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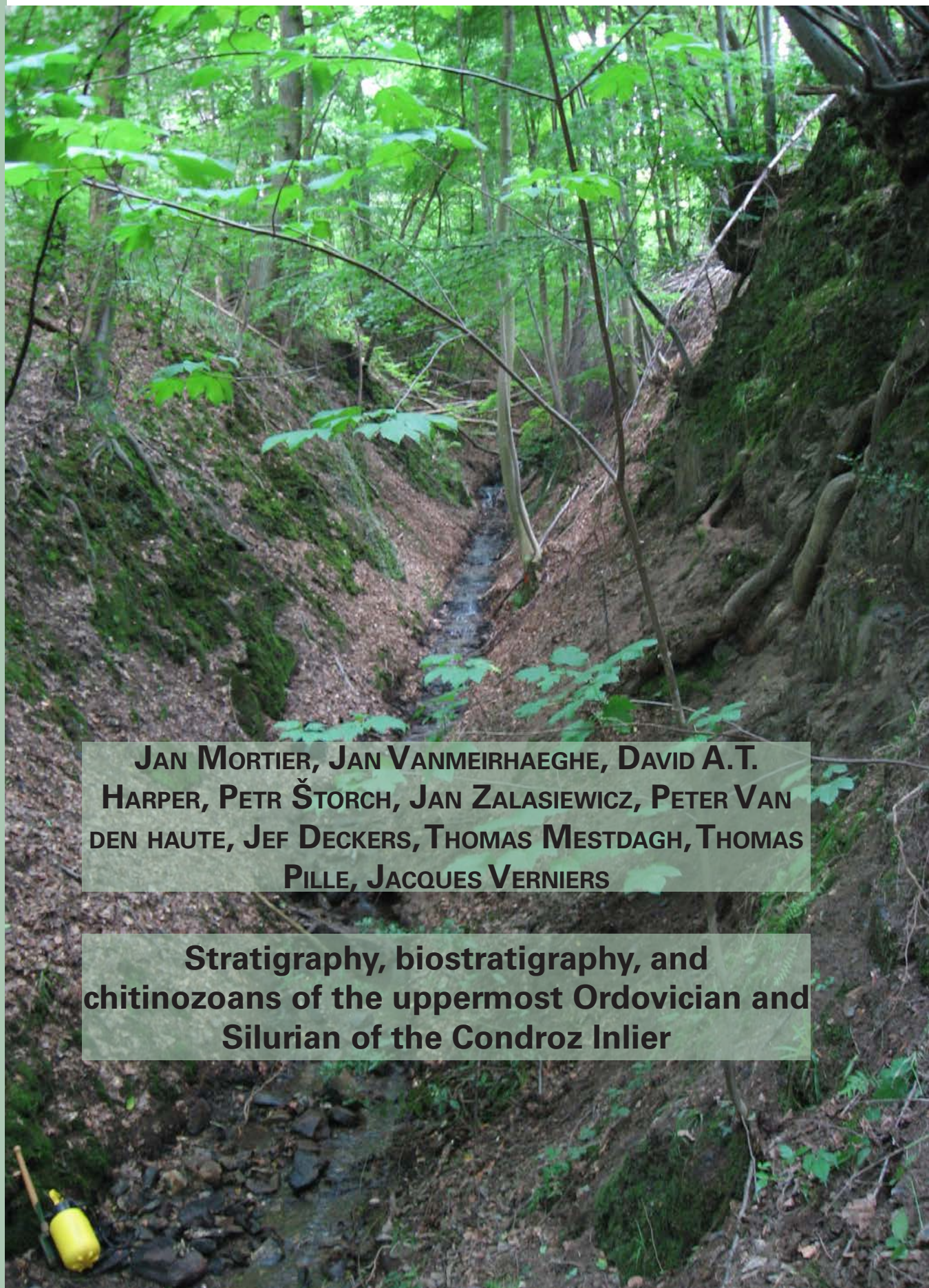

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Cover illustration: View of the ravine 700 m east of the Parc de la Neuville (Neuville-sous-Huy), from volcaniclastic bed V5 in the foreground up to layer V8 in the back of the picture. Small shovel and spray bottle in the lower left corner for scale (photograph © Jan Mortier, 2008).

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STRATIGRAPHY, BIOSTRATIGRAPHY, AND CHITINOZOANS OF THE UPPERMOST ORDOVICIAN AND SILURIAN OF THE CONDROZ INLIER

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Abstract

Exhaustive fieldwork in long stratigraphic sections in the Neuville-sous-Huy area (near Huy), allows detailed lithostratigraphic descriptions of the formations, accurate location of macrofossil levels, and of samples for palynological and thin section research. Similarly, the type areas of the Silurian formations of the uppermost Ordovician and Silurian of the Condroz Inlier are studied.

For the biostratigraphy chitinozoans are mainly used together with graptolites. In total, 210 samples were dissolved for palynological analysis. Some 7514 chitinozoan specimens were studied. Unfortunately, the moderate state of preservation resulted in many specimens remaining unidentified or recorded under open nomenclature, with no new taxa recognized in any assemblage. However, the presence of many index species allowed to attribute samples to local or global chitinozoan biozones.

Graptolites from previous collections and from new samples in 101 levels facilitated additional accurate biozonation. In several cases the rare discovery of brachiopods aided the biostratigraphy.

The Vitrival-Bruyère and the Fosses formations crop out in four sections of the Tihange area. Three members of the latter formation (Bois de Presles, Faulx les Tombes and Tihange) are described and dated (Sandbian, Katian, Hirnantian to earliest Llandovery), as is the overlying newly described Bonne Esperance Formation (Rhuddanian, Llandovery).

Four areas around Neuville-sous-Huy expose Aeronian to Ludlow formations: the ravine 1200 m east and the ravine 700 m east of the Parc de la Neuville, the Parc de la Neuville, with a northern and a southern part, and a section along a road 300 m west of the Parc de la Neuville.

The Génicot Formation is identified here for the first time in the north-eastern part of the Condroz Inlier and dated with chitinozoans as middle Aeronian, Llandovery. The overlying lithostratigraphic unit, the newly described Neuville-sous-Huy Formation, is a lateral facies equivalent of the still poorly known Dave Formation. The new unit is characterized by volcaniclastic rocks and red mudstone intervals and dated as Telychian (Te1?, Te2 to Te4, Llandovery).

The covering Naninne Formation is correlated by graptolites and chitinozoans to the uppermost Telychian (Te5), Llandovery, and no longer as lowest Sheinwoodian (Sh1), lower Wenlock as previously understood. The succeeding

Jonquoi Formation is described in two long sections and dated by the same fossil groups to the upper Sheinwoodian (Sh3) and the Homerian (Ho1-Ho3?), both Wenlock.

Chitinozoans in the Thimensart Formation confirm the previously established age of Gorstian (Go1-Go2), Ludlow.

The Criptia Group only occurs in the Puagne Inlier, a different tectonic unit in the Condroz Inlier, where it overlies the Genicot Formation, itself dated as middle Aeronian by graptolites and chitinozoans. The latter fossil group indicates a Telychian age (Te1- Te4), Llandovery for the Criptia Group.

In the Moncheret and the Longues Royes formations, the few chitinozoans did not allow a more precise dating than established with spores in the literature.

Sixteen volcaniclastic beds have been identified and numbered in the Neuville-sous-Huy area. But probably only 14 volcaniclastic beds are present, since beds Vβ and Vδ probably are part of the same bed, and Vγ is possibly the same bed as the thick volcanic sandstone bed of the Parc de la Neuville. Thirteen of them lie in the Neuville-sous-Huy Formation. Nearly all are located in the Telychian, Llandovery from the upper *Spirograptus turriculatus* Biozone (Te2) to *Cyrtograptus lapworthi* Biozone (Te4). The age of bed V9 is not precisely established because of the lack of fossils in the adjoining strata; only a general Telychian to Wenlock range is proposed.

A brief petrographical study of the least weathered beds indicates that all beds are volcaniclastic rocks and rule out the presence of lavas. For the origin of the volcanic sandstone beds a magma rich in plagioclase is indicated, at least partly differentiated as shown by the presence of magmatic quartz, biotite and pumice. One layer (V5) considered a volcanic ash tuff has some characters suggesting a basaltic composition.

The red mudstone horizons in the Neuville-sous-Huy area were described since 1932 and have now been logged in detail and dated more accurately. At least four levels with many red mudstone layers occur, with the three lower and important ones occurring in the Telychian, as already known, but now their age is more precisely constrained: the two lower groups (red 1 & red 2) are lower to middle Telychian (uppermost Te2 to lower Te3), and the next group (red 3) is middle to upper Telychian (middle and upper Te3 to Te4). The few thin beds of the fourth group (red 4) are upper Telychian (Te4), and the few thin beds of the highest group (red 5) are only situated in the broad range of Telychian to Wenlock. Higher, in the Thimensart Formation, a sixth fine red mudstone level is present.

Keywords: Condroz Inlier, Silurian, Upper Ordovician, lithostratigraphy, biostratigraphy, chitinozoans, graptolites, brachiopods, Neuville-sous-Huy Formation, volcaniclastic rocks, red mudstone.

1. Overview of the knowledge of the Upper Ordovician and Silurian of the Condroz Inlier, prior to our study

1.1. Introduction

The Condroz Inlier is one of the six areas in Belgium where the Lower Palaeozoic crops out. The other areas being the Brabant Massif, the Stavelot Inlier, the Rocroi Inlier, the Givonne Inlier, and the Serpont Inlier (see Figure 1). These latter four are also named the Ardennes Inliers.

The Condroz Inlier is a narrow belt consisting of mainly siliciclastic rocks of the Ordovician and the Silurian situated south of the Sambre and Meuse rivers and north of the Condroz Plateau. It extends from Bouffioulx (east-southeast of Charleroi) to Engis (west-south-west of Liège) over a length of approximately 65 km and a width varying between approximately 0.5 and 4 km (Figure 1).

The Condroz Inlier has a west-southwest to east-northeast orientation west of the Meuse River near Dave and a southwest to northeast orientation east of the Meuse river.

Four tectonic wedges have been distinguished within the Condroz Inlier (Figure 2; Michot, 1980; Verniers *et al*., 2001), with their own tectonic history and characteristic strata which they share to a certain extent with other zones:

- (1) a central and major part, the Central Condroz Inlier, with no tectonic cleavage present except proven at one place (Ruisseau des Chevreuils, Dave) by Debacker & Vanmeirhaeghe (2007);

two southern parts:

- (2) the Puagne Inlier in the southwest and
- (3) the Oxhe Inlier in the northeast both showing a Variscan tectonic cleavage (Fourmarier, 1939; Michot, 1979);

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Exhaustive fieldwork in the Condroz Inlier around Huy and in the type areas of the uppermost Ordovician and Silurian resulted in refined lithostratigraphic descriptions of the formations, accurate positioning of macrofossil levels and samples for palynological and thin section analysis. For biostratigraphical dating mainly chitinozoans and graptolites are used. 210 dissolved samples produced 7514 chitinozoan specimens, unfortunately in a moderate state of preservation. As a consequence, many specimens remain under open nomenclature or are unidentified and no new taxa could be defined. The presence of several index species, though, allowed to attribute samples to local or global biozones and hence enabled reliable age determination. Graptolites from previous and new collections facilitated a second line of biostratigraphical dating and in two cases the discovery of brachiopods reinforced the biostratigraphy.

The three members of the Fosses Formation exposed in the Tihange area (Bois de Presles, Faulx-les-Tombes and Tihange) are described and dated as Sandbian, Katian, Hirnantian to earliest Llandovery (Ordovician to Silurian). The overlying Bonne Esperance Formation is dated with chitinozoans and graptolites as Rhuddanian (Llandovery, Silurian), as was already known.

The main part of this study concentrates around Neuville-sous-Huy, where four outcrop areas expose Aeronian to Ludlow formations in the ravine 1200 m east of the Parc de la Neuville, the ravine 700 m east of the same park, the Parc de la Neuville itself, with a northern and a southern part, and the road section 300 m west of the park. The Génicot Formation is identified for the first time, here in the north-eastern part of the Condroz inlier and dated with chitinozoans as middle Aeronian (Llandovery). The overlying deposits, a lateral facies of the still poorly known Dave Formation, are defined here as a new unit: the Neuville-sous-Huy Formation characterized by the presence of volcaniclastic rocks and red mudstone intervals. The overlying Naninne Formation is placed in the uppermost Telychian (Llandovery) based on graptolites and chitinozoans and no longer in the lower Wenlock as previously thought. The succeeding Jonquoi Formation described in two long sections is dated as Sheinwoodian and Homerian (Wenlock). Chitinozoans in the Thimensart Formation confirm its previously established Gorstian age (Ludlow).

The Criptia Group (Puagne inlier) could only be tentatively dated by chitinozoans as Telychian (Llandovery). Our data did not allow a more detailed age assignment for the two highest Silurian units (Moncheret and Longues Royes) , previously established by means of spores.

Fifteen volcaniclastic beds have been observed. Fourteen of them occur in the Neuville-sous-Huy Formation and are Telychian (Llandovery) in age. The other bed is poorly dated (Telychian to Wenlock). A brief petrographical study indicates that all beds are composed of volcaniclastic rock altered by low-grade metamorphism. One bed is interpreted as a volcanic ash tuff with a basaltic composition. Lavas do not occur, in contrast to what has been reported in earlier studies. The thick volcanic sandstone bed, containing plagioclase, quartz, biotite and pumice fragments suggests nearby volcanic eruptions of a differentiated possibly calc-alkaline magma.

The red mudstone horizons in the Neuville-sous-Huy area, known since 1932, have now been logged in detail and dated. At least four intervals occur (Red 1 to 4). The three lower and important ones are Telychian (Llandovery) in age as was already known, but they are now more precisely dated: the lower intervals (Red 1 & Red 2) are lower to middle Telychian and interval Red 3 middle to upper Telychian. The few thin red mudstone beds of interval Red 4 are upper Telychian. The few thin beds of interval Red 5 are roughly dated as Telychian to Wenlock.

The first author of this monography, Jan Mortier, obtained his M.Sc. in Geology in 2007 at the Ghent University under the guidance of Jan Vanmeirhaeghe and continued there for his PhD studies (2014) in the Research Unit Palaeontology with Jacques Verniers as promotor. He is now technical manager in a laboratory involved in environmental studies.

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