

THE EVOLUTION OF THE GRAIN-SIZE DISTRIBUTION IN THE SEDIMENTS OF THE IEPER FORMATION IN BELGIUM

by

S. GEETS

(with 3 figures)

ABSTRACT

The grain-size distribution of many sediments of the Ieper Formation has been thoroughly determined in order to establish a lithostratigraphic scheme of that deposit. The base of the formation, the Mont-Héribu Member, consists of a very-fine-sandy, coarse silt to coarse-silty, fine sand: that facies becomes more important to the east and the north-east of the Belgian Basin.

The lower part of the Flanders Member is mostly composed by very-fine-silty clay. It is followed by a heterogeneous fine-silty sediment, even with sandy intercalations in the southern part of the basin: the heterogeneity decreases to the north. The top of the member consists again of a very-fine-silty clay.

A silty transition sediment with a sudden appearance of a rather important sand fraction, is already reckoned to the Egem Member: it passes into a (clayey) very fine sand and even, near the contact with the sediments of the Mont-Panisel Formation, into a fine sand.

Key words: Tertiary, Lower-Eocene, Sedimentology, Grain-Size-Distribution, Lithostratigraphy.

SAMENVATTING

De korrelgrootteverdeling van vele sedimentmonsters uit de Formatie van Ieper werd nauwkeurig bepaald om een lithostratigrafisch schema van deze afzetting op te stellen. De basis van de formatie, het Lid van de Mont-Héribu, bestaat uit een zeer-fijnzandige, grove silt, tot grofsiltig, fijn zand: dit faciës wordt belangrijker naar het oosten en het noordoosten van het Belgisch Bekken.

Het onderste deel van het Lid van Vlaanderen bestaat vnl. uit zeer-fijnsiltige klei. Daarop volgt een heterogeen fijnsiltig sediment, zelfs met zandige interkalaties in het zuidelijk deel van het bekken: de heterogeniteit vermindert naar het noorden. De top van het lid bestaat opnieuw uit een zeer-fijnsiltige klei.

Een siltig overgangssediment, waarin plotseling een tamelijk belangrijke zandfractie optreedt, wordt reeds bij het Lid van Egem gerekend: het gaat naarboven toe over in een (kleiig) zeer fijn zand en zelfs, nabij het contact met de sedimenten van de Formatie van de Mont-Panisel, in een fijn zand.

Sleutelwoorden: Tertiair, Onder-Eoceen, Sedimentologie, Korrelgrootteverdeling, Lithostratigrafie.

RESUME

La distribution granulométrique de beaucoup d'échantillons de sédiments de la Formation d'Ypres a été déterminée avec précision afin d'établir un schéma lithostratigraphique de ce dépôt. La base de la formation, le Membre du Mont-Héribu, consiste en un silt grossier, très finement sableux ou un sable fin, grossièrement silteux: ce faciës gagne en importance vers l'est et le nord-est du Bassin belge.

La partie inférieure du Membre des Flandres est principalement constituée d'argile très finement silteuse. Elle est couverte par un sédiment finement silteux hétérogène, qui contient même des intercalations sableuses dans la partie sud du bassin: l'hétérogénéité diminue vers le nord. Le sommet de ce membre consiste de nouveau en une argile très finement silteuse.

Un sédiment de transition silteux, avec une importante fraction sableuse, est déjà inséré dans le Membre d'Egem: il passe vers le sommet en un sable très fin (argileux) et même, vers le contact avec les sédiments de la Formation du Mont-Panisel, en un sable fin.

Mots-clés: Tertiaire, Eocène inférieur, Sédimentologie, Granulométrie, Lithostratigraphie.

1. INTRODUCTION

The Ieper Formation, especially the very important clayey section, has long time been held for a rather homogeneous deposit. GULINCK (1967) however recognised some different units in it and pointed to the increase of the sand fraction towards the eastern part of the basin. DE MOOR and GEETS (1975) made a further subdivision of the Ieper Formation from outcrops and wells, mainly from northern Hainaut and southern West- and East-Flanders. This paper deals with an extension of that study.

About 800 sediment samples from more than 20 wells and 35 outcrops (fig. 1) have been granulometrically analysed through sieving (fraction $> 50 \mu\text{m}$) and sedimentation technique. In order to get a complete definition of every type of sediment in the Ieper Formation the characteristics of the grain-size distribution have been determined through different methods: detailed nomenclature (GEETS, 1985), granulometrical parameters, several types of curves.

The lithostratigraphic subdivision, used in this paper, has been established by the Subgroup Lithostratigraphy and Maps of the IGCP Program 124 (Compiler KOCKEL, 1980).

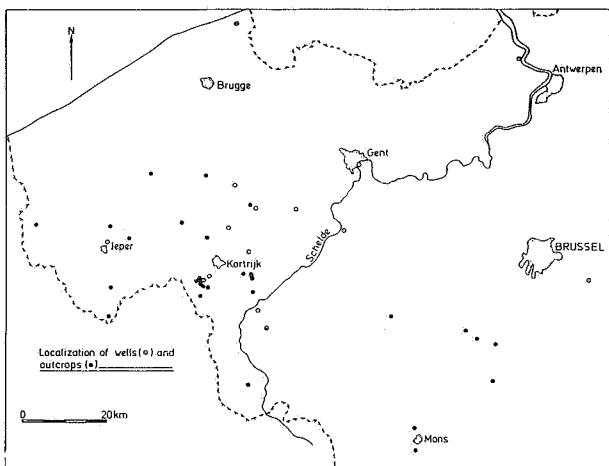


Fig. 1

Localization of wells and outcrops

2. THE MONT-HERIBU MEMBER

The base-sediments of the Ieper Formation in Belgium have been described in detail from outcrops in the vicinity of Mons (DE CONINCK et al., 1983) (fig. 3, unit 2). The member reaches there a thickness of 4 m and is composed of very-fine-sandy coarse silt to coarse-silty, fine sand.

The same kind of sediments have been studied from the boreholes in Molembaix, Pottes, Ooigem, Tielt, Kallo and Knokke (fig. 2, unit 2), at the contact with deposits of the Landen Formation and covered by those of the Flanders Member: their thickness varies from 1 m (Kallo) to 4 m (Knokke and Tielt). The member consists there in a clayey,

coarse-or-fine-silty, fine or very fine sand to a clayey, very-fine-sandy, coarse silt (Knokke).

The average mean diameter, \bar{x} , amounts to 5,5 in the south of the Belgian Basin; it increases in the center (Ooigem, Tielt, $\bar{x} = 4,5$), whereas the sediment becomes again finer ($\bar{x} = 6,2$) in the northern wells of Knokke and Kallo.

With regard to the type-locality near Mons, the facies becomes more important to the north-east: it reaches 4 m at Ecaussines-Lalaing (on Tournaisian limestone), 7 m at Quenast and 10 m at Bierghes (fig. 3, unit 2) (in both places on intrusive rocks). The sediment there is composed of (clayey) very-fine-sandy coarse silt ($\bar{x} = 5,6-5,95$).

In all exposures of this member, the sand-fraction decreases from bottom to top. At the Mont-Héribu both the clay- and silt-fraction increases, in Mons-Ghlin, Quenast and Bierghes only the silt-fraction, whereas in Lessines the clay-fraction becomes more important.

In the Molembaix and Pottes wells, the grain-size distribution stays steady within the member; at the top, within one meter, the sand-fraction disappears, whereas the silt- and clay-fractions double. The same phenomenon is observed in Ooigem, but already from the base on the sand-fraction slowly decreases, only in favour of the clay-fraction. In Tielt and Kallo the sand-fraction disappears over 2 m at the top of the member, whereas the clay-fraction rapidly increases, less the silt-fraction (fig. 2, unit 2).

Most of the sediments show the characteristics of deposition in the transition zone between the shoreface and the shelf. Nevertheless, the alternation of sandy and muddy laminations, which locally appear, may suggest some tidal influences.

3. THE FLANDERS MEMBER

This member constitutes a thick deposit, more than a hundred meters in a large part of the basin. It is composed of very fine-grained clayey and silty sediments. It can further be subdivided in three units, which are best recognised in northern Hainaut and southern West-Flanders. Northward the differences are not as sharp, although three different kinds of sediment are still present.

3.1. The lower unit of the member is formed by a very homogeneous deposit, largely consisting of very-fine-silty clay, with some minor intercalations of coarse-silty clay or clayey, very fine silt.

It only crops out in the northern part of Hainaut, where it covers the sediments of the Mont-Héribu Member and has a thickness of 10-16 m. It has also been found in more northward boreholes, where it reaches 32 m (Ooigem) 24 m (Tielt) and 20 m (Kallo) (fig. 2, unit 3.1.).

At the Knokke well it is extremely well developed and a 106 m of the same homogeneous deposit is found (fig. 2, unit 3.1.).

To the east we can follow these sediments till a line, going from the western vicinity of Brussels till the Antwerp Campine.

They present the facies of a mud shelf.

3.2. The former unit is covered by a rather heterogeneous sediment complex, which crops out in some parts of northern Hainaut and southern West-Flanders: its thickness reaches here nearly 40m. It can be followed in the boreholes to the north, where the thickness varies from 56m in Ooigem, 41 m in Tielt, to 94m in Kallo (fig. 2, unit 3.2.). The average texture of the sediment is a clayey medium silt.

Nevertheless, in the region of Kortrijk a larger variability in grain-size distribution can be noted. The unit starts with a clayey, coarse or medium silt, which contains, on an average, only 21 % clay: at its top this sediment, which reaches nearly 10m, contains some sand fraction. This lower part is covered by clayey, medium or very fine silt (more than 10m thick), without any trace of sand, but with more than 40 % clay. It is followed there by another 10m of medium silt or clayey medium silt, with only 25 % clay fraction, but with layers, up to 1,5m thick, containing 10 % fine or very fine sand. The top consists of a very-fine-silty clay or a clayey, coarse or very fine silt, with averagely more than 50 % clay, but with thin layers, containing up to 10 % fine and very fine sand.

Just north of that region, at the borehole of Ooigem (fig. 2, unit 3.2.), scarcely two different types of sediment can be distinguished: a clayey, fine to very fine silt appears at the bottom of that zone, growing into a clayey medium silt: there is no trace anymore of a sand addition.

In Tielt remains only a clayey, very fine to fine silt, again without any sand-fraction. In the Knokke well we find the same sediment again, mixed up with the very-fine-silty clay of the top of the member (fig. 2, unit 3.2.).

In Kallo one remarks a relative "coarsening" of the sediment, which consists here of a clayey, medium silt, becoming a clayey, coarse silt at the top, with some sand addition, and even a thin very-fine-sandlayer at 267m (fig. 2, unit 3.2.).

The "coarsening", remarked in the Kallo well probably extends to the east and the sediment passes into the lower north-eastern and eastern facies.

Most of the sediments were deposited at the top of a mud shelf, during a short regression period of the Ypresian-sea. The "sandy" intercalations of the southern and eastern margin, represent, together with some coarse glauconitic layers and shell layers, deposits, brought in from the shore during storm periods.

3.3. The top of the Flanders Member is occupied by a very homogeneous deposit of very-fine-silty clay, without any sand-fraction (fig. 2, unit 3.3.). It crops out in a large part of the Flanders. Its greatest encountered thickness (probably nearly 20m) is found at Ieper and at Knokke (a large part of the 34m very-fine-silty clay and clayey very fine silt). In the region of Kortrijk its thickness reaches roughly 10m, but at Kallo it is reduced to 4m (fig. 2, unit 3.3.).

The reinstallation of the mud-shelf-sedimentation after the short regression was not so extensive as during the deposition of the lower part of the Flanders Member; indeed, we don't find any trace of the very-fine-silty clay back in the region of Aalst and Dendermonde, nor further to the east.

3.4. In comparison with some other deposits of the Belgian Tertiary, which are denominated as formations, the Flanders Member is a very important unit. Since it seems, through the definition of the grain-size distribution, that in a very large part of the basin it is composed of three distinct sediment types, it would perhaps be useful to replace the only "Flanders Member" by three different new members in order to show the rhythmicity of the sedimentation.

4. THE EGEM MEMBER

4.1. Immediately above the very fine silty clay of the top of the Flanders Member, the deposit becomes loaded with a sand-fraction, which occupies more than 5 % of the total sediment (fig. 3, unit 4.1.). It passes from a clayey, coarse silt at the base into a (clayey) very-fine-sandy coarse silt, with a steady increase in sand. Despite the still very fine character, this transition zone is reckoned to the Egem Member, because of the sudden reappearance of a sand-fraction, which can be used as a good limit between the two members. Its thickness ranges from a few meters in most outcrops and wells to an exceptional 25m in the region of Tielt.

4.2. The more sandy part of this member starts with a clayey or coarse-silty, very fine sand (fig. 3, unit 4.2.). It passes into a very fine sand, which is found more to the north, and even into a fine sand, near the contact with the overlying member of the Mont-Panisel Formation.

In the region of Kortrijk, the very-fine-silty clay of the Flanders Member becomes loaded at the top (± 1 m) with very thin layers of clayey very fine sand. It is covered by the same (clayey-) sandy sediment, which higher up passes into a (very glauconitic) fine sand. The "Ypresian"-sands in the region of Peissant show the same grainsize distribution.

5. NORTH-EASTERN AND EASTERN FACIES

In Mol, where the Ieper Formation still has a thickness of almost one hundred meter, roughly two kinds of deposits can be recognised. The lowest 35m consists mostly of clayey coarse silt, with important intercalations of clayey, very-fine-sandy coarse silt (fig. 3, unit 5). The same facies is found at the borehole of Overijse, where, with a thickness of 20m, it forms the only deposit of the Ieper Formation (fig. 3, unit 5). It can easily be compared with the sediments found above the paleozoic and intrusive rocks at Ecaussines-Lalaing, Lessines, Quenast and Bierghes and which, we believe, belong to the Mont-Héribu Member (fig. 3, unit 2).

Fig. 2
 Grain-size distribution of the Ieper Formation
 in different boreholes: Mt. Héribu Member (2),
 Flanders Member: lower clayey part (3.1),
 middle silty part (3.2.), upper clayey part (3.3.).

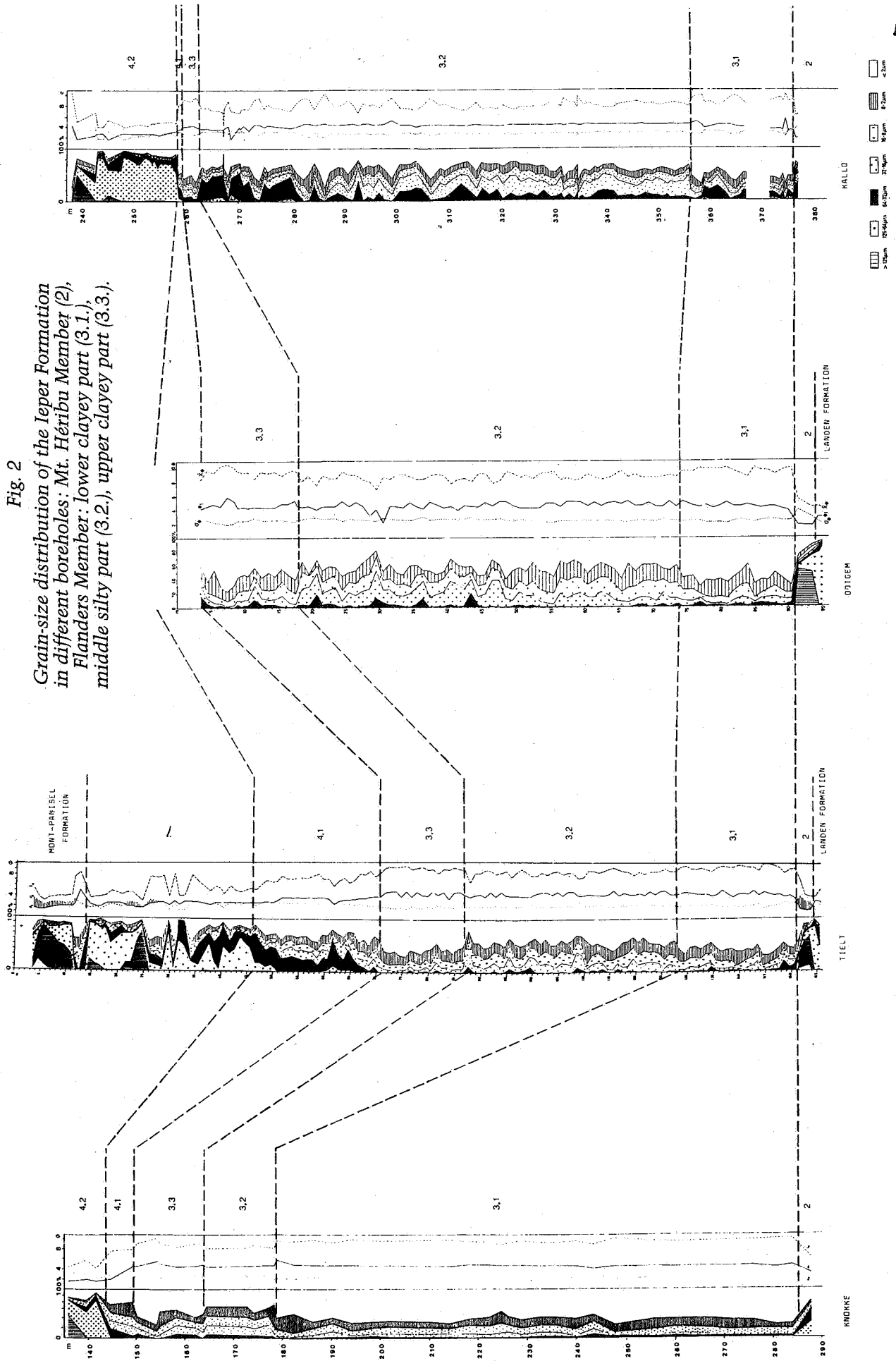
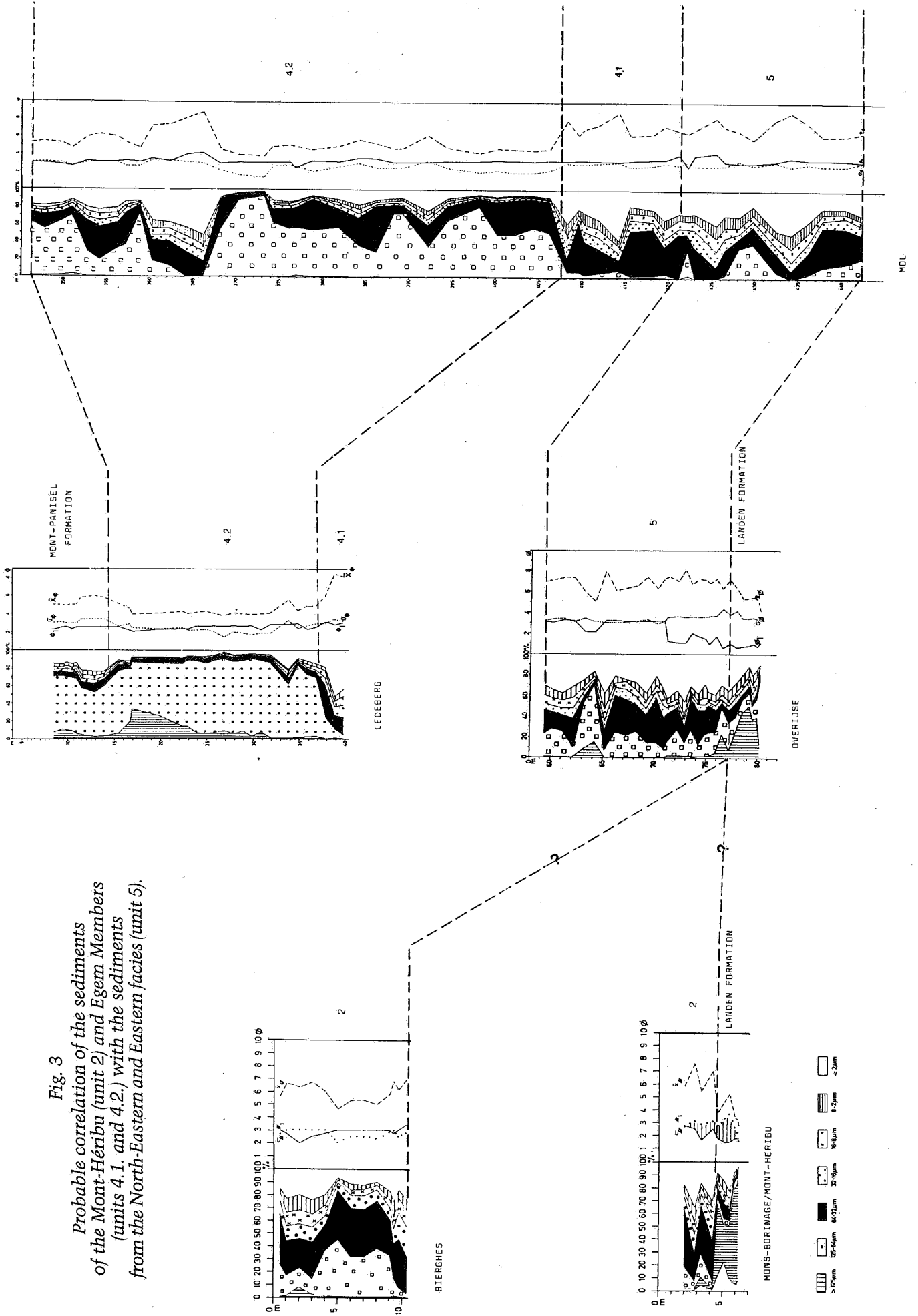


Fig. 3
 Probable correlation of the sediments
 of the Mont-Hérību (unit 2) and Egem Members
 (units 4.1. and 4.2.) with the sediments
 from the North-Eastern and Eastern facies (unit 5).



MOL

These sediments are covered at Mol by a very fine or coarse-silty very fine sand, with some small intercalations of very-fine-sandy, coarse silt and coarse-silty clay (fig. 3, units 4.1. and 4.2.). They have the same characteristics as the sediments of the Egem Member in the outcrop zone in the south of the Belgian basin.

6. CONCLUSION

The sedimentation of the Ieper Formation starts under quiet coastal conditions with the formation of a silt-sandy member, which can be recognised throughout the complete basin. It seems to grow in importance to the east and north-east, where it occupies a large part of the whole formation.

In the south and the center of the Belgian Basin it is rather abruptly followed by a very-fine-silty, clayey member, probably the product of a very quiet shelf-sedimentation. Although, its middle part is characterised by a coarsening of the sediment, even with sandy passages in the southern area and more silty sediments in the other regions.

A reinstallation of a coastal sedimentation is noticed at the top of the Formation, with the deposition of the upper-sandy member. Probably this sedimentary environment has prevailed all the time in the eastern and north-eastern part of the Belgian Basin.

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