Netherlands Journal of Geosciences — Geologie en Mijnbouw | **84 - 4** | **409 - 413** | **2005**

New geological data (Middle Triassic, Rhaetian-Liassic and Oligocene) of the Winterswijk quarry, the eastern Netherlands

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Manuscript received: March 2005; accepted: August 2005

Abstract

The present publication deals with recent palynological results of a relatively small interval of Muschelkalk and exposures of the overlying clay deposits in the Winterswijk quarries. For the first time the Lower Muschelkalk Member in the Netherlands could be independently dated as Bithynian (Anisian, Middle Triassic). Contrary to widely accepted opinions the overlying almost black clay deposit is not Liassic but Rhaetian in age and it is assigned to the Sleen Shale Formation. This marginal marine clay which pinches out to the south, is in turn overlain by a light gray, full-marine Lower-Oligocene clay of the Rupel Formation. An anomalous occurrence of Liassic clay is now attributed to subrosion of Röt salt followed by collapse of the overlying Muschelkalk, Rhaetian and Lias strata.

Keywords: eastern Netherlands, Muschelkalk, Rhaetian, Liassic, Oligocene, subrosion

Introduction

Since the publication of Visscher & Commissaris (1968) dealing with the Muschelkalk of the Winterswijk quarry (Fig. 1), the stratigraphic position and precise age of their palynomorph productive samples is uncertain. In quarry III an isolated occurrence of Liassic shale is found of which the relation to the deposits of supposed Liassic and Tertiary age overlying the Muschelkalk (Harsveldt, 1973; Peletier & Kolstee, 1986) is unknown. The extension in recent years of the exploitation in northern direction, i.e. in quarry IV, provided an excellent opportunity to revisit older conceptions.

Muschelkalk

Some years ago Diedrich (2001) presented an update of the lithostratigraphy and sequence stratigraphic interpretation of the Lower Muschelkalk Member in which he described some so-called 'Black Clay Beds' which are essentially dark-coloured, organic-rich marls (Fig. 2). These layers I to IV, together with the marl bed with lamellibranch remains, were processed for palynological purposes. The lamellibranchiata bed and black clay bed III yielded rich and varied palynomorph assemblages. The associations are dated Anisian on the basis of the joint occurrence of *Angustisulcites gorpii*, *Colpectopollis ellipsoideus*, *Guttatisporites guttatus*, *Microcachryidites fastidioides*, *Stellapollenites thiergartii* and *Tsugaepollenites oriens*. More precisely, the frequent presence of *Microcachryidites* spp. and in particular of *A. gorpii* and *T. oriens* are indicative of the Aegean, the but one oldest substage of the Anisian (Herngreen, 2005). This age-assignment is in agreement with the dating based on conodonts and ammonites of the lowermost Wellenkalk in Germany (Kozur, 1999).

The parent plant producing the very common *Triadispora* spores is a xerophytic element. Plant macro-remains are rare, their habitus and SEM-studies strongly suggest an Isoetalean

https://doi.org/10.1017/S0016774600021223 Published online by Cambridge University Press

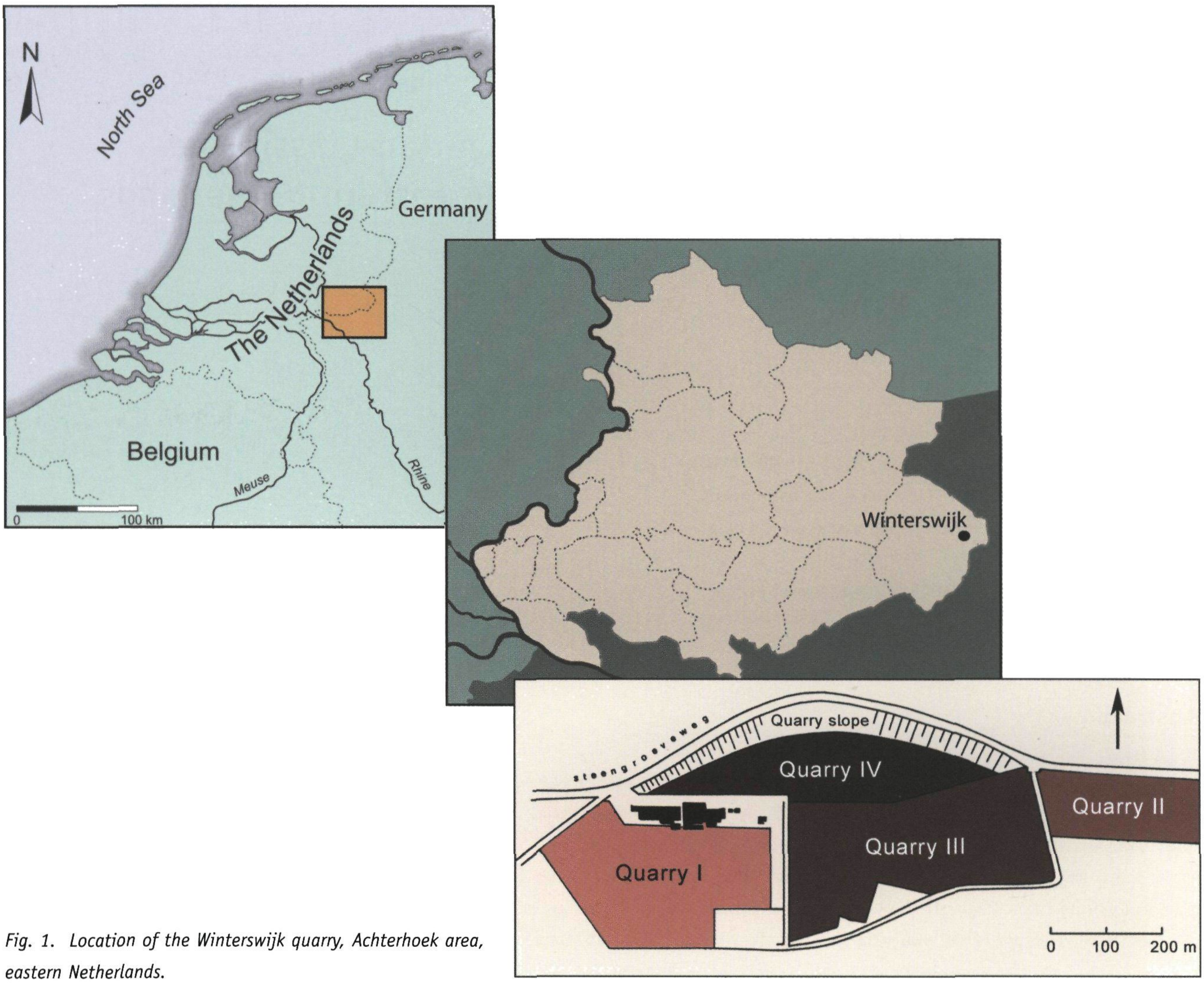

Fig. 1. Location of the Winterswijk quarry, Achterhoek area, eastern Netherlands.

affinity (quillwort) of which, indeed, the spores, *Aratrisporites*, have been found in the assemblages.

After tracing the student essay of Commissaris (1965) it proved that his (and Visscher and Commissaris, 1968) samples which yielded palynomorphs were taken between the lamellibranch and black clay bed III. In conclusion it seems likely that only a small interval of the total Lower Muschelkalk section in the quarries is palynomorph, mainly pollen and spores, productive.

Liassic clay

In 1989 the first author sampled in quarry III some material from a dark shale, at that time a block of circa 6 × 6 m and about 4 metres high, which at all sides was surrounded by Muschelkalk limestones and marls. The palynological and micropaleontological analyses proved to have an age around the Hettangian/Sinemurian boundary (Herngreen, 1989; Lissenberg, 1989). This isolated occurrence of the Lower Liassic was not well understood at that time and a relationship to clays overlying the Muschelkalk was suggested.

Rhaetian and Oligocene clay

Since spring 2004 good exposures of the clays overlying the Muschelkalk deposits have been available at the northern edge of the newest quarry (IV; Fig. 3). In stratigraphic order they represent a dark gray to almost black clay of 4 m thickness and ca. 3 m light gray, slightly sandy clay.

Five samples of the lower unit yielded extremely rich and fairly preserved sporomorph assemblages with a minor amount of marine acritarchs and dinoflagellates of the genus *Rhaetogonyaulax*. The pollen and spore microfloras mainly consist of representatives of the *Circulina-Classopollis* plexus, with common marker species such as *Ovalipollis pseudoalatus*, *Rhaetipollis germanicus* and *Ricciisporites tuberculatus*, more rarely guide types such as *Cerebropollenites pseudomassulae*, *Cingulizonates rhaeticus*, *Heliosporites altmarkensis* and *Limbosporites lundbladii* are also present. The co-occurrence definitely indicates a Rhaetian age (Herngreen, 2005). This dating of the slightly marine influenced organic-rich black clay which is assigned to the here southward rapidly pinching out Sleen Shale Formation, is new information for the local

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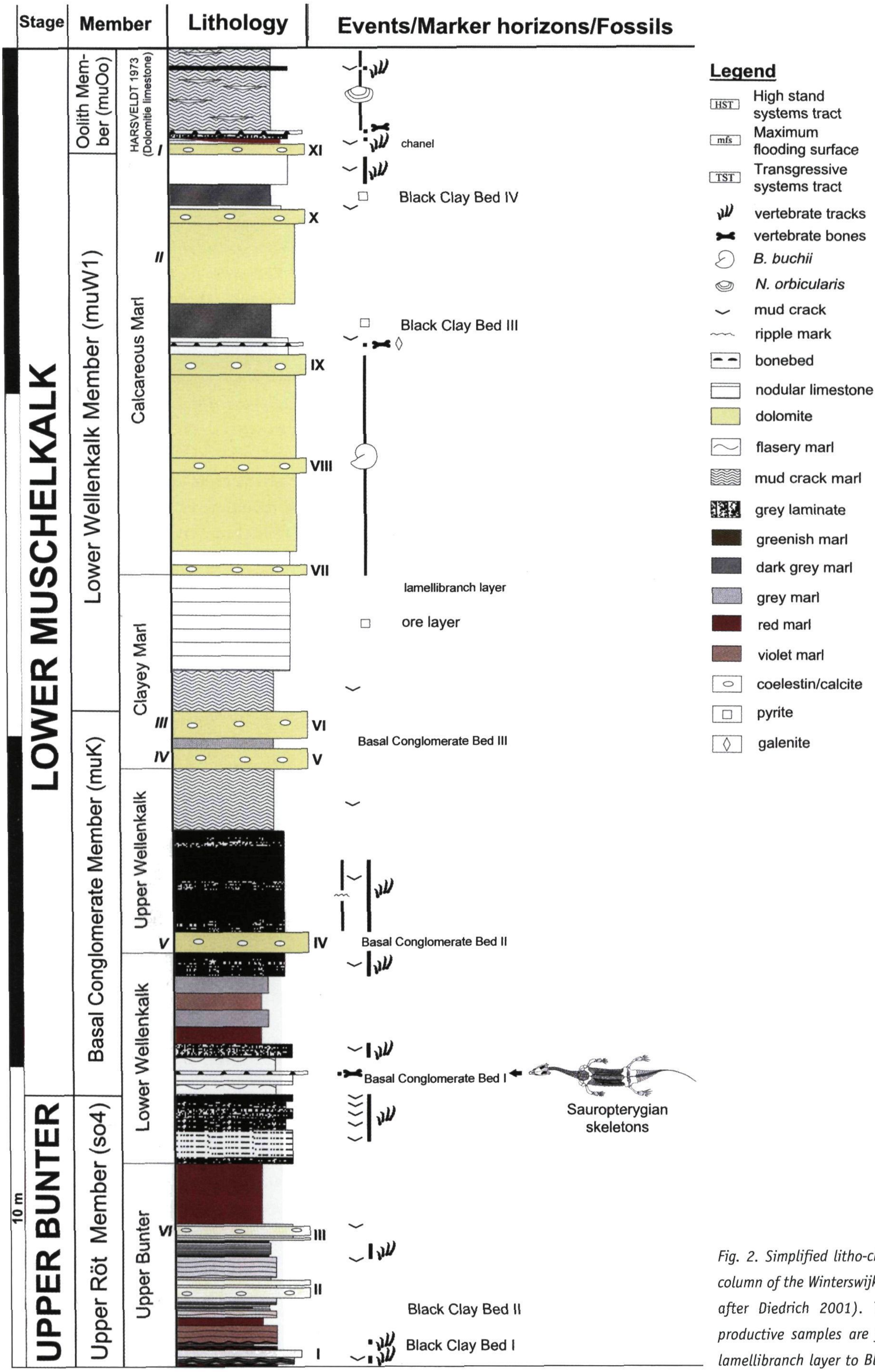

Fig. 2. Simplified litho-chronostratigraphic column of the Winterswijk quarry (modified after Diedrich 2001). The palynomorph productive samples are from the interval lamellibranch layer to Black Clay Bed III.

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Fig. 3. Detail of the lithologic succession in the SW corner of quarry IV. Dark gray to black: Rhaetian Sleen Shale Formation, light gray: Lower-Oligocene Rupel Formation which is overlain by Quaternary deposits (light yellow). The ochre-coloured bed at the seemingly base of the Rhaetian is a level with concentration of pyrite. Note the sharp unconformity between the Sleen Shale and Rupel formations. In the foreground is displaced/fallen Muschelkalk debris. The Rhaetian is pinching out in southward direction over the (here not exposed) Muschelkalk.

geology. It rectifies earlier data in Harsveldt (1973) who indicated, although without any (micro)paleontologic proof, Liassic in his N-S directed section across the quarry complex.

Two samples of the overlying light gray clay proved extremely rich in dinoflagellates. Of stratigraphical significance are *Deflandrea phosphoritica*, *Membranophoridium aspinatum*, *Thalassiphora pelagica* and the *Wetziella gochtii-symmetrica* plexus, which are indicative of an Oligocene age. In more detail *Achilleodinium biformoides*, *Enneadocysta arcuata*, *Gerdiocysta conopea*, *Glaphyrocysta semitecta*, *Histiophora* spp. and *Phthanoperidinium comatum* prove Lower, although not lowermost, Oligocene, equivalent of the NP 22 to 23 Zone interval (Van Simaeys et al., 2005). This deposit is correlated with the transition Vessem to Rupel Clay Member of the Rupel Formation (Van Adrichem Boogaert & Kouwe, 1997). In his local lithostratigraphy, Van den Bosch (1984) correlates this with the transition Ratum Formation to the Kotten Member of the Brinkheurne Formation. In Belgium and Brabant-Limburg (Roerdal Graben) these strata are indicative for the transition from the Zelzate to the Boom Clay Formation.

Discussion

As said before the sizable occurrence of Lower Liassic clay in the southern part of quarry III is enigmatic. The usual suggestions to explain such a phenomenon as (1) presence of a normal fault, (2) karstification in combination with a solution pipe, or (3) a slumped down deposit, do not satisfy, as small faults occur to a maximum displacement of 1.60 m (Oosterink,1986, his photo 3), in addition, the karstification is superficial and in combination with joints reaches a maximum depth of one and a half metre (Crommelin, 1943; Oestreich, 1943). Moreover these solution structures are filled in with Quaternary material. Also the third explanation is not plausible as the necessary accomodation is lacking.

Dr T. Simon drew our attention to subrosion (= subsurface erosion, apparently from solution of salts and subsequent adjustment/collapse) described from Hesse, Germany (Laemmlen, 1991). Indeed, these structures (fissures, pipes) as described from Buntsandstein deposits which collapsed into Zechstein strata due to solution of salt and anhydrites, provide a workable hypothesis. In the Achterhoek area the Main Röt Evaporite and Upper Röt Evaporite members, together with the Intermediate Röt Claystone Member, reach a thickness of ca. 26.5 m in well Winterswijk-1 (NITG-TNO, 1998). These members are just below the Lower Muschelkalk Member. Other salt accumulations in this region occur in the Zechstein Group, the top of which is at much greater depths: east of Winterswijk between 500-800 m, in well Plantengaarde-1 at 340 m and in well Ratum-1 at 751 m (NITG-TNO, 1998, map 3). In our opinion solution of Röt salt, followed by collapsing Muschelkalk and the overlying Rhaetian and Liassic deposits, seems a plausible explanation here for the presence of the Lias block at all sides surrounded by Muschelkalk.

Acknowledgements

The directors, at present Mr. J.B.W.G. Mentink, of the 'Winterswijksche Steen- en Kalkgroeve B.V.' are kindly thanked for their permission to visit the quarries. Our appreciation goes out to Dr T. Simon, Landesamt für Geologie, Rohstoffe und Bergbau Baden-Württemberg, Stuttgart, for constructive discussion on salt subrosion structures. Leonard P.M. Bik (LPP, Utrecht University) drew the figures. This is NSG contribution no. 20050302.

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