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The tidal character of the Formation of Tegelen in northern Belgium

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Abstract

In northern Belgium a fining upward sequence in the Campine clays and sands (Formation of Tegelen) has been studied. Thinly interlayered sediments of fine sand and clay are overlaid by two claylayers with an intercalated peat-layer. In the sand-clay alternations small scale current ripples with opposed high-angle cross lamination indicate tidal movements. Ebb and flood ripples, covered with mud, point to subtidal deposition. The absence of bioturbation and the presence of fresh water peat indicate a fresh or brackish subtidal (lagoonal) depositional environment.

Introduction

In the summer of 1984 a clay-pit was investigated at the village of Meerle in northern Belgium (fig. 1). Two clay-layers (together 2 m thick) are being excavated here for the DESTA brick-factory. These clay-layers (beds 3 and 5, see below) are present over large areas in northern Belgium and the southern Netherlands. In the Netherlands they belong to the top of the Formation of Tegelen of Lower Pleistocene age (Zagwijn & Van Staalduinen 1975). In Belgium they are part of the Campine sands and clays.

On top of the clay eolian cover sands of the Weichselian Pleniglacial age are present, described as 'Meerle member' by Vandenberghe (1985).

The aim of this investigation was to reconstruct the paleoenvironment of the Lower Pleistocene sediments at this spot. This fieldwork is part of a project concerning the paleogeographic evolution of western North-Brabant and northern Belgium during the Lower Pleistocene, financed by the Netherlands Organization for the Advancement of Science (Z.W.O.).

Description of the lithology and lithostratigraphy at Meerle (fig. 2)

In the clay-pit at Meerle 6 lithostratigraphic beds can be distinguished which are described below (fig. 2). Beds 3, 4 and 5 were dug for the brick-factory, while bed 2 was exposed at a deeper part of the pit.

bed 1: This layer was not exposed at the time of the investigations, but has been found frequently in hand-drilled borings in the neighbourhood of the clay-pit. It consists of fine (105–150 μm), grey, well sorted sands with some thin clay laminae.

bed 2: This unit consists of well laminated fine sands and clays, and is described in more detail in the next paragraph.

bed 3: A blue-grey clay (35–40% lutum) which

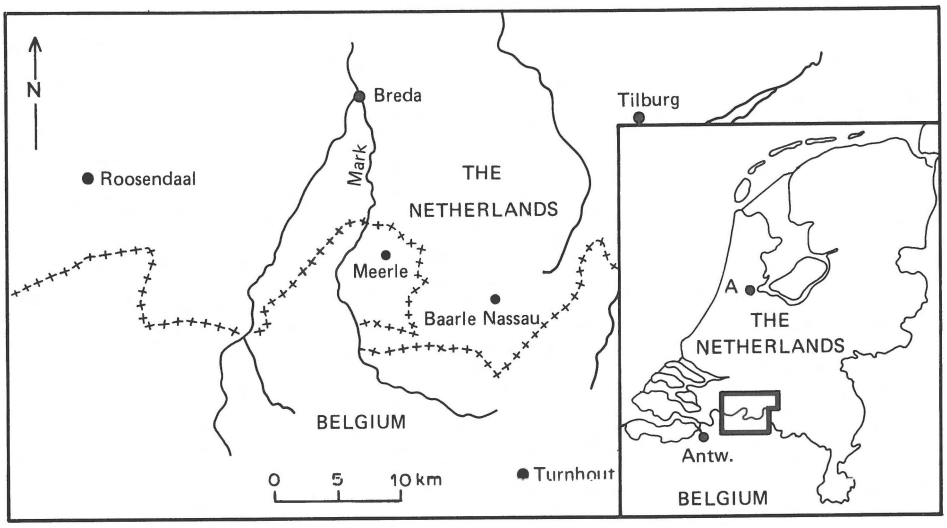

Fig. 1.: Locality map.

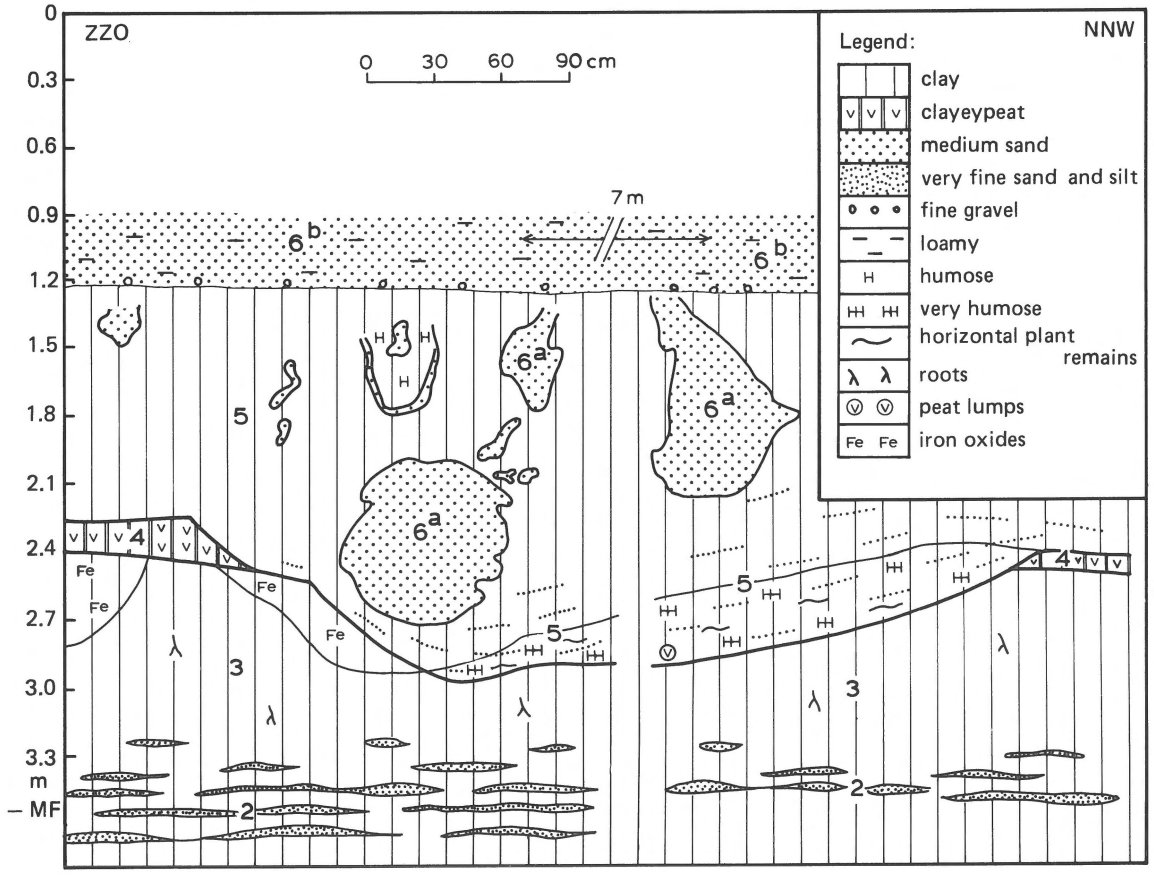

Fig. 2.: Lithology and lithostratigraphy at Meerle.

forms the upper zone of a fining upward sequence together with beds 1 and 2.

bed 4: A brown, compact peat-layer that in places separates the clay-beds 3 and 5. Locally the peat has been removed by gully erosion following peat growth. Pollen from a peat-layer in a comparable lithostratigraphic position have been analysed by De Ploey (1961) (see final paragraph).

bed 5: A sticky, grey clay-layer (30–35% lutum) that resembles bed 3. Where the peat-layer is removed by later gully erosion, beds 5 and 3 are separated by a sharp boundary. It is remarkable, however, that bed 5 has not been developed as a sandy gully facies as would be expected. Gully infillings consist predominantly of clay with only thin laminae of very fine sand or silt, which distinguishes bed 5 in this situation from bed 3.

bed 6: In bed 6 two layers, 6a and 6b are distinguished. Layer 6a represents sand involutions in the clay and is separated from the parallel laminated loamy cover sands of layer 6b by a gravel layer (Vandenberghe & Van den Broek 1982). Both layers belong to the Weichselian Pleniglacial (Vandenberghe 1985).

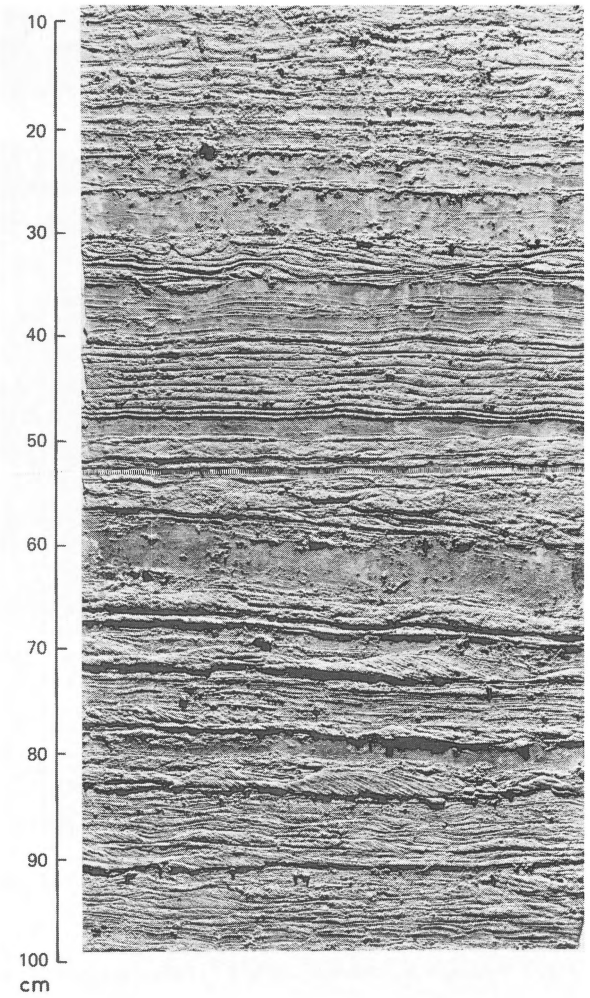

Fig. 3.: Lacquer peel showing the interlayered bedding in bed 2.

Sedimentary structures in bed 2

A lacquer peel was made from the deposits immediately below the heavy clay of bed 3. Beds 1, 2 and 3 together form one fining upward sequence (fig. 3 and 4). Bed 2 has been described in the field as thinly laminated very fine, well sorted sands and clays. Sedimentary structures and bedforms are described separately on the right hand side of the drawing (fig. 4). The sedimentary structures on the lacquer peel as a whole are characterized by interlayered bedding (Reineck & Singh 1975). Especially zone 2 shows small-scale cross laminated zones, with foresets dipping in opposite directions, separated by clay laminae. Two detailphotos (fig. 5 and 6) of the same lacquer peel illustrate these small-scale sedimentary structures. These opposite, high angle cross laminated sets, separated by clay laminae, indicate bi-directional water movements and were most likely formed by tidal currents. During ebb and flood small scale sand ripples migrated over the sedimentary surface while during the slack water periods, between ebb and flood, clay fell out of suspension, preserving the ebb and flood sand ripples. As both ebb and flood ripples are covered with mud, deposition must have taken place in a low-energy subtidal environment.

The lacquer peel further shows that the dominant stream direction was more or less to the southeast. According to the paleogeographic situation during the Tiglian, with an east-west coastline (Zagwijn

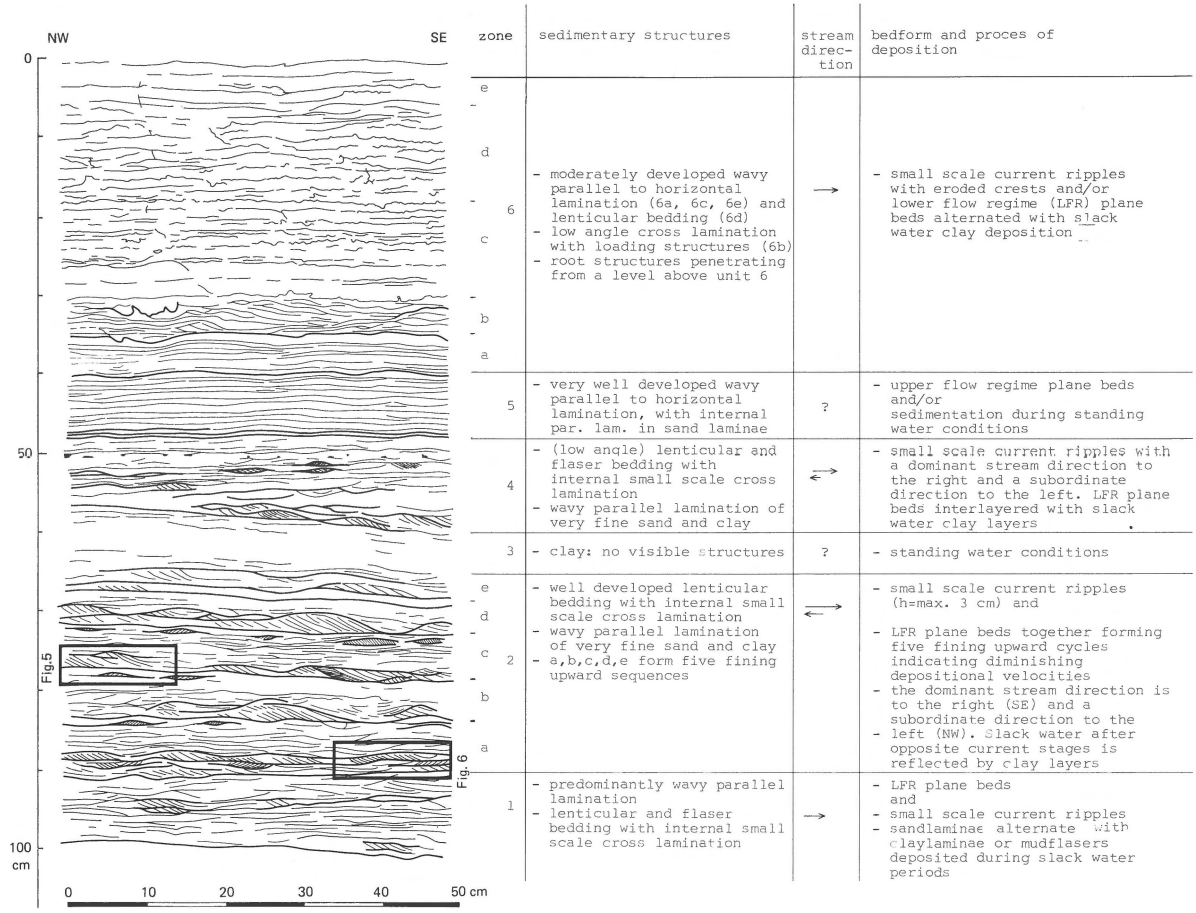

Fig. 4. Sedimentary structures in bed 2 (LFR = lower flow regime).

1974), this southeast direction could reflect flood current deposition.

Discussion and conclusions

Until now the discussion concerning the sedimentary environment of these Lower Pleistocene deposits in southern North-Brabant and northern Belgium has been inconclusive. A major problem is the lack of fauna in these sediments. Therefore pollen-analytical and sedimentological arguments were brought forward. Dricot (1961), who found pollen of *Chenopodiaceae* in lithological comparable clay-layers at Beerse and Van Oosten (1967, 1975) concluded that these layers had been deposited in a tidal flat and marsh environment. According to Doppert & Zonneveld (1955) and Geys (1978) these Lower Pleistocene deposits in North-Brabant are fluviatile.

My interpretation is that the sedimentary structures in these deposits reveal bidirectional water movement that were most probably caused by tidal currents, at least in some parts of the section (bed 2: zone 2). The sediments in bed 2 strongly resemble subtidal deposits in the Haringvliet (Oomkens & Terwindt 1960; Terwindt 1971) and the Jade Bay (Reineck & Singh 1975). This subtidal environment in bed 2 was dominated by northwest–southeast flowing (flood) currents. Ebb currents appear to be subordinate and only little sediment could be transported. Slack water periods after the dominant and

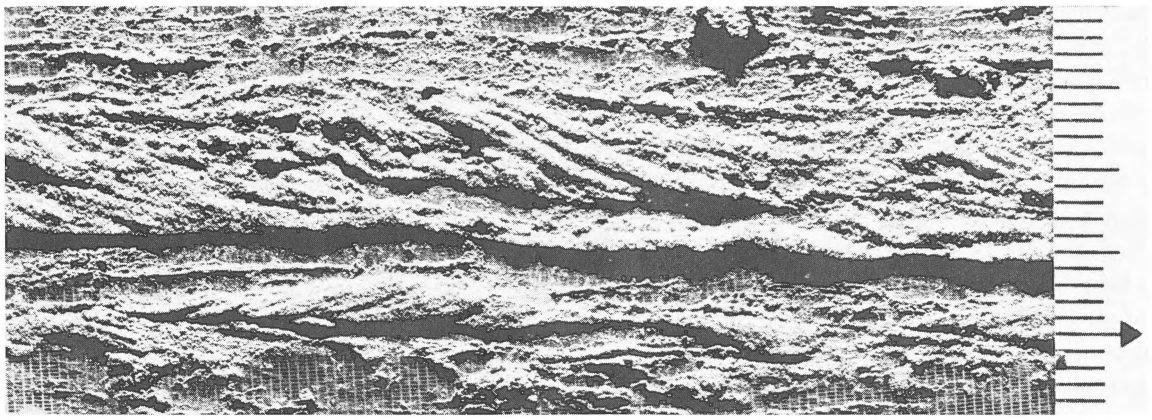

Fig. 5.. Detail of the sedimentary structures in bed 2 (scale in centimetres).

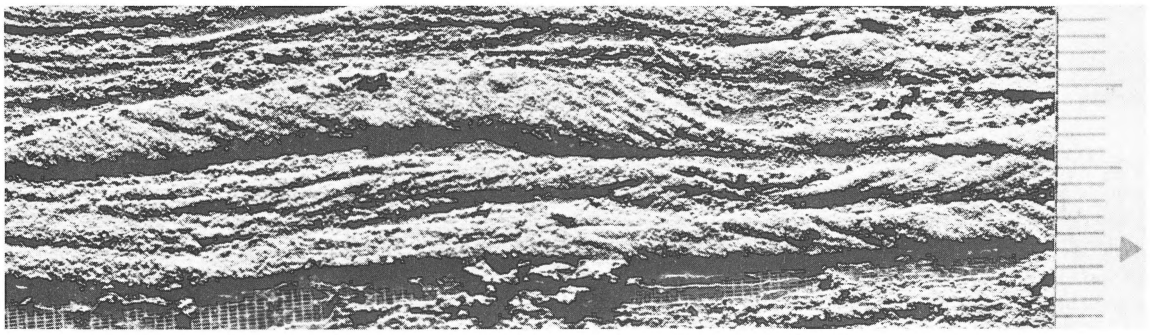

Fig. 6.: Detail of the sedimentary structures in bed 2 (scale in centimetres).

subordinate current stages are presented by mud layers. In spite of the tidal character, bioturbation appears to be absent in bed 2, probably due to a low or fluctuating salinity.

A gradual decrease in current velocity resulted in mud deposition (beds 3 and 5) and peat formation (bed 4). The peat, first described by De Ploey (1961), is dominated by *Alnus* and lacks salt tolerant plants (*Chenopodiaceae*). Thus peat formation took place in a fresh water swamp environment. Because of the absence of marine bioturbation and *Chenopodiaceae* we may presume that sedimentation at Meerle took place in a low energy, (sub)-tidal, fresh to brackish environment.

This investigation supports the conclusions of Dricot (1961) and Van Oosten (1967, 1975) with respect to the tidal origin of these sediments. The absence of marine shells is no proof for a fluviatile depositional environment, as these sediments may have been decalcified after deposition, during the long period following the Tiglian.

Geys (1978) in contrast, who based his conclusions almost entirely on granulometric and morphoscopic data, proposed a fluviatile origin for these deposits. Sedimentological arguments, however, are scarce in his work. It is not impossible that much of the fluviatile sediments he described are in fact reworked fluviatile sediments deposited in a tidal environment. Such sediments will probably show fluviatile morphoscopic textures, although they were deposited in a subtidal paleoenvironment. The sediments described above, which are part of the Formation of Tegelen, form the logical, sequential link between the fully marine Formation

of Maassluis (Zagwijn & Van Staalduinen 1975) and the continental, fluviatile Alphen sands of the Formation of Kedichem (Vandenberghe & Krook 1981) in this area. The paleoenvironment at Meerle probably resembled the subtidal (lagoonal) depositional environments in the western Netherlands during the Holocene Calais transgression phases (Van Staalduinen 1979, p. 23–26).

It has been known already for some time that the base of the Formation of Tegelen is locally marine and that it can be correlated laterally with the marine Formation of Maassluis in this area (Zagwijn & Van Staalduinen 1975). This investigation shows that not only the bases but almost the complete Formation of Tegelen in the area investigated was subject to tidal influences in a fresh or brackish subtidal depositional environment.

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