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# OLIGOCENE BIOSTRATIGRAPHY OF SHALLOW WATER DEPOSITS IN BELGIUM COMPARED WITH DEEP WATER SUCCESSIONS OF MORE NORTHERN AREAS OF THE NORTH SEA BASIN

Thierry L. MOORKENS[1]

The Oligocene sediments of the classical outcrops of the Rupelian Boom Clay Formation in Belgium, and of the underlying Lower Oligocene Tongeren Formation have been deposited in a shallow shelf sea at the southern edge of the North Sea Basin. Some sedimentary gaps and/or non-marine deposits occur, mainly in connection with the upper part of the Tongeren Formation. In this area the thickness of the Oligocene does not exceed hundred meters.

During the same period deep water sedimentation took place in the central and northern North Sea leading to a fully marine continuous succession of several hundred meters of sediment; the biostratigraphy of this succession, based on different microfossil groups, is well known, as it has been studied in numerous wells.

The comparison of the multi-biozonation of the deep water (bathyal) succession with the microfossil assemblages of the shallow water (neritic) deposits of Belgium allows to better assess the time spans corresponding to the transgressive cycles, i.e. the marine incursions which occurred from the north onto the Brabant Massif.

Although deposited at different bathymetric depths, the microfossil assemblages are generally well comparable, since they belonged to the same basin. The biostratigraphic frame used for the here presented North-South correlation is based on the juxaposition of the biozonations of dinoflagellates, calcareous nannoplankton, planktonic and benthic foraminifera, as compiled from existing publications; mainly the results from the IGCP project No. 124 can be used and have been compiled into detailed biostratigraphic schemes for different parts of the North Sea Basin. The biostratigraphy of the Oligocene of the North Sea Basin is based on several groups of planktonic microfossils which have a nearly worldwide distribution and allow transcontinental correlations.

However, these data do not allow a direct comparison with the recently proposed Eocene-Oligocene boundary stratotype located at the hantkeninid extinction level in the Massignano section in Italy. It is thought that the mentioned extinction is not a valid criterion for world-wide correlation of this boundary, as it can only be recognised in the tropical to warm temperate climatic belt of that period, excluding all areas of the higher latitudes. Other groups of planktonic microfossils (e.g. some dinoflagellate species etc...) are thought to provide somewhat more cosmopolitan criteria for biostratigraphic correlation and appear therefore more appropriate to define a stage boundary of worldwide acceptance than the above mentioned extinction level of some warm water Hantkenina species.



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# SEDIMENTATION MODEL OF EOCENE CONTINENTAL SHELF DEPOSITS OFFSHORE THE BELGIAN COAST

**P. JACOBS[1], & E. SEVENS[1]**



Four wells drilled on the Belgian part of the continental shelf display a sediment series of nearly 200 m ranging from Lowermost Eocene to Lower Oligocene. Sedimentary facies analysis and grain size trends were used to unravel sediment genetic history and sequence stratigraphy.

During Earliest Eocene times (Phase 1), sediments were deposited in a distal position on an open mud shelf, at the moment the uplift of the Artois-Weald axis accelerated, causing the separation of the southern North Sea bight from the opening North Atlantic. The first 4 stacked TST parasequences topped by a HST indicate a constantly rising relative sea level.

In Mid Early to Late Early Eocene times (Phase 2), in a more proximal position nearer to the coast, sedimentation first shifts from a delta front back to an offshore mud shelf and than back again to a delta complex. An ebb tidal delta starts prograding onto the shelf, fed by a precursor of the Rhine-Meuse-Scheldt fluvial drainage system, with a southern sediment supply caused by the Alpine uplifting hinterland. At the end of Early Eocene times, tidal influence becomes prominent and general relative sea level is becoming somewhat lower. After a short period of locally greater water depth, (responsible for the last reappearance of the offshore mudshelf in the basal portion of the Uppermost Lower Eocene sediments), the constantly rising but relatively lower sea level induces in Late Early Eocene times the deposition of the delta complex as TST and HST of the prograding delta in the early highstand, mainly by loss of accommodation space.

In Middle Eocene times (Phase 3), the sedimentation system shifts even further to the coast towards a most proximal position, characterized by higher energetic conditions. Higher wave energy and long-shore currents replace the ebb tidal delta by a series of sand waves and barriers protecting a lagoon with estuaries and tidal flats. Large coarse sediment supply and loss of accommodation space are responsible for the wave influenced intertidal and supratidal sand shoals (LPW), the wave influenced subtidal and intertidal sedimentation with subtidal gullies and mixed intertidal flats (TST), and even the outbuilding of a submarine coastal barrier and a lagoon open to the sea (lagoonal storm deposits) as stacked HST-HPW parasequences, indicating the constant shoreline regression and the shallowing of the basin.

In Late Eocene times (Phase 4), the sedimentary environment shifts from a tidal mud flat to a coastal mud plain for the predominant clay layers to a tidal sand flat sedimentation for the sand layers, bounded by two major sedimentary and erosive hiatuses. The distal muddy portions of terminal fans are interbedded with coarser sandy packages of more medial sediments (on a scale of a few to ten meters), and display the progradational pulses of the delta fan lobes. Proximal sandy sediments with a southern origin are trapped at the basin margins, the basin itself being dominated by the monotonous distal facies. Aggradation produces rather thick sedimentary sequences with a regular geometric architecture predicting very gentle intra-basin relief.

The Upper Eocene units are deposited in relatively greater water depths with a finer sediment supply. They display 3 stacked (LPW) - TST - HST sequences, separated by 2 unconformities documenting 2 SB.
The sandy tidal flat sedimentation is again installed during Early Oligocene times (Phase 5). After a new but minor sea level drop responsible for the thin peat layers and burrows filled in with peaty sand at the top of the Upper Eocene unit, stacked LPW-TST parasequences develop in the Lower Oligocene.

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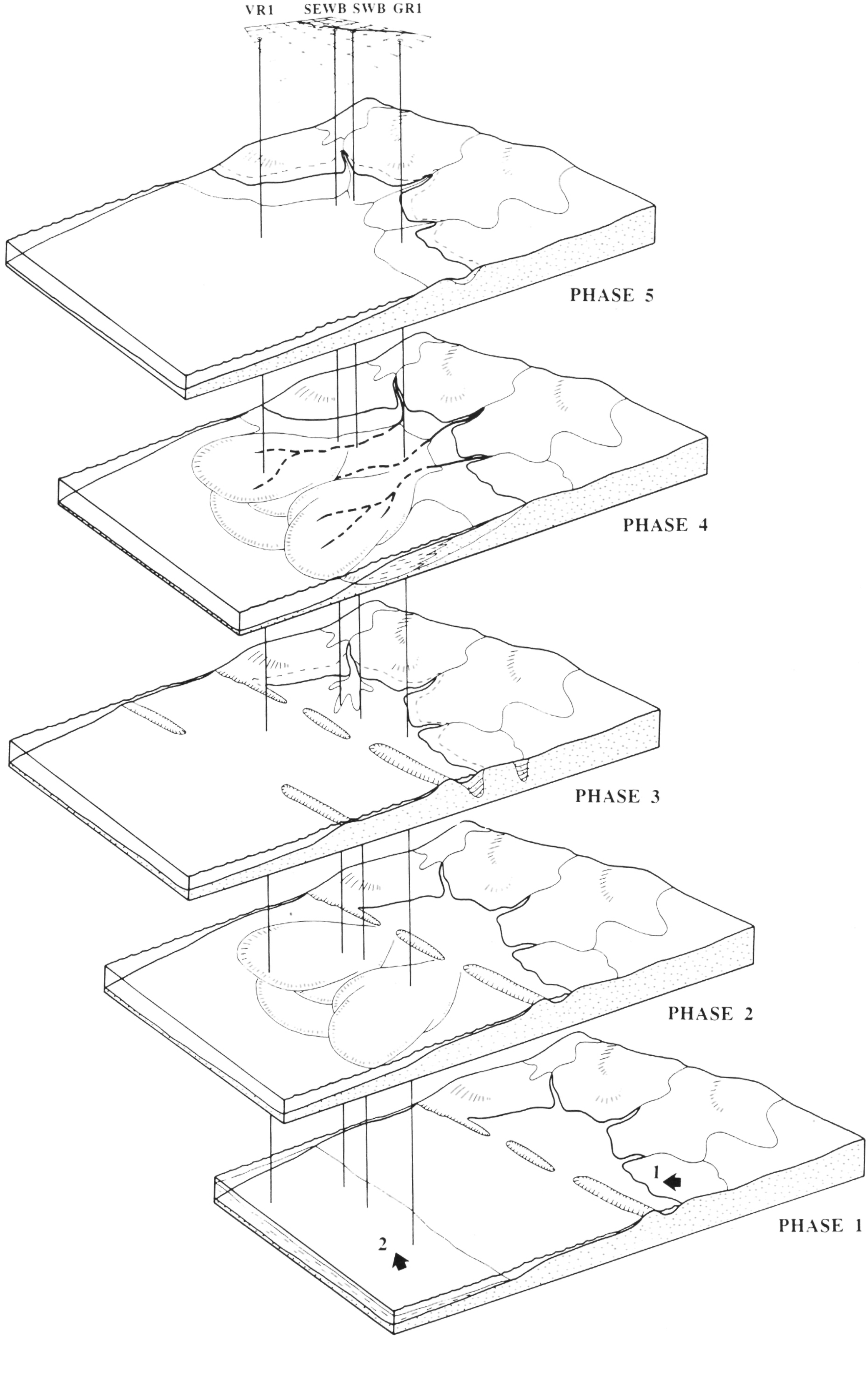
VR1
SEWB
SWB
GR1
PHASE 5
PHASE 4
PHASE 3
PHASE 2
PHASE 1
1
2

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# YPRESIAN LITHOSTRATIGRAPHY IN NORTHERN BELGIUM

B. FOBE[1]

Recent biostratigraphical investigations of Steurbaut and Nolf (1986) resulted in a revision of some correlations within the Ypresian in the Belgian Basin. The Ypresian was subdivided into the Ieper Formation (including the Flanders clay, the Egem sand and the Merelbeke clay Members) and the Vlierzele Formation (Pittem sandy clay Member and Vlierzele sand s.s.). It was demonstrated that many deposits mapped as Pittem Member, in fact belong to the Egem Member and in contrast to former subdivisions, the Merelbeke Member was ranked into the Ieper Formation. The model presented by Steurbaut and Nolf implicated the existence of a sharp boundary between the Ieper and Vlierzele Formations. Hitherto, the limits concerned have been described as gradual transitions, but borehole profiles in northern Belgium provide new information.

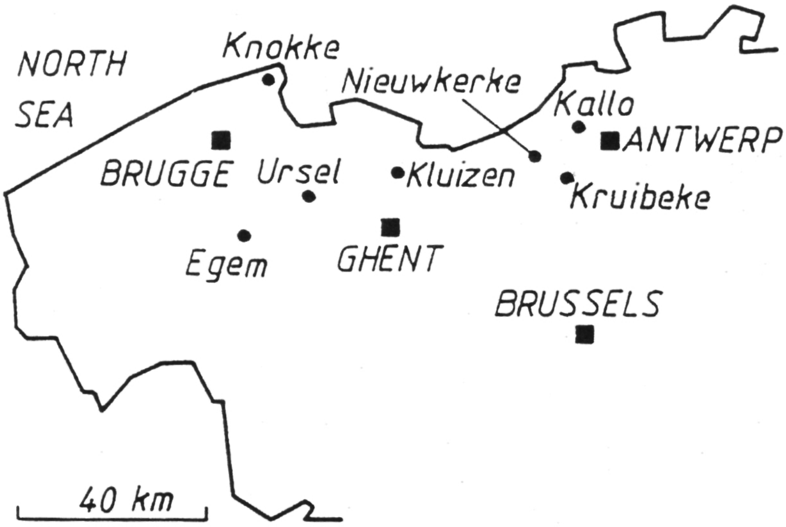


**Figure 1.** Location of the studied boreholes.

In the studied boreholes (Figures 1 and 2 and annex 1), the Merelbeke Member consists of heavy clay and is overlain by a lignitic sandy clay. The latter deposit was encountered in several boreholes between the North Sea and Antwerp (Knokke, Ursel, Kluizen, Nieuwkerke-Waas and Kruibeke). The overlying Vlierzele Formation is between 25 and 30 m thick and consists of a basal gravel, glauconitic sand, sandy clay (locally rich in fossils), and on top again glauconitic sand.

The lignitic sandy clay above the Merelbeke Member marks the end of the sedimentological cycle of the Ieper Formation. Until now, it has been correlated with the Pittem Member, because of its stratigraphic position immediately above the Merelbeke Member. However, the Pittem Member is ranked into the Vlierzele Formation by Steurbaut and Nolf and in its stratotype (the Egem sandpit), it is found above a sharp boundary marking the hiatus of the Merelbeke Member. Consequently, either the lignitic sandy clay covering the Merelbeke Member, and the Pittem Member are two different deposits, each one belonging to another cycle (in which case the Pittem Member may correspond to the middle sandy clay of the Vlierzele Formation), or the lignitic sandy clay correlates with the Pittem Member, which, in that case, does not belong to the Vlierzele Formation cycle.

In the outcropping areas, the limit between the Ieper and Vlierzele Formations is often marked by an erosional surface, by a basal gravel in the Vlierzele Formation, or by lignitic sediment on top of the Ieper Formation. A correlation study between the borehole sections and the outcropping area is in progress.

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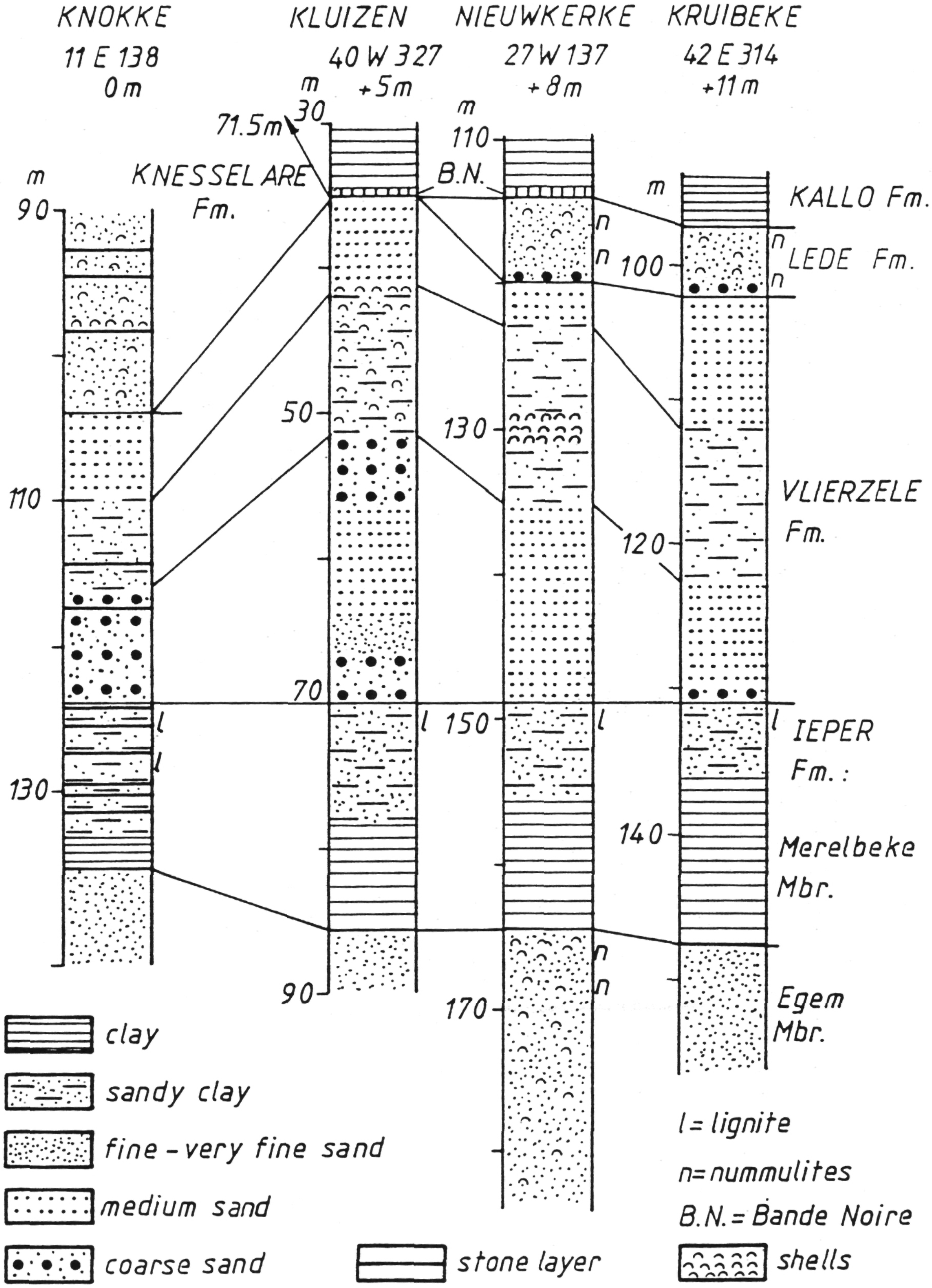


**Figure 2.** Detailed sections of the boreholes of Knokke, Kluizen, Nieuwkerke-Waas and Kruibeke.

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## ANNEX 1 - Borehole descriptions

### Kluizen (40W327)

| | |
|---|---|
| 0 - 25 m | grey fine to medium sand |
| 25 - 34 m | grey heavy clay |
| 34 - 35 m | shell-bed with glauconite |
| 35 - 43 m | grey grenn glauconitic medium sand |
| 43 - 51 m | grey green glauconitic fine sand and sandy clay with shells and stone layers |
| 51 - 56 m | grey green glauconitic coarse sand |
| 56 - 64 m | grey green glauconitic medium sand |
| 64 - 67 m | brown green argillaceous fine sand with glauconite and wood fragments |
| 67 - 70 m | grey green glauconitic coarse sand |
| 70 - 78 m | grey green (brown on top) glauconitic sandy clay |
| 78 - 86 m | grey green glauconitic clay |
| 86 - 90 m | grey green glauconitic, very fine argillaceous sand. |

*Interpretation*

| | |
|---|---|
| 0 - 25 m | Pleistocene |
| 25 - 35 m | Maldegem Formation, Asse Member with Bande Noire (34 m) |
| 35 - 70 m | Vlierzele Formation |
| | 35 - 43 m : upper sand unit |
| | 43 - 51 m : middle sandy clay |
| | 51 - 70 m : lower sand unit |
| 70 - 78 m | Ieper Formation, Pittem Member |
| 78 - 86 m | Ieper Formation, Merelbeke Member |
| 86 - 90 m | Ieper Formation, Egem Member |

### Nieuwkerke-Waas (27W137)

| | |
|---|---|
| 0 - 1 m | dark brown sand |
| 1 - 3 m | grey green sand |
| 3 - 4 m | grey green sand with shells |
| 4 - 5 m | shell-rich gravel with reworked flint and phosphate |
| 5 - 36 m | grey heavy clay |
| 36 - 40 m | grey green glauconitic very fine argicellaceous sand |
| 40 - 42 m | grey clay |
| 42 - 52 m | grey green glauconitic fine sand |
| 52 - 56 m | grey green glauconitic sandy clay |
| 56 - 60 m | grey, slightly glauconitic clay with black inclusions |
| 60 - 65 m | grey sandy clay |
| 65 - 71 m | green glauconitic sandy clay and argillaceous sand |
| 71 - 73 m | green glauconite-rich argillaceous sand with black sand inclusions |
| 73 - 75 m | argillaecous and less glauconitic |
| 75 - 83 m | grey heavy clay |
| 83 - 112 m | grey heavy clay with some glauconite |
| 112 - 114 m | glauconite- and shell-rich sand |
| 114 - 120 m | grey glauconitic very fine sand, fossil-rich (shells and *Nummulites variolarius*), with stone layer at 114 m. At 117 m : rolled *N. laevigatus*. |
| 120 - 123 m | grey green medium coarse sand |
| 123 - 129 m | grey green glauconitic sandy clay with sandstone layers |
| 129 - 131 m | fossil-rich grey green glauconitic sandy clay |
| 131 - 135 m | grey green glauconitic sandy clay |
| 135 - 149 m | grey green glauconitic medium coarse sand |
| 149 - 151 m | brown glauconitic sandy clay |
| 151 - 163 m | green glauconitic sandy clay |
| 163 - 165 m | grey glauconitic clay |
| 165 - 184 m | grey green glauconitic very fine sand with shells and *Nummulites planulatus*. |

*Interpretation*

| | |
|---|---|
| 0 - 5 m | Quaternary |
| 5 - 36 m | Boom Formation |
| 36 - 56 m | Zelzate Formation |
| 56 - 114 m | Maldegem Formation |
| 114 - 120 m | Lede Formation |
| 120 - 149 m | Vlierzele Formation |
| | 120 - 123 m : upper sand unit |
| | 123 - 135 m : middle sandy clay unit |
| | 135 - 149 m : lower sand unit |
| 149 - 165 m | Ieper Formation, Merelbeke Member |
| 165 - 184 m | Ieper Formation, Egem Member |

**Kruibeke (42E314)**

| | |
|---|---|
| 0 - 1 m | dark brown sand |
| 1 - 27 m | grey clay with septaria beds |
| 27 - 48 m | fine sand with glauconite and clay beds |
| 48 - 98 m | alternation of heavy clay, silt and sandy clay, occasionally with glauconite |
| 98 - 103 m | grey very fine sand with fossils and stone layers |
| 103 - 112 m | medium sand, glauconitic, with stone layers |
| 112 - 122 m | very fine argillaceous sand with stone layer (115 m) |
| 122 - 131 m | medium sand, glauconitic, with clayey sand (129 m) and coarse sand at the base (130-131 m) |
| 131 - 135 m | brown glauconitic sandy clay |
| 135 - 145 m | grey glauconitic clay |
| 145 - 148 m | grey clay and *Nummulites planulatus* |
| 148 - 156 m | green grey very fine glauconitic sand |

*Interpretation*

| | |
|---|---|
| 0 - 1 m | Quaternary |
| 1 - 27 m | Boom Formation |
| 27 - 48 m | Zelzate Formation |
| 48 - 98 m | Maldegem Formation |
| 98 - 103 m | Lede Formation |
| 103 - 131 m | Vlierzele Formation |
| | 103 - 112 m : upper sand unit |
| | 112 - 122 m : middle sandy clay unit |
| | 122 - 131 m : lower sand unit |
| 131 - 148 m | Ieper Formation, Merelbeke Member |
| 148 - 156 m | Ieper Formation, Egem Member |

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# LITHOSTRATIGRAPHY OF THE EGEM MEMBER (YPRESIAN) SOUTH-EAST OF THE GENT AGGLOMERATION (BELGIUM)

**I. BOLLE & P. JACOBS**[1]

For the construction of the southern part of the Ring-canal around Gent and the Merelbeke lock, an intense soil investigation programme was carried out in the 1940's, consisting of cable-tool drilling with disturbed and undisturbed sampling and of cone penetration tests. The results of these investigations showed the Egem Member (Yd of the geological map) between the Aalbeke (Yc) and the Merelbeke Member (P1m) to be characterized by an alternation of fine sandy and clayey sediment packages (1).

Between 1975 and 1990 a great number of deep cone penetration tests (up to 30 m) were carried out for the soil mechanical maps of the Gent region. Especially the cone resistance versus depth logs confirmed the alternation of the fine sandy and clayey units within the Egem Member (fig. 1). Laboratory analyses (grain-size e.g.) of both disturbed and undisturbed samples enabled the division of the Egem Member into three sandy and three clayey deposits (2, 3, 4).

Hydrogeological investigations in the 1980's with direct rotary drilling and geophysical borehole logging to characterize the different aquifers, confirmed the alternation of sandy and clayey layers within the Egem Member (5, 6). Especially resistivity and point-resistance logging showed very characteristic patterns (fig. 2).

Cross-sections, particle size distribution curves, plasticity index versus liquid limit diagrams, cone penetration tests and borehole logs led to the following division of the Egem Member southeast of Gent (from bottom to top):
- unit Yd1c: alternation of thin stiff clay layers and fine sandy clay layers (perhaps to be correlated with the Kortemark Member); thickness up to 15 m
- unit Yd2: very dense packed fine sand with glauconite; very high cone resistance values; thickness of about 5 m
- unit Yd3: 1 to 2 m thick stiff clay
- unit Yd4a: up to 10 or 15 m fine sand with glauconite and shells (Nummulites)
- unit Yd4b: sandstone layer of about 0,5 m thick
- unit Yd5: stiff clay to sandy clay; thickness about 3 m
- unit Yd6: fine sand with glauconite and shells, up to 10 m thick.

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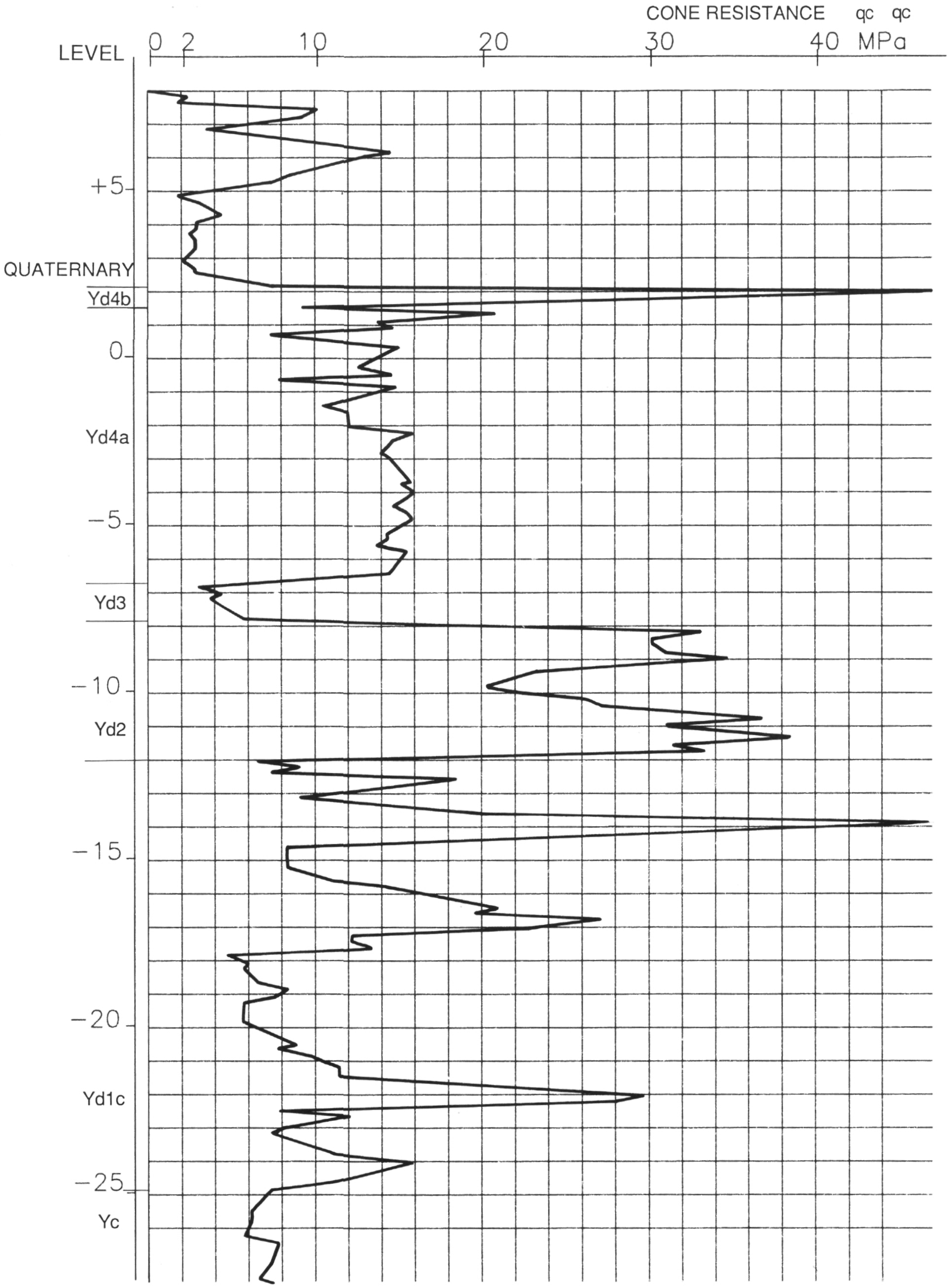


**Figure 1.** Cone penetration test in the Egem Member.

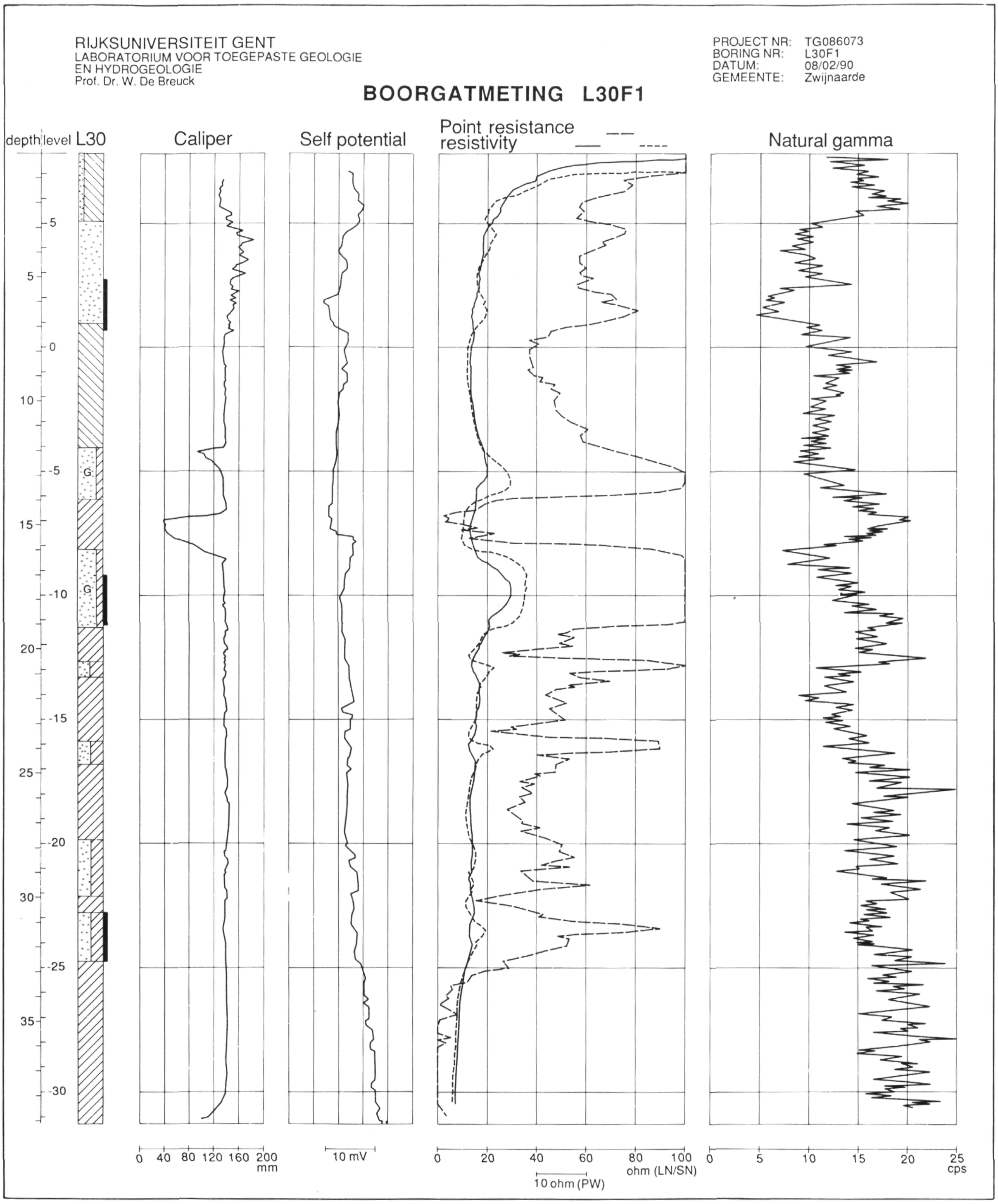


**Figure 2.** Borehole logs in the Egem Member.