginning of the latest Devonian regression.

The Upper Famennian (transitional zone doli-
dolI, or Fa2a) Zorn Formation has a thickness of some 25–30 m. It is only known from two locations: Porsgwen (Rade de Brest) and Le Zorn (Crozon Peninsula). It consists of essentially shales and alternating shales and limestones with some synsedimentary slumpings. This formation forms the youngest pre–Carboniferous marine deposit in the central Armorican Massif (Babin et al., 1976; Morzadec & Babin, 1976) and it is characterized by the occurrence of reworked spores (Morzadec & Streele, 1980) indicating that the sedimentary succession has been deeply truncated, sometimes even into the Emsian rocks (i.e. down to 850 m). This erosion is a result of (non-folding) deformations linked to the early Bretonic movements of the Hercynian orogeny.

3.2. - WESTERN BORDER OF CHATEAULIN BASIN

The Quivit section is situated in an isolated micro-

gaben near the southwestern border of the present-day Châteaulence Basin. The outcrops exhibit the Lower Tn3c (anchoralis to latus conodont zones) Quivit Limestone (Plusquellec et al., 1983). This shelf limestone forms the oldest deposit of the marine Dinantian in the Châ-
taulence Basin. Probably, it unconformably overlies (at least according to cartographical mapping) marine Devonian (Givetian or possibly Frasnian) strata. The Lower Frasnian Traonlios Shales have been observed a few hundreds of meters to the South–East. But the Porsgwen and Zorn Formations are absent along the entire border of the Châteaulence Basin. The Quivit Limestone is overlain by the Guoennent Conglomerate (including reworked Upper Viséan Limestone pebbles) and the Pont-de-Buis shales and wackes of Upper Viséan (V3b–V3c) to Namurian age. The detrital material in the latter may have been deposited by presumably shallow prodeltaic turbidites (Guillocheau & Rolet, 1982). The marine facies of the Pont-de-Buis strata may only be deduced from the occurrence of cal-
careous lenses (V3b) which might have been reworked within the same area where these were formed.

3.3. - NORTHERN BORDER OF CHATEAULIN BASIN

3.3.1. - Kermervien section

The Kermervien Formation was originally described in its type locality (Rolet & Thonon, 1979; Guillocheau & Rolet, 1983), which outcrops along the ancient road from Braspars to Pleyben (road D785) completed with sections along the paths around Kermervien. A recent trench for a road between Kermervien and the Coatiliou farm has yielded complemen-
tary information in 1984.

The lowermost strata of this formation occur at the foot of the northern slope of the Kermervien hill. These consist of black shales with thin laminae of rhythmic sandstones (striped shales). In some levels the sandstones predominate (varved sandstones) and sometimes these may become tuffitic (cherty tuffites). Normally however, they contain reworked volcanogenic material. These sediments enclose olistoliths of varying dimensions and consisting of Siluro–Devonian material (Rolet, 1982). They also enclose chaotic shale masses with pebbles and blocks of quartzite and acid tuffs which represent typical olistoliths (along the new road to Braspars and in the section of Toulanay to the South of St. Herbot).

The gravititic shales at Kermervien which occur West of a plurimetric olistolite of black stratified quartzite (probably of Upper Silurian age) have yielded palygocrine assemblages with acritarchs (Gorgoni-
sphaeridium abisatum, G. ohiense, Elektoriakos dofos, Acriara sp., Veryachium rosiculi and Dallidium quadridactyles; det. Deunff) and spores (Retispora leipocephyta, Valtissitporis pusillitaris, Verrucosisspori-
tes nitidus, Dictyoitrites sp. and numerous leiospheres; det. Streele). These point to an Upper Strunian age and do not contain any reworked elements.

This formation is overlain by acid tuffs, the contact being either a fault (new road section) or a wash-
out with reworked Strunian shales (Toulanay section and express road of Vieux Tronc to the South of Huel-
goat). In the latter case, these acid tuffs belong to the Kertanguy Formation which has not been dated but which is assigned to the Tournaisian.

The base of the Kermervien Formation is not exposed in the Kermervien section, but can be ob-
served at Toulanay. It consists of a vertical fault with dextral sliding putting into contact the Strunian (striped) shales with Lower to Middle Devonian Braspars shales enclosing several dykes. It should be noticed that the complete extension of the Kermervien Formation has not been observed in any of these sections, and also that the Upper Devonian strata known from the Rade de Brest seem to be absent on the present-day borders of the Châteaulein Basin.

3.3.2. - Quenech Guen section

This section is located to the East of the Kermervien section along a North–South path which descends to the Eliez River. It is situated on the northern bor-
der of the Châteaulein Basin (South of Huelgoat, West of Plouyé). The some 600 m long section exhibits in its lower part clastic Devonian deposits (Lower Emsian to Eifelian) which disconformably overly Siluro–Devonian formations (Rolet & Thonon, 1979). The Devonian deposits exhibit gravitational slumpings (Deunff et al., 1984) and thus a reworking of fossil faunas and micro-
floras cannot be excluded.

The upper part of the section (level 11, section E in Deunff et al., 1984) consists of shales with rare no-
dules and decalcified layers. These have not yielded any identifiable fossil. They are overlain by an apha-
Figure 2. - Lithostratigraphical columns of the late Devonian and Dinantian in the western part of the Armorican Massif.
Nomenclature of the formations (14-19 after Morzadec's numbering, 1983).


In this paper the authors say that no microfossils have been found in the Hyenville Formation and that "It appears to be preferred to consider the Hyenville Formation as undated at best, and in all likelihood to be older than Devonian".
nitic lava flow (bed 13) and shaly tuffs with quartzitic pebbles (bed 15). These volcanics might represent the lower strata of the Kermerrien Formation, here overlying the presumably Devonian shales of level II without any apparent disconformity or fault. The overlying sequence closely resembles that of the Kermerrien section and consists of alternating shales and black quartzites overlain by striped shales. Some crinoid fragments and unidentifiable plant remains have been found in the tuffitic beds in these shales which have been attributed to the Strunian Kermerrien Formation because of their similar facies and cartographic lateral continuity with the same. These can be followed over a distance of some 100 m to the South where the section is interrupted by the Ellez River. At the other side of the river they appear again with a very tuffitic facies. There, these are overlain by the conglomerates of the Kerroch Formation. Although this section is incomplete and poorly dated, it is of interest because it shows that the rocks attributed to the Strunian rest upon a chaotic sequence (Quencic’h Guen shales and sandstones) of at least Eifelian age which was deposited here by gravitational sliding somewhere between the Eifelian and Strunian.

3.4. - MORLAIX BASIN

The Morlaix Basin is a structural unit of its own (Cabanis et al., 1979), bordered by volcanoclastic sandstones which are related to or pass into a breccia (Dourduff Breccia) to the North-East and which are overlain by the Morlaix striped shales.

The intense tectonisation of the Morlaix Basin and also the scarce data about the stratigraphic age of the formations make it rather difficult to compare the same with those of the other Dinantian basins. The actual information (Rolet et al., 1984) allows the distinction of two formations within the Dourduff Breccia, the Melin Vor Formation and the Kerivoalen Formation.

3.4.1. - Melin Vor Formation (new formation)

This formation outcrops in ancient quarries South of the bridge of Melin Vor on the southern bank of the Dourduff River. It is a very heterogranular conglomerate without any graded-bedding, consisting of pebbles of sandstones, quartzite, shale and keratophytic tuffs enclosed in a shaly matrix. This matrix, and the shaly intercalations and black shales occurring to the North of the quarries have yielded a rich microflora (numerous spores and scarce acritarchs) and sclerco-
donts (Deuff & Coquel, 1979). These assemblages correspond to the top of the Wockumeria-Kallocly-
menia beds (to VI) of the Tn1a or to the lowermost Tn1b equivalent of the Strunian in Belgium. The homogeneity of the assemblages collected from different samples seems to exclude the hypothesis that these might have been reworked. Thus, these strata are the oldest ones known in the Morlaix Basin.

3.4.2. - Kerivoalen Formation (new formation)

The formation occurs on the northern banks of the Dourduff River between Dourduff-en-Mer and Dourduff-en-Terre, and it outcrops along the river in a cliff where limestones have been quarried. Geometrically, this formation overlies the Melin Vor Formation. It is distinguished by the nature, shape and size of its elements and also by the nature of the matrix. This formation exhibits all the characteristics of a gravitational subaqueous olistostrome. The occurrence of limestone blocks with unidentifiable crinoid remains had been observed already a long time ago. Recently these blocks have yielded some conodont fragments similar to Gnathodus ex group pseudosemiglaber (det. Weyant) which ranges from the Upper Tournaisian (Tn3) to the Lower Visean (V1a). Other samples had yielded algae, among which Koninckoporina inflata which is also known from the Middle Visean (V2a) in Belgium (Peléhâte, 1973).

One might accept that the reworking of these limestone blocks from the Northern-European Dinantian carbonate shelf occurred during the Middle or Upper Visean, i.e. during the same period as the reworking of the calcareous lenses of V3b age in the Pont-de-Buis strata of the western Châteaulin Basin. Also the Morlaix striped shales which geometrically occur on top of the Kerivoalen Breccia might be of Visean age.

The basal strata of the Morlaix Basin are cartographically represented by shales and greywackes of the Berlingar Formation, which has been assigned (without palaeontological evidence) to the Upper Devonian (Cabanis, 1972; Morlaix map 1:50.000, 1981). However, the petrographic characteristics of this formation suggest a correlation with the tuffitic sandstones associated with the Kerivoalen Breccia. If this suggestion is correct, the Morlaix Basin would be a Visean basin (Middle or Upper Visean) resting discordantly upon a small Strunian outlier (Melin Vor Conglomerate) in the Dourduff River and overlying to the South of Morlaix the chloritoid shales (or black shales) of the Lower Devonian.

4. - PALEOGEOGRAPHIC AND GEODYNAMIC INTERPRETATION

The foregoing data help us understand the tectono-sedimentary processes around the Devonian-Carboniferous boundary in the western part of the Armorican Massif. At the same time these provide the basis for a paleogeographic interpretation (fig. 3). The Bretonic phase is only marked by a simple upwarp of the eastern area since the Middle Devonian, but it has its complete significance in the western part where the first movements are recorded by the reworked spores in the Zorn Formation and culminate in the Upper Famennian regression. Subsequently, all the Palaeo-
zoic deposits (including the Famennian II-III) have
Figure 3. - Paleogeographic maps of the Armorican Massif for the Frasnian to Tournaisian and hypothetical position of this area with regard to the O.R.S. continent.

1. Emerged area or without deposits; 2. Continental facies; 3. Lacustrine (?) area with marine effect; 4. Marine; 5. Locality with a controlled age (micro- or macrofossils); 6. Possible or questionable age.

(For the map "Middle and Upper Tournaisian", the reference of the locality situated on the flank of the shelf is Auffret et al., 1979).
been affected by the Bretonic tectonics during a very short time interval (Famennian II-III to Strunian). As a result of these movements in the West some areas of clastic deposition (with blocks) developed since the Strunian. These formed the centers of the tectono-sedimentary basins which acquired their full extension during the widely extended Dinantian transgression.

REFERENCES


