

The Belgian coastal plain during the Quaternary

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In Belgium the Middle Pleistocene marine deposits of Cromerian and Holsteinian age are restricted to the western part of the coastal area. In Eemian time the marine influence moved eastward and had a landward extension along the Flemish valley. During the Holocene the coastal plain was covered with sediments of the Vlaanderen Formation, with a maximum thickness of 30 m, and with distinct regional environmental differences. The underlying Calais Member is relatively thick compared to the overlying Dunkerque Member. Both members were deposited during transgressive phases. Peat belonging to the Holland Peat Member interfingers with the Calais Member and is also present between the Calais and Dunkerque Members.

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Introduction

The Belgian coastal plain, about 15 km wide, is part of the narrow strip of low-lying land between the Sangatte Cliff in France and the large polder area of the Netherlands. The

southwestern part of the plain, however, has an extension into the mainland along the river IJzer; it has been called the IJzer Golf (IJzer embayment) (Rutot 1897). The landward boundary

of the coastal plain is defined by the line of maximum extension of Holocene marine and brackish deposits. This line is nearly conformable with the contourline of +3 m N.A.P., while the most general level of the Holocene ranges from +0.5 m to +2 m. The plain is separated from the present coast by an almost continuous dune barrier. The Belgian Ordance Datum level at Oostende (O.P.) is 2.33 m lower than the Dutch Ordance Datum Level (N.A.P.).

Pleistocene marine transgressions

At the end of the Tertiary, the southern boundary of the North Sea had moved from the vicinity of the French-Belgian border towards the area of the Belgian-Dutch border, north of Antwerp. Laga (1973), on the basis of the foraminiferal content, assigned the so-called Merksem Sands to the Pliocene. Overlying these are the Sands of Mol of continental origin; the lower part beneath the Arendonk lignite layer is still of Pliocene age, the upper part with cryoturbation structures (Tavernier 1943) is of Pleistocene Pretiglian age. The whole formation may reach a thickness of more than 70 m.

The Sands of Mol are followed by a series of continental and estuarine deposits called the Campine Formation. The upper part is subdivided into a lower Rijkevorsel (estuarine) clay Member and an upper Turnhout (estuarine) clay Member of Tiglian and Waalian age respectively (Paepe & Vanhoorne 1970). Between these two members is a continental Beerse Member, of Eburonian age (Dricot 1961, Paepe & Vanhoorne 1971), consisting of sand and peat. The age of these deposits was based on palaeobotanical and palaeomagnetic investigations (Van Montfrans 1971, Hus et al. 1976). The alternating continental and estuarine deposits in this northern part of Belgium, from the surface at about +30 m O.P. (Belgian Ordance Datum level) to a maximum depth of 40 m, are proof of transgressions and regressions in this area during the Early Pleistocene.

Marine influence is virtually absent in this area after the beginning of the Middle Pleistocene. It may be assumed that the formation of

the Campine High Terrace started during Menapian times and that deposition continued during the "Cromerian". In the meantime, the North Sea apparently withdrew definitely from its eastern parts. Tilting of the North Sea basinal margin to the West seems a plausible explanation for the renewed marine deposition since the "Cromerian" in the French-Belgian border area. These marine deposits are situated around +15 m O.P.

The Herzele Formation (Sommé 1973) described elsewhere in this volume by Sommé, contains two marine deposits separated by a peat layer formed during a warm period, and a marine crag unconformably overlying the deposits mentioned above. The two marine deposits are assumed to belong to the second and third "Cromerian" stages (*sensu* Zagwijn), whereas the upper crag is believed to be of Holsteinian age according to its fauna. Baeteman (unpublished) found these deposits extending eastward, into Belgian territory. None of them, however, were found east of the line Oostende-Gistel (Paepe 1970).

On the contrary, marine deposits of Eemian age are present all over the eastern Belgian coastal plain. The landward boundary of these deposits is further inland than the margin of the coastal plain. The Eemian deposits are generally present at a depth of 5 m below the surface. Towards the present coastline, Eemian deposits are rapidly sloping to 12–15 m in the middle of the plain and to about 20–25 m near the shore. A gradual change in lithology can be observed: the landward clayey lagoonal or tidal flat facies becomes increasingly sandy towards the sea.

Estuarine Eemian deposits are found at 12–20 m and far inland along the so-called Flemish Valley east of Ghent (Tavernier 1973). In these deposits and in many of the tributary valley deposits such as the Scheldt, Lys and Zenne, "*Corbicula fluminalis*" was found (Rutot 1910, Halet 1921). Recently, double shelled specimens of *Tapes senscens* var. *eemiensis* have been collected from Eemian deposits, most of them in the Eemian of the coastal plain.

The distribution of Eemian and Middle Pleistocene marine deposits indicates a considerable change in the position of the coastline.

West of Oostende, up to the Cliff of Sangatte, a large bay seems to have existed throughout Cromerian and Holsteinian times; later, it disappeared. The shoreline west of Oostende was then generally located off the present coast. West of Gravelines, however, the coastline turned landward to the Sangatte Cliff. During Eemian times, the coastline extended east of Oostende, with a landward extension along the Flemish valley and further to the North, towards the Delta area of the southern Netherlands.

Holocene marine transgressions

Stratigraphical units

The Holocene sediments in the coastal plain attain a maximum thickness of 30 m near the present coastline and of only 2 m near the mainland. This must be attributed to the steeply dipping top of the Tertiary substratum. The contourlines of the top Tertiary are generally parallel to the present coastline. Along the IJzer embayment, however, the top Tertiary is -20 m.

The coastal plain is covered with sediments of the Vlaanderen Formation, which consists in this area of the Calais, Dunkerque, and Holland Peat Members (Paepe, Sommé, Cunat & Baeteman 1976). In the western part of the plain, these deposits rest directly upon the Tertiary substratum. In the eastern part, the Holocene (Flandrian) deposits are resting upon marine Eemian deposits and in some areas upon sediments of Weichselian age.

In the IJzer Golf (IJzer embayment) Pleistocene deposits of the Herzele Formation are absent over a large part of the area. However, the Tertiary substratum is covered by continental deposits consisting of reworked Pleistocene, mainly derived from the Herzele Formation, and peat remnants of Atlantic age. This Lampernisse Member belongs to the Vlaanderen Formation. The Calais Member occurs in two small channel-fills. The marine Holocene is only represented by the Dunkerque Member resting upon the main peat layer of the Holland Peat Member.

The Calais Member

The Calais Member is found all over the coastal plain except in the IJzer embayment. It is generally covered by the main peat layer belonging to the Holland Peat Member and by deposits of the Dunkerque Member. In the area of De Moeren (near the French border) Calais deposits are found directly at the surface. The thickness ranges from 0.5 m on the landward side of the coastal plain to nearly 25 m at the present coast.

The lithology of the Calais Member in the inland area and in the area near the coast is distinctly different. Near the landward margin of the coastal plain, the Calais Member is a bluish-grey clay with numerous molluscs as *Cardium edule*, *Hydrobia ulvae*, *Macoma balthica*, *Macra* and others. The clay contains several peat or peaty layers at -11.5 m, -9.5 m, -7.5 m, -6 m, -5 m and -2 m N.A.P. The peat layers are local and discontinuous, except the one at -2 m. A brown loamy sand is the main sediment at a depth of -8 m N.A.P.

In the area east of Oostende and in other places in the middle of the coastal plain, the bluish-grey clay passes into grey sand with sporadic peaty intercalations. In an area about 5 km wide along the present coast, the Calais Member has a different lithology. In certain areas (especially in the westernmost), the Calais Member consists of grey sand, up to 25 m thick. Clayey or peaty intercalations are missing; numerous molluscs (especially *Cardium edule* and their fragments, concentrated in layers, are found in many places. The sandy sediments have been considered in the Belgian literature as the typical Calais facies, erroneously named Atlantic tidal flat sediments. In doing so, the beach character of part of the deposits was neglected.

The Holland Peat Member

The Calais Member is separated from the Dunkerque Member by the main peat layer (so-called surface peat) that belongs to the Holland Peat Member. The peat is the most distinct layer

of the Holland Peat Member, as regard its distribution and its thickness of 2 m. It is found almost everywhere in the coastal plain at a depth of about -2 m; it may be absent as a result of erosion in former tidal channel areas belonging to the Dunkerque transgressions. The main peat layer is dated 4150 B.P. (mean ^{14}C dating) and the top is dated 2900 B.P. It does not contain clayey intercalations, contrary to the clayey Dunkerque 0 layer, which is usually found in equivalent Dutch deposits. A second but minor peat layer is situated at -5 m and dated 5830 B.P. (mean ^{14}C dating). Finally, the peat layer at -11.5 m has been found only locally; it corresponds most probably to the so-called Basal Peat or Lower Peat. See the contributions by Jelgersma, Oele & Wiggers and Behre, Menke & Streif elsewhere in this volume.

The presence of several peat or peaty layers points to several transgressive and regressive phases during deposition of the Calais Member. The available data from radiocarbon dating and pollen analysis are insufficient to establish a chronological timescale for the area.

The Dunkerque Member

The Dunkerque Member, overlying the so-called surface peat, has the largest extension of all members of the Vlaanderen Formation. As stated above, it is absent in the De Moeren area. The predominantly clayey facies reaches a thickness of 2 m, whereas a sandy facies generally found in tidal channels may be more than 4 m thick. This member contains only sporadic root levels, and not the peat or peaty layers, as found interfingering in the Calais Member.

On the basis of archaeological data, lithological characteristics and sedimentological studies, several transgressive phases can be distinguished, i.e. Dunkerque I, II, IIIA, and IIIB. The greatest lateral extension was reached during the Dunkerque II transgressional phase, the sediments of which cover nearly the entire coastal plain (J.B. Amerijckx, 1960).

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