Correlation and biostratigraphy of the Kortrijk (Sint-Antonius) and Kortrijk (Lust) boreholes (early Silurian, Belgium).

[Corrélation et biostratigraphie des sondages Courtrai (Saint-Antoine) et Courtrai (Lust), Silurien inférieur, Belgique]

Bastien WAUTHOZ [1]

Key Words: Acritarch; Belgium; biostratigraphy; Llandovery; Silurian

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Mots-Clefs : Acritarche ; Belgique ; biostratigraphie ; Llandoverien ; Silurien

Introduction

Since their drilling, respectively in 1961 and 1971, the 83W421 Kortrijk (Sint-Antonius) and 83W44 Kortrijk (Lust brewery) boreholes have been studied rather extensively for biostratigraphical information. Three fossil groups are included in these studies: graptolites, chitinozoans and acritarchs.

LEGRAND (1962, 1981) made the first studies of the graptolites; VAN GROOTEL (1990) investigated the chitinozoans; VAN GROOTEL *et alii* (1998) revised the graptolites and provided biostratigraphical data on both graptolites and chitinizoans. Acritarchs have been studied over the years, first by STOCKMANS & WILLIÈRE (1963), and thereafter by MARTIN (1966, 1969), WAUTHOZ (1997), WAUTHOZ & GÉRARD (1999), WAUTHOZ (2003) and WAUTHOZ (in press). This contribution, based on the data now available, discusses in chronological order possible correlations between the boreholes and it reviews the biostratigraphies of graptolites, chitinozoans and acritarchs as they are understood currently.

Correlation based on graptolite data from LEGRAND (1962, 1981) (Fig. 1)

LEGRAND (1962, 1981) did not propose a formal correlation between the Kortrijk (Sint-Antonius) and Kortrijk (Lust) boreholes although he states that (1981, translation): "[…] there is a perfect palaeontological tie between both boreholes". He recognises three, possibly four, of the biozones of ELLES & WOOD (1913) in Kortrijk (Sint-Antonius) and two, possibly three, of them in Kortrijk (Lust).

He gives fairly detailed graptolite distributions in both boreholes. It appears that no single species can be used to correlate the two sections (see Fig. 1). So the only correlation possible would of necessity be based on the boundary between the *sedgwickii* and the *turriculatus* graptolite biozones.

In Kortrijk (Lust), this boundary lies in a barren interval spanning 8.00 m. In Kortrijk (Sint-Antonius), LEGRAND (1981) places it at -205.00 m. However, a close inspection of graptolite distribution in this borehole show that a 5.50 m interval exists between the disappearance of *M. sedgwickii* at -207.40 m and the first appearance of *M. runcinatus* at -201.90 m (see data in LEGRAND, 1981). Thus a correlation of the two boreholes based on the graptolite ranges reported by LEGRAND (1962, 1981) involves an error of as much as 8.00 m.

Correlation based on chitinozoan data from VAN GROOTEL (1990)

In his unpublished Ph.D. thesis, VAN GROOTEL (1990) used the base of the *turriculatus* graptolite Biozone to correlate the two boreholes. Thus, he equates level -205.00 m in Kortrijk (Sint-Antonius) with level -190.80 m in Kortrijk (Lust).

He defines some local biozones in these boreholes. However, his data reveal that no biozone defined in Kortrijk (Sint-Antonius) can be recognized in Kortrijk (Lust) and vice-versa. Thus it appears that this study can neither confirm the chosen correlation based on the appearance of the *turriculatus* graptolite Biozone, nor propose a discrete correlation based on chitinozoans.

Correlation based on data from VAN GROOTEL *et alii* (1998) (Fig. 2)

VAN GROOTEL *et alii* (1998) revise the graptolites and relate them to LOYDELL's (1992, 1993) biozones and subzones. Chitinozoans too

[1] *Laboratoire de Paléobotanique, Paléopalynologie et Micropaléontologie, Université de Liège, Allée du 6 août, B18, Sart-Tilman, 4000 Liège (Belgium)*
acritarche@yahoo.fr

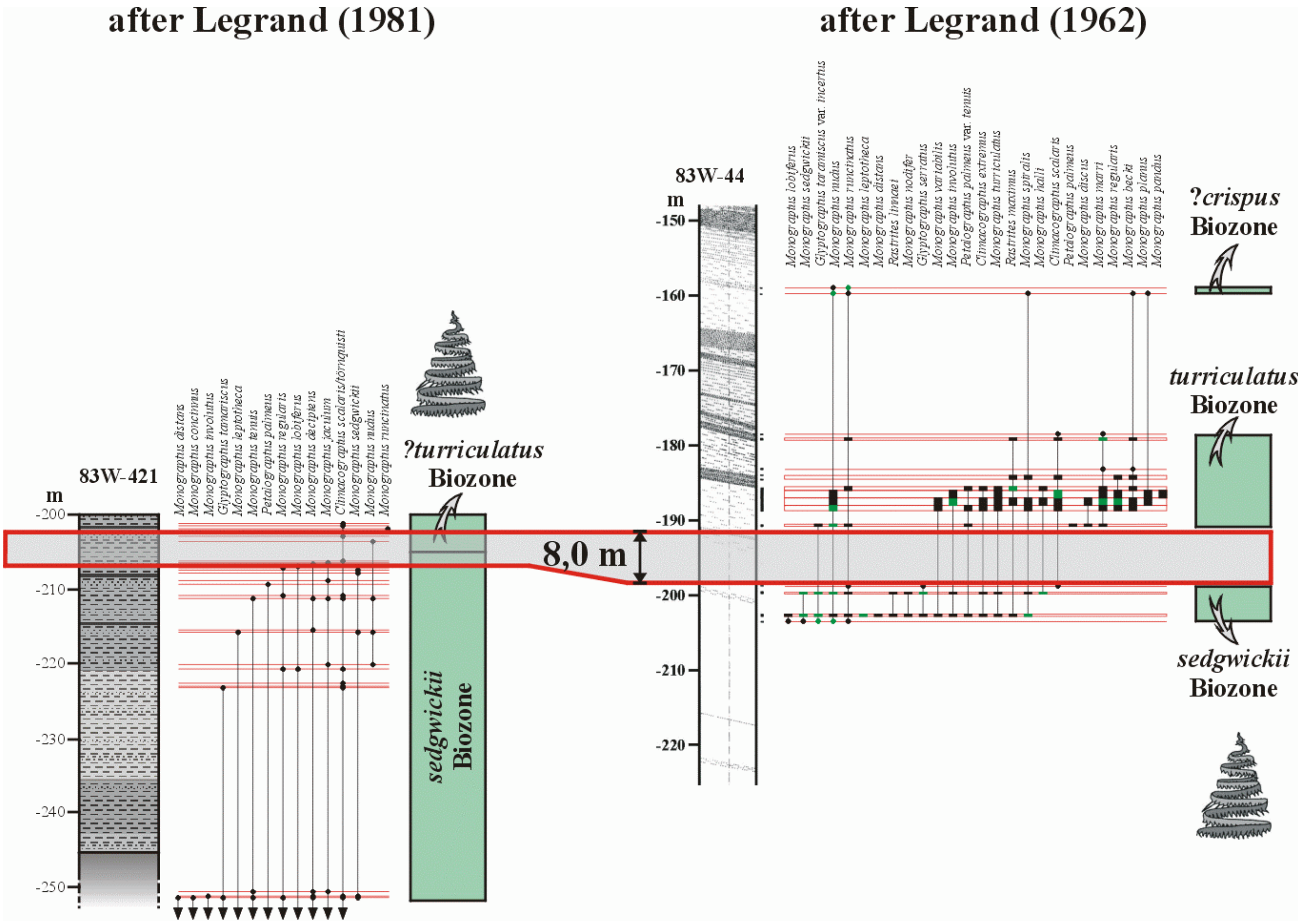

Figure 1: Graptolite distribution in the two boreholes with reference to the biozonation of Elles & Wood (1913). Names of graptolites as in the original papers.

are revised and related to the global chitinozoan biozonation of Verniers *et alii* (1995).

Below the base of the *turriculatus* s.l. (? *guerichi*) Biozone in Kortrijk (Sint-Antonius), determinable graptolites are absent in a large interval: -220.00 to -250.00 m (Van Grootel *et alii*, 1998). In Kortrijk (Lust), a definite *guerichi* Biozone is present from -203.50 to -159.00 m and some subzones can be recognised (Van Grootel *et alii*, 1998). But as the Kortrijk (Lust) borehole is devoid of graptolites from -225.50 to -203.50 m, no reasonable correlation can be proposed using this revision of the graptolites.

As regards chitinozoans, only the global *Eisenackitina dolioliformis* Biozone can be recognised in the upper part of the Kortrijk (Sint-Antonius) borehole. *E. dolioliformis* does indeed appears at -240.10 m. Unfortunately, Van Grootel *et alii* (1998) are not clear about chitinozoan biozonation between -265.30 and -240.10 m and do not refer to or discuss the limit between the *alargada* and *dolioliformis* biozones.

The *dolioliformis* Biozone is recognised in Kortrijk (Lust) from -215.50 to -148.30 m (Van Grootel *et alii*, 1998), *i.e.* it occupies all of the borehole with the exception of the lowermost 10 m (-225.50 to -215.50 m). Those ten meters yielded only one barren sample and another with no indicative chitinozoans (Van Grootel, 1990).

Thus, the revisions of Van Grootel *et alii* (1998) do not permit any correlation of the two boreholes, mainly because of the presence of intervals either barren or with no meaningful biota.

Correlation based on acritarchs (Fig. 3)

An early palynological investigation of Kortrijk (Sint-Antonius) by the author revealed that acritarchs in samples below -150 m are too mature thermally for convenient study with the notable exception of levels at -260.50 m, -267.20 m and -285.00 m where stratigraphically interesting species were recognised (Wauthoz, 1997). These are *Elektoriskos williereae*, *Tylotopalla robustispinosa*, *Multiplicisphaeridium fisherii* and *Tunisphaeridium tentaculaferum*.

Above -150.00 m, diversity is high with a minimum of 26 species, a mean of 65 species and a maximum of 89 species. Inspection of the

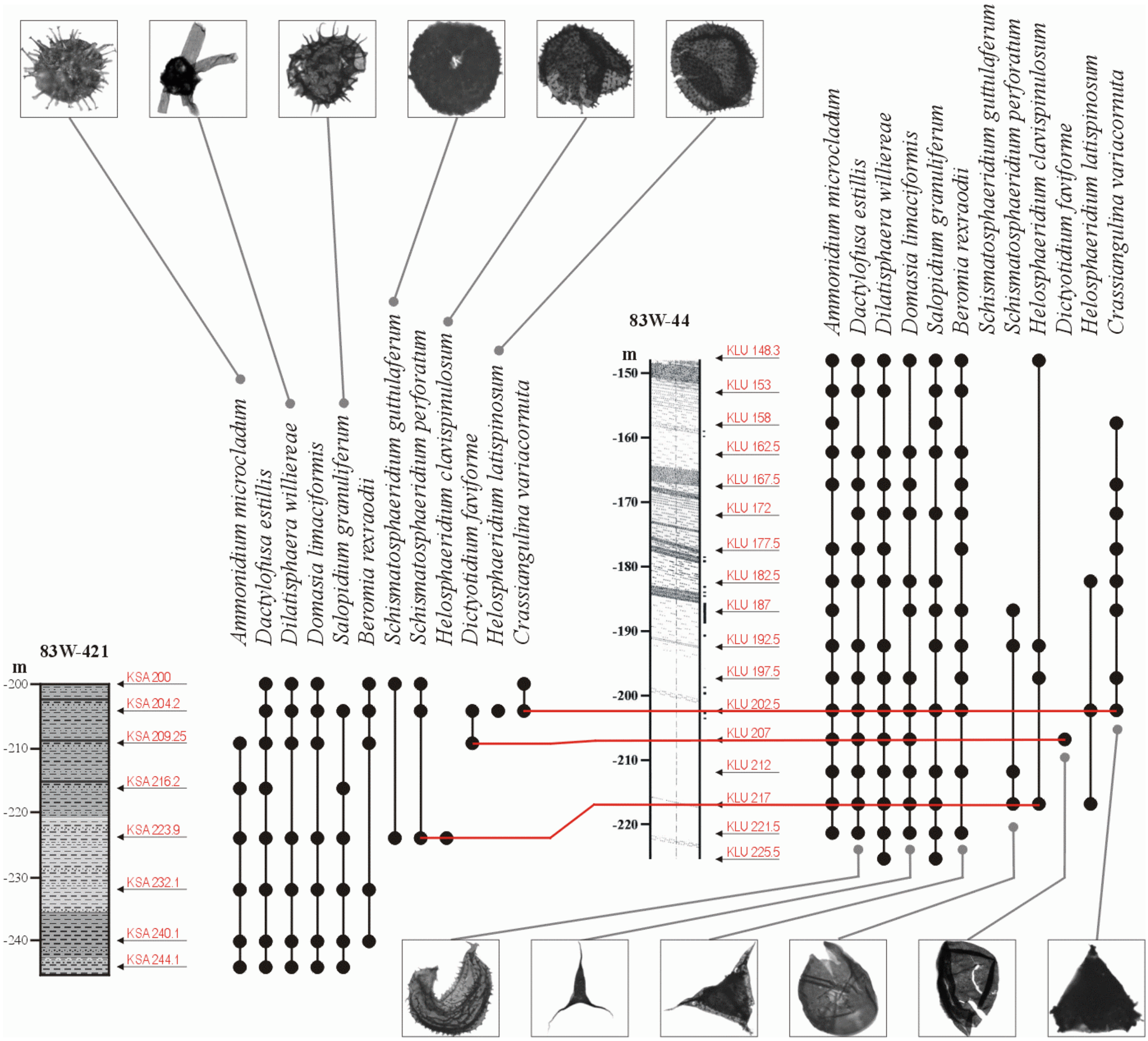

Figure 2: Distribution of chosen acritarchs in the two boreholes together with three possible correlations (red lines) discussed in WAUTHOZ (in press). Photomicrographs are not to scale.

stratigraphic ranges of acritarchs reveals four species with a potential for the correlation of the two boreholes (see Fig. 2 and WAUTHOZ, in press). These species are *Crassiangulina variacornuta*, *Dictyotidium faviforme*, *Helosphaeridium clavispinulosum* and *Schismatosphaeridium perforatum*.

Crassiangulina variacornuta is known from Gondwana and Balonia. It does not appear prior to the Telychian on the Balonian palaeocontinent (WAUTHOZ *et alii*, 2003). New information from Argentina indicate an early appearance of this species in Gondwana during late Aeronian times (RUBINSTEIN & TORO, in press).

Dictyotidium faviforme is known from Balonia and Laurentia where it ranges from the upper Llandovery to the Ludlow (SCHULTZ, 1967; CRAMER & DIEZ, 1972; LE HÉRISSÉ, 1989; MULLINS, 2001).

Helosphaeridium clavispinulosum is known from Balonia and Gondwana. It appears first in the Aeronian (*convolutus* graptolite Biozone) and ends in the Ludlow (LISTER, 1970; SMELROR, 1987; MULLINS, 2001)

Schismatosphaeridium perforatum is recorded on Balonia and Laurentia where it seems to be restricted to the upper Llandovery to Wenlock (STAPLIN *et alii*, 1965; CRAMER & DIEZ, 1972; DORNING, 1982; DORNING & ALDRIDGE, 1982; SMELROR, 1987; LE HÉRISSÉ, 1989). One specimen tentatively referred to this species is recorded in the basal part of the Hemse Formation, of the lower Ludlow of Gotland (LE HÉRISSÉ, 1989).

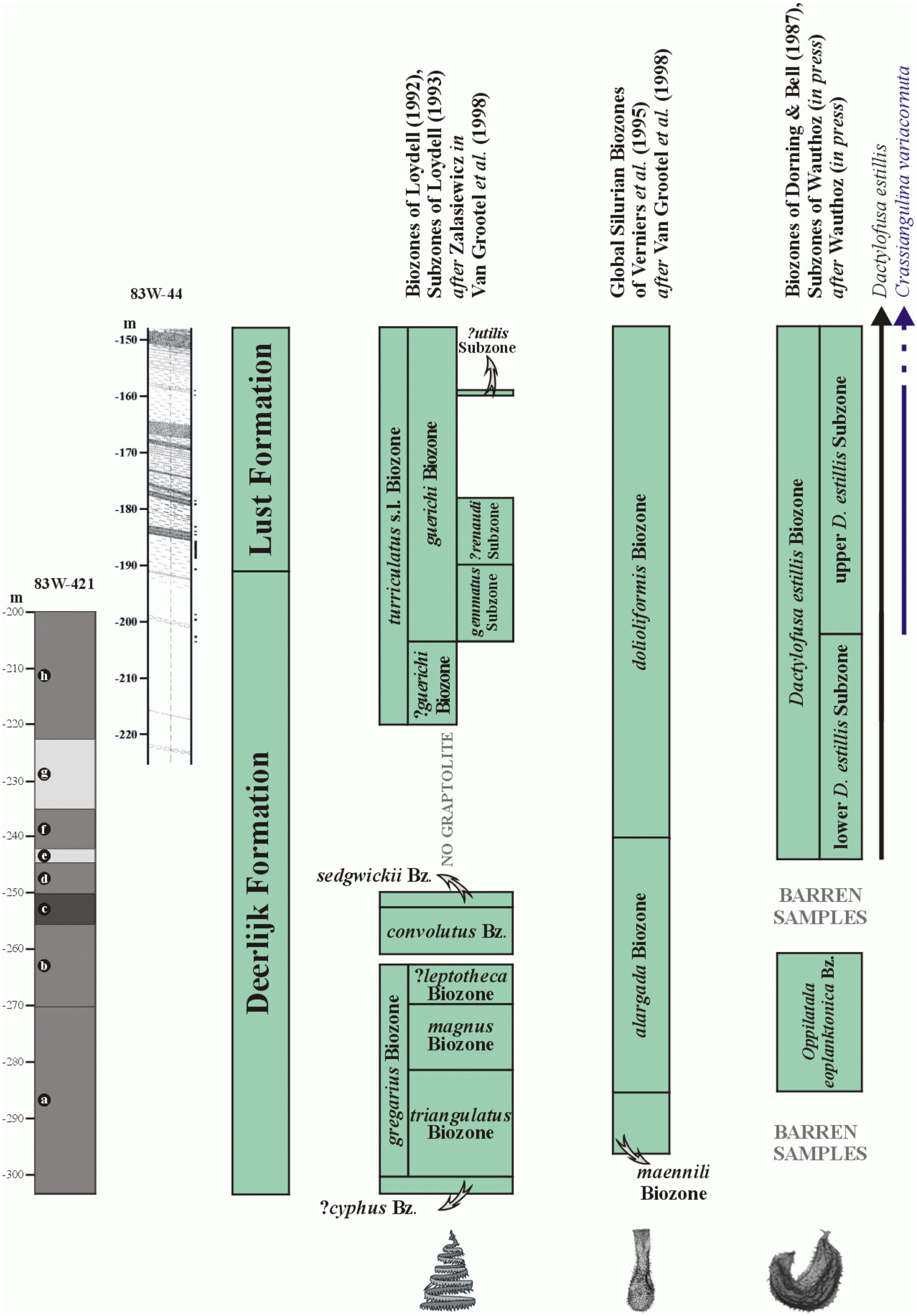

Figure 3: Integrated biostratigraphy of the Kortrijk (Sint-Antonius) and Kortrijk (Lust) boreholes based on the correlations of WAUTHOZ (in press) and data from VAN GROOTEL *et alii* (1998) and WAUTHOZ (1997, in press). Letters in the black circles refer to lithologic units defined by LEGRAND (1981).

Thus it appears that a correlation based on the first appearance of *Helosphaeridium clavispinulosum* would be hazardous because this species appears in Balonia earlier than its first occurrence in the boreholes. *Dictyotidium faviforme* was not recorded frequently enough to provide a reliable basis for correlation. In WAUTHOZ (in press), *Crassiangulina variacornuta* is preferred to *Schismatosphaeridium perforatum* because it is recorded more consistently than the latter in the boreholes. Moreover the First Appearence Datum of *Crassiangulina variacornuta* is better assessed in Balonia than that of *Schismatosphaeridium perforatum*. Consequently, based on the first occurrences of *Crassiangulina variacornuta*. WAUTHOZ (in press) correlates level -204.20 m in Kortrijk (Sint-Antonius) with level -202.50 in Kortrijk (Lust).

Acritarch biostratigraphy of the Kortrijk (Sint-Antonius) borehole

Tunisphaeridium tentaculaferum is present from sample -285.00 on. This species appears in zone 2 of (HILL & DORNING, 1984), *i.e.* the *Oppilatala eoplanktonica* Biozone (DORNING & BELL, 1987). The *Ammonidium microcladum* Biozone was not recognised although it should be present for it is roughly equivalent to the *sedgwickii* graptolite Biozone (MOLYNEUX *et alii*, 1996; DAVIES *et alii*, 1997). The *Dactylofusa estillis* Biozone is recognised from -244.10 m upward in Kortrijk (Sint-Antonius). Its occurrence in levels attributed to the *guerichi* graptolite Biozone confirms its extension in time into strata of Telychian age, contrary to the findings of MOLYNEUX *et alii* (1996). WAUTHOZ (in press) proposes the subdivision of the *D. estillis* Biozone into two subzones, the upper *D. estillis* Subzone being the concurrent range zone between *D. estillis* and *Crassiangulina variacornuta*. This upper *Dactylofusa estilis* Subzone is also recognised in the 50E134 Steenkerke borehole in levels attributed to the *crispus* graptolite Biozone (WAUTHOZ, 2003). This is consistent with the findings of DAVIES *et alii* (1997).

Discussion

Early work on the graptolites (LEGRAND, 1962, 1981) of the Kortrijk (Sint-Antonius) and Kortrijk (Lust) wells suggested a possible correlation with an imprecision of 8.00 m. This correlation is founded on the limit between the *sedgwickii* and the *turriculatus* graptolite biozones of ELLES & WOOD (1913). Because of the revision of graptolite taxonomy and distributions together with the application of LOYDELL's (1992, 1993) biozonation scheme, this correlation is no longer possible, principally because many long intervals are barren.

Our current knowledge of chitinozoan distribution does not provide a means of correlation between the two boreholes. The local biozonation proposed by (VAN GROOTEL, 1990) does not appear to be applicable between the boreholes although the two are near each other (~600 m). Global chitinozoan biozones (VERNIERS *et alii*, 1995) cannot be used for the correlatable portions of both boreholes are in the *dolioliformis* Biozone.

Acritarchs provide a sounder basis for correlation. Among four species potentially useful for this purpose, *Crassiangulina variacornuta* is retained because of its well-defined FAD, potential world-wide recognition, and consistency of occurrence (WAUTHOZ *et alii*, 2003; WAUTHOZ, in press). The imprecision of this correlation is represented by the largest interval between the uppermost sample with *C. variacornuta* and the lowest one lacking it. The gap is 5.05 m in Kortrijk (Sint-Antonius) and is 4.50 m in Kortrijk (Lust). Therefore the maximum possible error in correlation is 5.05 m.

The correlation proposed by WAUTHOZ (in press) coincides precisely with the lithologic pattern and is geometrically coherent. So this correlation is well-supported and we can confidently present an integrated biostratigraphical scheme for graptolites, chitinozoans and acritarchs covering the whole of the sequences present in the two boreholes (Fig. 3).

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Bibliographic references

CRAMER F.H. & DIEZ M.D.C.R. (1972).- North American Silurian palynofacies and their spatial arrangement: Acritarchs.- *Palaeontographica*, *Abteilung B*, Stuttgart, vol. 138, n° 5-6, p. 107-180.

DAVIES J.R., FLETCHER C.J.N., WATERS R.A., WILSON D., WOODHALL D.G. & ZALASIEWICZ J.A. (1997).- Geology of the country around Llanilar and Rhayader.- Memoir for 1:50 000 geological sheets 178 and 179 (England & Wales), British Geological Survey, London, 267 p.

DORNING K.J. (1982).- Early Wenlock acritarchs from the Knockgardner and Straiton Grit formations of Knockgardner, Ayrshire.-

Scottish Journal of Geology, Edinburgh, vol. 18, n° 4, p. 267-273.

DORNING K.J. & ALDRIDGE R.J. (1982).- A preliminary investigation of palynological assemblages from the early Silurian of Ringerike.- *Contributions from the University of Oslo*, n° 278, p. 105-108.

DORNING K.J. & BELL D.G. (1987).- The Silurian carbonate shelf microflora: acritarch distribution in the Much Wenlock Limestone Formation. *In*: HART M.B. (ed.), Micropalaeontology of Carbonate Environments.- Ellis Horwood, Chichester, p. 266-287.

ELLES G.L. & WOOD E.M.R. (1913).- A monograph of British graptolites.- *Palaeontographical Society Monographs*, London, vol. 171, 539 p.

HILL P.J. & DORNING K.J. (1984).- The Llandovery Series of the type area. Appendix I. Acritarchs. *In*: COCKS L.R.M., WOODCOCK N.H., RICKARDS R.B., TEMPLE J.T. & LANE P.D. (eds.), The Llandovery Series of the type area.- *Bulletin of the British Museum of Natural History,* London, (*Geology*), vol. 38, n° 3, p. 174-176.

LE HÉRISSÉ A. (1989).- Acritarches et kystes d'algues Prasinophycées du Silurien de Gotland, Suède.- *Palaeontographia Italica*, Pisa, vol. 76, p. 57-302.

LEGRAND R. (1962).- Le Tarannonien à Graptolites reconnu sous Courtrai (Flandre Occidentale).- *Bulletin de la Société belge de Géologie*, Bruxelles, vol. 70, p. 174-185.

LEGRAND R. (1981).- Le Llandoverien à Graptolites reconnu sous Courtrai.- *Professional Papers*, *Service géologique de Belgique*, Bruxelles, vol. 184, 4 p.

LISTER T.R. (1970).- The acritarchs and chitinozoa from the Wenlock and Ludlow Series of the Ludlow and Millichope areas, Shropshire.- *Palaeontographical Society Monographs*, London, vol. 124, part 1, p. 1-100.

LOYDELL D.K. (1992).- Middle and Upper Llandovery graptolites from western mid-Wales. Part 1.- *Monograph of the Palaeontological Society*, London, vol. 146, p. 1-55.

LOYDELL D.K. (1993).- Middle and Upper Llandovery graptolites from western mid-Wales. Part 2.- *Monograph of the Palaeontological Society*, London, vol. 147, p. 56-180.

MARTIN F. (1966).- Les Acritarches du sondage de la brasserie Lust, à Kortrijk (Courtrai) (Silurien belge).- *Bulletin de la Société belge de Géologie*, Bruxelles, vol. 74, n° 3, p. 354-400.

MARTIN F. (1969).- Les acritarches de l'Ordovicien et du Silurien belges. Détermination et valeur stratigraphique.- Institut Royal des Sciences Naturelles de Belgique, Bruxelles, 175 p.

MOLYNEUX S.G., LE HERISSE A. & WICANDER R. (1996).- Acritarch and Prasinophyte Stratigraphy. *In*: JANSONIUS J. & MC GREGOR D.C. (eds.), Palynology: principles and applications.- American Association of Stratigraphic Palynologists Foundation, vol. 2, Chapter 16, p. 493-529.

MULLINS G.L. (2001).- Acritarchs and prasinophyte algae of the Elton Group, Ludlow Series of the type area.- *Monograph of the Palaeontological Society*, London, n° 616 for vol. 155, 154 p.

RUBINSTEIN C. & TORO B.A. (in press).- Aeronian (middle lower Silurian) palynomorphs and graptolites from the Eastern Cordillera, North-West Argentina.- *Geobios*, Villeurbanne.

SCHULTZ G. (1967).- Mikrofossilien des oberen Llandovery von Dalarne (Schweden).- *Kölner Geologische Hefte*, Köln, Heft 13, p. 175-187.

SMELROR M. (1987).- Early Silurian acritarchs and prasinophycean algae from the Ringerike district, Oslo region (Norway).- *Review of Palaeobotany and Palynology*, Amsterdam, vol. 52, n° 2-3, p. 137-159.

STAPLIN F., JANSONIUS J. & POCOCK S.A.J. (1965).- Evaluation of some Acritarchous Hystricosphere genera.- *Neues Jahrbuch für Geologie und Paläontologie - Abhandlungen*, Stuttgart, vol. 123, p. 167-201.

STOCKMANS F. & WILLIÈRE Y. (1963).- Les Hystricosphères ou mieux les Acritarches du Silurien belge. Sondage de la Brasserie Lust à Courtrai (Kortrijk).- *Bulletin de la Société belge de Géologie*, Bruxelles, vol. 71, n° 3, p. 450-481.

VAN GROOTEL G. (1990).- Litho- en Biostratigrafiesche studie met Chitinozoa in het westelijk deel van het Massief van Brabant.- Ph.D. thesis (unpublished), Rijksuniversiteit Gent, 83 + 108 p.

VAN GROOTEL G., ZALASIEWICZ J., VERNIERS J. & SERVAIS T. (1998).- Chitinozoa and graptolite biozonation of the Aeronian and lower Telychian in the Brabant Massif (Belgium).- *Temas Geologico-Mineros ITGE*, Madrid, vol. 23, p. 135-136.

VERNIERS J., NESTOR V., PARIS F., DUFKA P., SUTHERLAND S. & VAN GROOTEL G. (1995).- A global Chitinozoa biozonation for the Silurian.- *Geological Magazine*, Cambridge, vol. 132, n° 6, p. 651-666.

WAUTHOZ B. (1997).- Étude palynologique des acritarches du sondage Kortrijk 83 W-421, Silurien (Aeronian) du Massif du Brabant, Belgique.- Unpublished M.Sc. thesis (unpublished), Université de Liège, 66 + 40 p.

WAUTHOZ B. (2003).- Methodological approach to unravel acritarch distribution in chosen sections and boreholes in the late Aeronian-early Telychian from the United Kingdom and Belgium.- Ph.D. thesis (unpublished), Université de Liège, 255 + 250 p.

WAUTHOZ B. (in press).- Correlation of the 83W-

421 Kortrijk (Sint-Antonius) and 83W-44 Kortrijk (Lust) boreholes with acritarchs (late Aeronian-early Telychian, Silurian, Belgium).- *Geologica Belgica*, Liège.

WAUTHOZ B., DORNING K.J. & LE HÉRISSÉ A. (2003).- *Crassiangulina variacornuta* sp. nov. from the late Llandovery and its bearing on Silurian and Devonian acritarch taxonomy.- *Bulletin de la Société Géologique de France*, vol. 174, n° 1, p. 67-81.

WAUTHOZ B. & GÉRARD P. (1999).- Biometric study of some *Domasia* species (Acritarcha) from the Silurian of the Brabant Massif, Belgium.- *Bollettino della Società Paleontologica Italiana*, Modena, vol. 38, n° 2-3, p. 381-395.