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CROSS-SECTIONS THROUGH THE BELGIAN VARISCAN MASSIF[1]

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ABSTRACT

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Two profiles through the Belgian Ardennes are described and depicted. The Cambrian to Silurian rocks, folded during the Caledonian orogeny, show a weak metamorphism. The cover, consisting of Devonian and Carboniferous, thickens towards the south and is thrown into a number of major folds during the Variscan orogeny. This was accompanied by a second stage of low-grade metamorphism.

INTRODUCTION

Caledonian formations, ranging from Cambrian up to and including the Silurian, are characterised mostly by a low degree of metamorphism, and are unconformably overlain by an important complex of sediments, from Early Devonian to Late Carboniferous in age. These Variscan formations, south of the London-Brabant Massif, belong to a southerly situated geosyncline. During the whole Devonian period the area of subsidence was situated in the southwest, so that transgressions occurred to the northeast, the area where Caledonian tectogenesis had been most intense.

The Lower Devonian, more than 4000 m thick in the south, consists mainly of terrigenous material, whereas in the Middle Devonian and the lower part of the Upper Devonian organogenic sediments dominate with the development of local bioherms in the south and biostromes in the north. The thickness of the Middle Devonian and the Frasnian changes from 1100 m in the south to 200 m in the north.

A more continental facies is to be found towards the northeast, in the Middle as well as in the Upper Devonian. Biohermal and biostromal deposits can also be found in the Lower Carboniferous with local evaporites in the west. A continental complex of Late Carboniferous age closes the Variscan sedimentation cycle.

The Belgian Variscan massif (that outcrops south of the London-Brabant Massif) consists of a series of large folds. From north to south (Fig 1):

- the Namur Basin with Upper Carboniferous in the centre;
- the Condroz Anticline with Ordovician-Silurian in the centre;

the Dinant Basin with locally Upper Carboniferous in the centre; this basin retains its structure at the other side of a transverse culmination and is then known as the Vesdre and Herve Basin;

- the Ardennes Massif;
- the Eifel Basin;
- the Givonne Massif.

The Condroz anticlinal zone with its incompetent layers of Silurian and Ordovician was originally a much larger region between the Namur and Dinant Basins. The zone contains faults with an ENE direction which intersect the direction (WNW) of the coastlines of the Middle and Late Devonian seas at an acute angle.

Let us now look at two cross-sections through the Belgian

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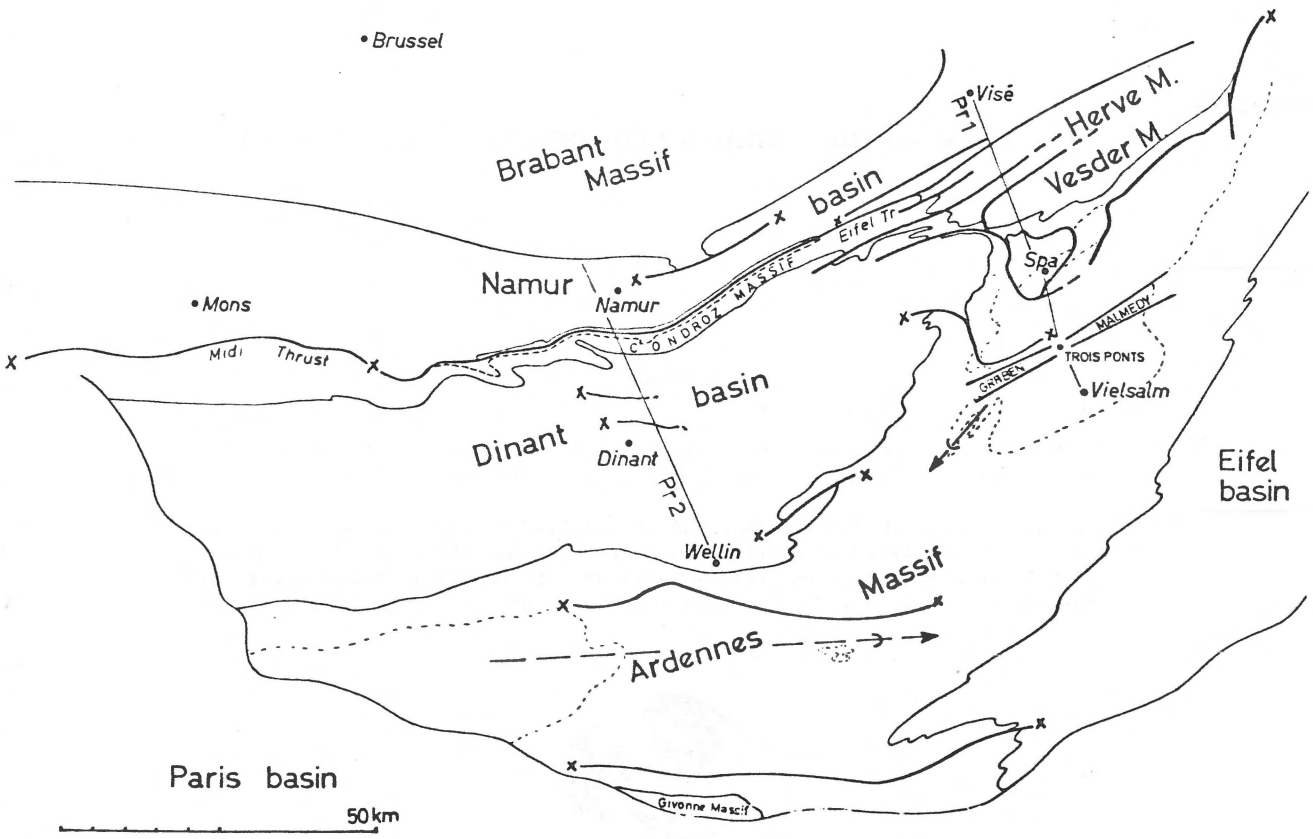

Fig. 1
Schematic structure of the Belgian Ardennes.

Variscan massif, from the Brabant Massif to the Ardennes anticline, in both the eastern and central parts.

CROSS-SECTION 1

In the eastern part of Belgium we have a series of deep bore-holes arranged in a generally north-south direction, going from Hermalle via Bolland–Soumagne–Soiron–Pepinster (wells 1 and 2) up to Grand Halleux. These bore-holes, in conjunction with field observations, allow us to get a general idea of the Variscan deformation in this area.

In the Namur Basin, bordering the Brabant Massif, no trace of Lower Devonian has so far been observed. Apart from secondary faults (Seraing) and folds (Cointe) this basin is very regular but is limited by the great Eifel Overthrust which continues in an easterly direction (fault of Asse: RAUCQ, 1943). This area to the southeast of Liège is characterised by an important stratigraphical break in the Lower Carboniferous (ANCION ET AL., 1943) so that Upper Carboniferous is overlying directly the Upper Devonian.

The same stratigraphical hiatus can be found in the overthrust slice observed in the Bolland bore-hole. The great importance of the Eifel Asse fault is shown by the difference between the Namur Basin where no Lower Devonian is deposited and the southerly overthrusted Dinant Basin in which thick Lower Devonian can be found. The upper part in the Bolland well, characterised by the presence of a reduced Lower Carboniferous, belongs to a second overthrusted massif that is also observed in the lowermost part of the Soumagne bore-hole (GRAULICH, 1977-a).

The uppermost part of the Soumagne boring corresponds to a disturbed inverted limb (*Reticuloceras* Zone) of a syncline of which the centre (*Gastrioceras* Zone) lies approximately 600 to 1100 m deep. The part of the Lower Devonian found in the bore-hole points lithologically to the upper part of the Lower Devonian.

In the Soiron bore-hole (GRAULICH, 1977-b) there are three important facts to be noticed:

(1) A recumbent syncline is present so that we go from Upper Devonian to Upper Carboniferous and back to Upper Devonian.

(2) The youngest beds (*Gastrioceras* Zone) are discovered here at 1200 m depth (it is found in the same syncline as in Soumagne).

(3) The Lower Carboniferous is much better developed in the Soiron well than in the Soumagne bore-hole. The difference is explained by the net slip of the thrust fault, known at the surface as the Prayon Fault (= St. Hadelin fault). In the area north of these faults the thickness of the Lower Carbon-

iferous is greatly reduced.

Both Pepinster bore-holes prove irrefutably the existence of an overthrusted complex composed of Middle and Lower Devonian overlying a recumbent isoclinal fold with Namurian in the core. This syncline in the Upper Carboniferous reaches the surface near Juslenville.

This overthrusted massif, known as the Vesdre Massif, is connected with the same beds within the autochthonous Theux Window. The formations in the Theux Window as well as those of the Vesdre Massif, form the northern border of the Ardennes Massif (Stavelot Massif). This is not only proved by the Caledonian structures inside and outside the window (GEUKENS, 1959), but also by the lithological and faunal composition of the Lower Carboniferous, Upper Devonian, Middle Devonian (COEN-AUBERT, 1974) and Lower Devonian of both regions.

The Vesdre Massif corresponds to the northwards overturned north limb of the Stavelot Massif, partly displaced by gravity gliding. An overturned broken fold structure is found along the whole of the northern border (GEUKENS, 1962) of the Stavelot Massif, known in Germany under the name 'Venn-Überschiebung'.

This intensely deformed Caledonian massif is little affected by the Variscan tectogenesis. The Caledonian slaty cleavage can be subparallel with the Variscan fracture cleavage. However, the Caledonian cleavage has been crenulated during a more recent phase of cleavage development. The Variscan cover above the Caledonian Stavelot Massif is very little disturbed. Only one important Variscan fault (Xhoris Fault) has been found far into the Caledonian Massif.

Over the central part of this Caledonian Massif a Variscan syncline is developed, the centre of which later, after the Permian period, subsided deeply along vertical faults (Malmedy graben) (GEUKENS, 1957). The majority of the faults in the Stavelot Massif are of Caledonian age and some of them are important overthrusts, for example the fault which displaced the Tremadoc (near Vielsalm) in a northerly direction up to the Middle Cambrian (CRIMES, 1976; GEUKENS, 1977).

A Variscan metamorphism influenced the southern contact area of the Caledonian and Variscan massifs so that the Caledonian formations are modified by a second metamorphic stage.

CROSS-SECTION 2

This profile also starts from the southern border of the Brabant Massif, where the northern limb of the Namur Sycline rests unconformably on the Upper Silurian. The Caledonian cleavage dips towards the north and the weak metamorphism – with sporadic development of ottrelite, garnet and ilmenite – is of Caledonian age. This metamorphism probably simultaneously influenced the Stavelot Massif.

The southern limb of the Namur syncline (Wépion borehole), situated below the northern frontal zone of the Variscan tectogenesis, is overturned and deformed to produce overthrust slices. The Middle Devonian develops from the northern limb (Givetian) towards the southern limb (Givetian and Couvinian); Lower Devonian on the other hand, is totally absent.

Along the whole width of the Silurian-Ordovician of the Condroz anticline a Caledonian cleavage occurs. The Condroz Overthrust in many places can hardly be distinguished from secondary faults. The Variscan tectonic movements reduced the originally wide Condroz anticline to an extremely narrow zone. Lower Devonian beds have never covered the area that now forms the southern limb of the Namur basin. By compression of the incompetent Silurian formations the Dinant Basin was pushed northwards (GEUKENS, 1964): the northern limb of the Dinant syncline, where the Lower Devonian is almost 2000 m thick, moved up above the southern limb of Namur in which there is no Lower Devonian.

We can divide the Dinant basin into two parts:
(1) The northern one with outcrops of calcareous Lower Carboniferous in the synclines alternating with Upper Devonian – characterised by a sandy facies in the anticlines. The same structure but more faulted exists in the Vesdre Massif.
(2) The southern part, separated by the southwest extension of the Xhoris fault, has no outcrops of Lower Carboniferous.

In the southern part both Late and Middle Devonian formations are thicker and the presence of bioherms indicates an area of subsidence (LECOMPTE, 1967). This region coincides with a depression zone occupied by the broken and overturned northern limb of the Ardennes Massif. Along the northeastern side of this structural depression a series of westward-dipping anticlines outcrop. Some of these folds are separated by faults (Lampsoul Fault). In spite of the wide heterogeneity of bioherms, biostromes and soft shales the area has kept its original structure. Only secondary faults, mostly related to the overturned and complex anticline of the Ardennes, disturb the general pattern of a depression area in front of a dome.

DISCUSSION

These two profiles characterise the eastern and central part of the Belgian Variscan belt. Nevertheless in the western part of the Variscan massif, in the Borinage area (Mons), the subsidence remained more active during the Early and Late Carboniferous (St. Ghislain borehole: DEJONGHE ET AL., 1976) than in the northeast.

This basin, partly filled with evaporites forms a wide synclinal depression dipping steeply to the west. This area of subsidence is situated just north of the Variscan frontal zone. The net slip is more important in the Midi Overthrust than in the Condroz and Eifel Overthrusts. Nevertheless we are of the opinion that the Variscan structure, as seen in numerous boreholes in eastern Belgium (Encl. I) and in the central part

(Encl. II), is the result of purely tectonic deformation; the centre of activity is often situated within an old Caledonian Massif. It is therefore hard to accept that dissolution phenomena (BOUCKAERT ET AL., 1977) could have played a part in central and eastern Belgium. Because of the more subhorizontal structure of the lower beds within the Dinant syncline it is to be expected that in these heterogeneous formations of Middle and Lower Devonian subhorizontal levels would show up in a seismic prospection at great depth.

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