

DEPOSITIONAL FEATURES IN OLIGOCENE TIDAL SEDIMENTS OF VALKENBURG, PROVINCE OF LIMBURG, THE NETHERLANDS, WITH THE DESCRIPTION OF A NEW LITHOSTRATIGRAPHICAL UNIT: VALKENBURG DEPOSIT

by

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From an exposure near Valkenburg (province of Limburg, the Netherlands) sediments of Early Oligocene age are described, representing a tidal regressive facies, developing on top of and eroding the Neerrepen Sands. For these tidal sediments the name Valkenburg Deposit is introduced. Stratigraphical, paleo-ecological and paleo-geographical aspects are discussed.

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SAMENVATTING

De oligocene afzettingen van Valkenburg vormen een sleutel voor de stratigrafie van deze afzettingen verder naar het westen. In de omgeving van Tongeren, en westelijk daarvan, worden in het Vroeg Oligoceen de Zanden van Grimmertingen, de Zanden van Neerrepen, de Klei van Henis en de Zanden en Mergels van Oude Biezen onderscheiden. In plaats van de Zanden van Neerrepen ligt in de ontsluiting te Valkenburg een pakket getijde-afzettingen op de Zanden van Grimmertingen. Voor deze getijde-afzettingen is de naam Afzetting van Valkenburg (Valkenburg Deposit) hier ingevoerd. Stratotype is het deel van 4,85 - 10,40 m van de profielbeschrijving van Cadée & Vaessen (1975).

De getijde-afzettingen zijn waarschijnlijk gevormd tussen de stranden en strandwallen van de Zanden van Neerrepen en de kust. De getijde-afzettingen migreren na de Grimmertingen transgressie met de kust mee naar het westen, en snijden zich in de Zanden van Neerrepen in. Bij Valkenburg werd het (dunne) pakket Zanden van Neerrepen geheel opgeruimd.

De transgressie, die leidde tot de afzetting van de Zanden van Neerrepen en de Afzetting van Valkenburg werd beëindigd door een snelle opheffing, zodat geen hoogwad-afzettingen worden aangetroffen. De afzettingen komen boven water te liggen. Tijdens deze periode wordt de Neerrepen Bodem gevormd.

De volgende transgressie, die van de Klei van Henis en de Zanden en Mergels van Oude Biezen, begint met een hoogwad-afzetting, en vertoont daarna sedimentatie in geleidelijk dieper wordend water.

ABSTRACT

The Early Oligocene sands in Belgian Brabant and Limburg are divided into the Grimmertingen Sands, a shelf deposit, and the Neerrepen Sands, a nearshore, beach and barrier deposit. Both deposits represent a facies, that migrates with the coast; the regressive Neerrepen facies overlying the transgressive Grimmertingen facies.

At Valkenburg the Neerrepen facies deposits overlying the Grimmertingen Sands are absent, but deposits with a distinct tidal influence are found instead. The term "Valkenburg facies" was introduced for this type of environment. For its sediments the name "Valkenburg Deposit" (new lithostratigraphical unit) is introduced. Stratotype is the part from 4.85 to 10.40 m of the description of Cadée & Vaessen (1975) of the Valkenburg sequence. The Grimmertingen Sands, the Neerrepen Sands and the Valkenburg Deposit are considered to be members of the Grimmertingen Formation.

The Oligocene sequence consists of the following parts:

- a transgression, characterized by the Grimmertingen facies shelf deposits (Grimmertingen Sands)
- a regression, represented by Neerrepen near-shore and beach deposits (Neerrepen Sands) and overlying tidal deposits (gully systems and a silting-up sequence: Valkenburg Deposit)

- a terrestrial phase, indicated by a fossil soil (Neerrepen Soil)
- a transgression, that starts with supratidal sediments, grading into lagoonal deposits (Henis Clay and Sands and Marls of Oude Biezen).

INTRODUCTION

The road-cut of the new motorway Maastricht-Heerlen, somewhat northwest of the borough of Valkenburg, in the province of Limburg, the Netherlands, provided an excellent section in Early Oligocene and overlying strata.

There are several reasons for a detailed study of these deposits. The depositional environment near Valkenburg is very much different from those encountered more to the west, in Belgium. Moreover, the exposure at Valkenburg is the only exposure east of Tongeren (Belgium) that shows a complete sequence of Early Oligocene strata. The present paper aims at a description of the sedimentary structures observed in the sandy and clayey deposits, at a reconstruction of the paleo-environment, and its implications for stratigraphy.

SITE AND POSITION

The site of the exposure is described by Cadée & Vaessen (1975, see the preceding paper in this issue).

The descriptions below bear on the strata between + 3.75 and 11.00 m in the section published in the paper mentioned above. Fig. 1 represents a part of this section, between 7.70 and 11.00 m.

GENERAL DESCRIPTION

The visible part of the Oligocene sequence of Valkenburg comprises four larger complexes (numbered 1 to 4 from bottom to top):

- complex 4: a complex of clays with intercalations of shell-beds and clay-layers (between 0.00 and 4.85 m in the section of Cadée & Vaessen).
- complex 3: a complex of indistinctly layered fine sands and silty deposits (between 4.85 and 7.70 m).
- complex 2: a complex of gully deposits and clay-beds, with a pebble-bed at the base (between 7.70 and 10.40 m).
- complex 1: a complex of more or less clayey sands without discernable sedimentary structures, but with occasional concentrations of ghosts of Mollusca in a secondary position (below 10.40 m).

SEDIMENTARY STRUCTURES AND DEPOSITIONAL ENVIRONMENT

Complex 1

Strong bioturbation and low clay contents in this lower sand complex (A in Fig. 1) indicate deposition in the shelf-shoreface transition zone. Occasional

burrows in this sediment point to the proximity of the lower shoreface environment.

Complex 2

The deposits of complex 1 are overlain by a series of tidal sediments (see Fig. 1). Directly on top of the shelf deposits occurs a bed of sandpebbles (B in Fig. 1) that can now easily be cut. These pebbles are yellowish green and distinctly greener than the overlying and underlying sands. They are treated in more detail in a special section below. The lower boundary of this pebble-bed shows only slight undulations (see Fig. 4). Above the pebble-bed occurs a series of layered and laminated sands (C in Fig. 1). These sands show common distortions, and fragments of thin, disturbed clay-layers with a thickness up to 3 cm (Fig. 2). The clay remains are slightly concave and intersecting.

Deposit C (Fig. 1) is dissected by large gullies (D in Fig. 1). At the bottom of these gullies a lag deposit of pebbles and clay slabs is found. The latter are oriented according to the lateral accretion of the gully (Fig. 2 left). The gullies are filled with sand and clay layers, that may show mega cross stratification (Fig. 3, 3a). Clay draperies on the foresets are common (Fig. 3a, compare Terwindt, 1971).

The gully system of phase D is covered by a clay layer (E in Fig. 1) that is only locally dissected by gullies of a later phase (F in Fig. 1).

The whole sequence is covered by a continuous clay layer (G in Fig. 1). In the sand H above G (Fig. 1) occurs a discontinuity, with irregularly shaped pebbles of sandy clay, up to 15 cm across. Clay layer I (Fig. 1) terminates the complex. Above I, clayey bands are inconspicuous.

The structures described here, represent the subtidal zone (Dutch: geulbodems) of a tidal environment. The pebble-bed B represents the lag deposit at the base of the migrating channel system (Dutch: geulbodemsediment).

The gullies show rapid movement (hardly rounded clay slabs) and various stages of filling in. Gully sediments are overlain by mud-flat deposits (clay layers), that are sometimes dissected by migrating gullies of a younger phase.

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Fig. 1

Schematic cross section of the upper part of the Grimmertingen Sands (A) and the lower part of the Valkenburg Deposit (B - I) in the Valkenburg road-cut, corresponding approximately with the part from 7.70 to 11.00 m of the description of Cadée & Vaessen (1975). Explanation see text. Numbers in hatched cadres indicate relative position of Figs. 2 - 6.

Schematisch dwarsprofiel door het bovenste deel van de Zanden van Grimmertingen (A) en het onderste deel van de Afzetting van Valkenburg (B - I), ontsloten in de wegensnijding te Valkenburg, ongeveer overeenkomend met het deel van 7,70 tot 11,00 m in de profielbeschrijving van Cadée & Vaessen (1975). Verklaring zie tekst. De nummers in de onderbroken kaders geven de positie aan van de afbeeldingen 2 - 6.

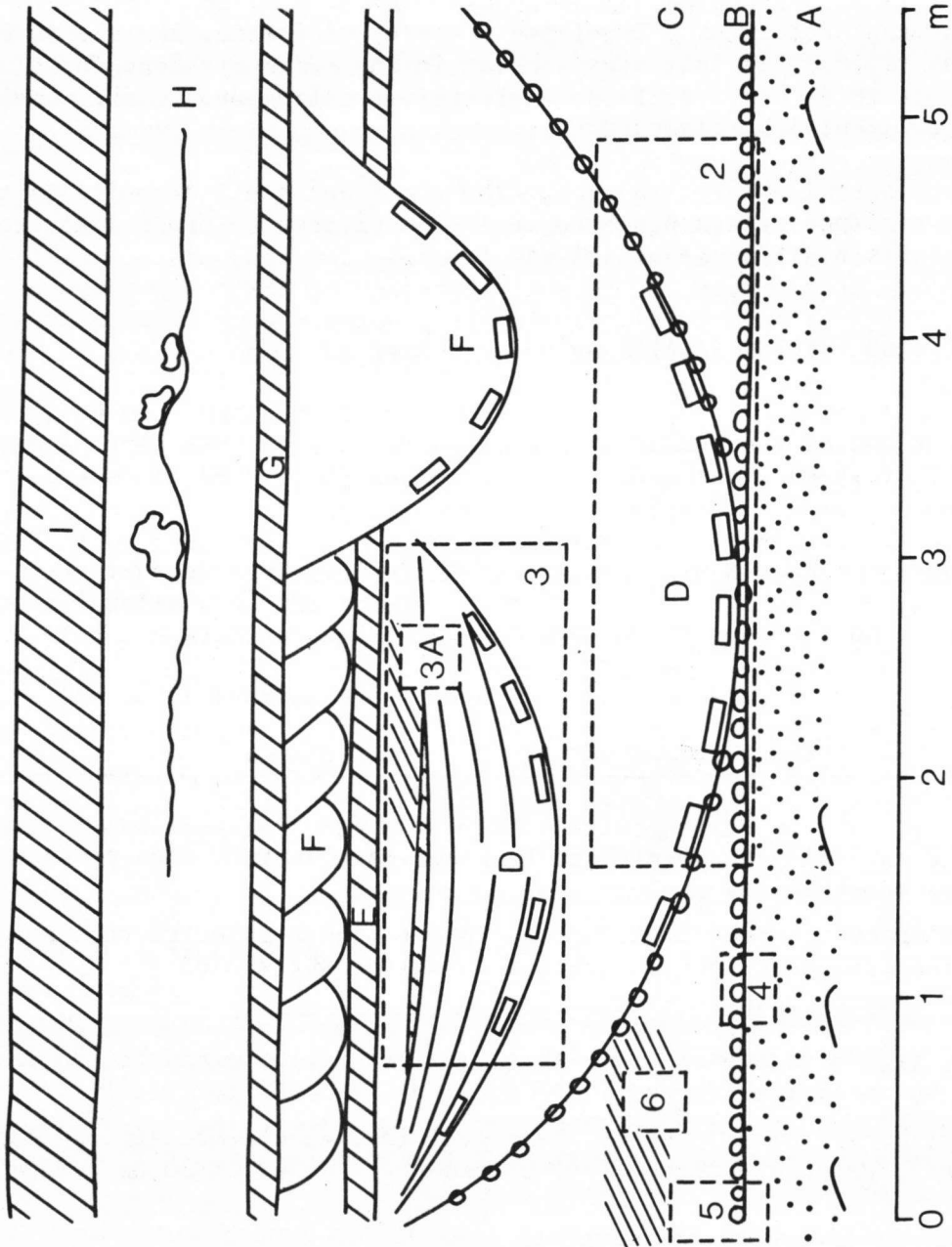


Fig.1

Gullies that erode consolidated mud deposits show clay slabs in their bottom sediments (compare van Straaten, 1964, Fig. 69).

Complex 3 and 4

The structureless fine sands and silty layers of complex 3 probably represent the intertidal zone (Dutch: laagwad).

In the top of complex 3 developed a terrestrial soil, that is easily identified in the field. This indicates a break in the sedimentation. The clay complex 4 on top of this fossil soil should therefore not belong to the same regressive sequence. It will be discussed below.

The whole sedimentary sequence, from the lower shelf deposits to the upper silting-up sequence represents a regressive environment (prograding shore, compare Reineck & Singh, 1973, Figs. 462 and 532).

REMARKS ON PALEOGEOGRAPHY AND STRATIGRAPHY

The sandy members of the Early Oligocene in Belgium and South Limburg, the Netherlands, are known as the Grimmertingen Sands (lower) and Neerrepen Sands (upper). The Grimmertingen Sands were deposited under shelf conditions and are structureless as a result of intense bioturbation.

The Grimmertingen Sands are generally overlain by a deposit that shows pronounced bedding-characteristics that point to deposition in shallow marine and beach environments. In the type area near Tongeren these deposits are called Neerrepen Sands.

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Fig. 2

Section through the basal part of a channel. Clay slabs at left show pronounced lateral accretion orientation.

Profiel door het onderste deel van een geul. In het linker gedeelte vertonen de verspoelde kleilaagfragmenten een laterale aangroeiingsstructuur.

Fig. 3

A smaller gully, higher in the section. This gully is filled with alternating sand and clay layers and occasional sets of about 20 cm.

Een kleinere geul hoger in het profiel. Deze geul is opgevuld met afwisselend zand- en kleilagen, met hier en daar scheve gelaagdheden van ongeveer 20 cm hoogte.

Fig. 3a

Detail of Fig. 3. In the centre thin clay flakes. The upper part shows a megaset migrating over a clay foot.

Detail van fig. 3. In het midden dunne kleiplakjes. In het bovenste deel is een megaset te zien, welke zich verplaatste over een kleilaagje.



FIG. 2



FIG. 3a

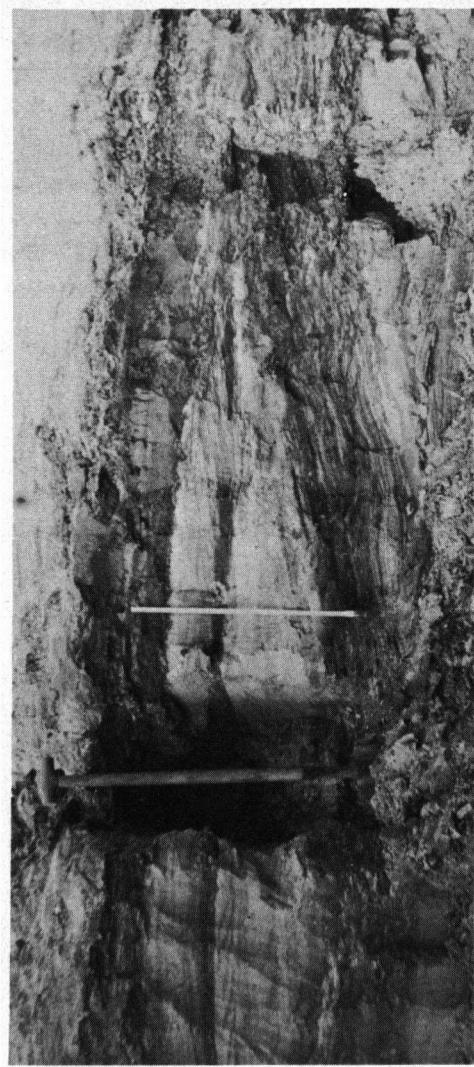


FIG. 3

Winkelmolen (1972) includes the eastern extension of these sands, in the Tongeren area, in the Grimmertingen Formation. He calls these sands the "Grimmertingen upper sandy member" (in contrast to "Grimmertingen clayey fine sandy member") by which the shelf deposits are meant and he speaks of a "Neerrepen type" of deposition.

In the present paper, the terms "Grimmertingen facies" and "Neerrepen facies" will be used for the shelf and the near-shore/beach depositional environments respectively. The terms "Grimmertingen Sands" and "Neerrepen Sands" will be used for the deposits of these environments.

As was already stressed by Winkelmolen (1972), the Grimmertingen/Neerrepen boundary is not a time-stratigraphic unit, but a transition between two facies, that migrates with the coast. The Neerrepen facies migrated seaward at the end of the Grimmertingen transgression (viz. Winkelmolen, 1972, Fig. 17).

In the section of Valkenburg, the lower sands (complex 1) show characteristics of the Grimmertingen facies. Deposits of the Neerrepen facies, however, are not present.

Till now, tidal sediments of Oligocene age have only been found near Vissenaeken, west of Tongeren in Belgium. Here, the tidal channels cut into the Neerrepen Sands. De Raaf & Boersma (1971) mention faint tidal influences in the Neerrepen Sands of the surroundings of Leuven (Belgium).

It is not correct to include the tidal deposits in the Neerrepen Sands, because they represent a different environment. Including them in the Neerrepen Sands would only add to the confusion. Till now, there is no name for the deposits of the tidal facies. We hereby introduce the names "Valkenburg facies" for the tidal environment in the Early Oligocene, and "Valkenburg Deposit" (Dutch: Afzetting van Valkenburg) for the sediments belonging to this facies. This includes the channel deposits and the fining-upwards sequence on top of it. Stratotype is the section from 4.85 to 10.40 m in the description of Cadée & Vaessen (1975), here indicated as complexes 2 and 3.

The Oligocene tidal channel deposits of Vissenaeken in Belgium are covered by Quaternary sediments, and therefore their age could not be established with certainty. Winkelmolen (1972) regarded the channel as time-equivalent with the Sands and Marls of Oude Biezen (occurring at Valkenburg from 0.00 to 0.90 m, see Cadée & Vaessen, 1975). In the exposure near Valkenburg, the tidal deposits are distinctly older than the Henis Clay and the Sands and Marls of Oude Biezen. The Vissenaeken tidal channel probably belongs to the Valkenburg facies.

The horizontal position of the Valkenburg facies is probably between the Neerrepen beaches and barriers, and the shore, so that the tidal channels migrate westward with the shore over the Neerrepen deposits. This explains, why the Neerrepen Soil occurs on Neerrepen facies deposits in the west and on Valkenburg facies deposits in the east.

The thickness of the Neerrepen Sands increases towards the west. They were thinnest in the Valkenburg area, and here they were fully eroded by the tidal systems. Locally in the region of Tongeren and further westward, the tidal channels

only dissect the upper part of the Neerrepen Sands. The greenish sand pebbles in the Valkenburg pebble lag (B in Fig. 1) are probably remnants of the Neerrepen Sands. Some of these pebbles still show clear stratification which is a further argument for an origin from the Neerrepen Sands.

As the Neerrepen facies did not proceed west of the Leuven region in Belgium, where it remained stationary for some time, the Valkenburg Deposit will only occur east of this area (compare Winkelmolén, 1972).

We consider the Valkenburg Deposit to be a member of the Grimmertingen Formation, together with the Grimmertingen Sands and the Neerrepen Sands.

HIGHER STRATA

As was already mentioned, the silting-upwards sequence (complex 3) of Valkenburg is concluded with the development of a soil. This soil is called "Neerrepen Soil" by Buurman (1972) and it is described from the Francart clay-pit near Tongeren, by Buurman & Jongmans (1975). Studies on the Neerrepen Soil in the Valkenburg exposure are still in progress. As supratidal (Dutch: hoogwad) sediments are lacking in the sequence, the Neerrepen Soil represents a terrestrial period after a fairly rapid regression.

After the soil formation, a retrogradational movement of the coast (transgression) resulted in the deposition of the overlying clayey sediments (complex 4).

The depositional environment of these clays is still not clear. In the
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Fig. 4

Pebble bed at the base of the channel systems. Material of the pebbles is slightly greener than that of the adjacent beds. Some partly rounded and more or less distorted clay flakes are visible above the pebble bed.

Zandrolstenen aan de basis van het geulensysteem. Het sediment van deze "pebbles" is iets groener dan dat van de omringende afzettingen. Boven de laag met zandrolstenen zijn enkele gedeeltelijk afgeronde en ten dele misvormde kleilaagfragmenten zichtbaar.

Fig. 5

Contorted bedding above the pebble bed. Arrow points to a structure due to an organism escaping from burial (compare de Raaf & Boersma, 1971, Fig. 6A).

Onregelmatige gelaagdheid boven de laag met zandrolstenen. De pijl wijst naar een structuur, die veroorzaakt werd door een uit een graafgang vluchtend organisme (zie De Raaf & Boersma, 1971, fig. 6A).

Fig. 6

Tabular set, dipping northward. Erosional contact with underlying strata.

Scheve gelaagdheid, hellend naar het noorden. Erosief contact met de onderliggende afzetting.



Fig. 5

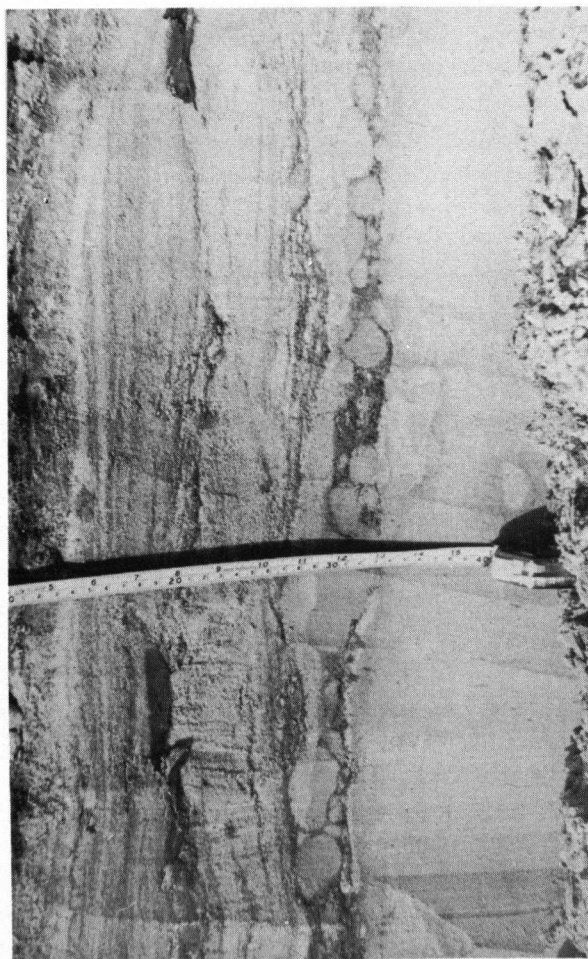


Fig. 4



Fig. 6

Valkenburg section and in sections near Tongeren, however, there are several features that point to deposition of the lower beds in a supratidal environment:

- The Neerrepen Soil always shows plant roots from a later, wetter phase.

Plant roots in the Neerrepen Soil show the accumulation of pyrite (now converted to gypsum and jarosite). This is normal for roots in brackish and marine environments.

- The clay deposits overlying the Neerrepen Soil at Valkenburg show channels that are very similar to those in supratidal deposits (Dutch: hoogwad geulen).

In the clay deposits, immediately overlying the Neerrepen Soil at Valkenburg, sand-filled channels with steep sides occur (clays from 3.85 to 4.85 m, channels belonging to the sand layer between 3.75 en 3.85 m, of the description of Cadée & Vaessen, 1975). Such channels are typical for supratidal deposits. In other environments channel-sides are less steep. The filling-up with coarser material (sand) indicates transgressive circumstances.

- The lower part of the Henis Clay, overlying the Neerrepen Soil in the Tongeren area, does not contain any pollen grains (personal communication Mrs R. P. L. Bremer, Rijks Museum van Geologie en Mineralogie, Leiden).

The sediment that is deposited in the supratidal zone (Dutch: hoogwad) is subjected to oxidation. Oxidation destroys pollen grains in the sediment. When the transgression proceeds, vegetation disappears (migrates with the coast). The inundated sediment is reduced. Further sedimentation at the site occurs in a reduced environment, and pollen in this part of the sediment are preserved.

The boundary between the formerly oxidated sediment and the sediment that was deposited under reducing conditions is indicated by the transition non-pollen/pollen, but this transition can hardly be identified in the field.

These three features indicate supratidal deposition for the lower part of the Henis Clay.

Fig. 7 gives a sketch of the chronological and stratigraphical relation of the sediments described.

SAND PEBBLES

Sand pebbles are a common feature in the lag deposit of the Valkenburg facies. They are also known from certain abrasion surfaces in the Miocene shore deposits of South Limburg.

However, all these sand pebbles are now so soft, that they could possibly be transported and rolled in the present condition. It is therefore probable, that at the time of transport, the pebbles were cemented by carbonates. Such cementation is known, e.g. in so-called "beach rock".

Together with molluscan shells, these cemented pebbles were leached after emersion of these sediments. We might speak now of "pebble ghosts".

CONCLUSIONS

The Early Oligocene sediments of Valkenburg consist of the following facies:

- the Grimmertingen facies (shelf deposits: Grimmertingen Sands)
- the Neerrepen facies (beach and shallow marine deposits: Neerrepen Sands, now eroded)
- the Valkenburg facies (subtidal and intertidal sediments: Valkenburg Deposit).

The sediments of these three facies form together the Grimmertingen Formation. They represent a prograding shore (regressing). The final uplift of the shore is fairly fast (supratidal sediments are lacking) and during a terrestrial period the Neerrepen Soil is formed.

The Henis Clay lies unconformably on the underlying sands; although the lower part of these clays represent a supratidal environment, it is NOT a continuation of the regressive Grimmertingen-Neerrepen-Valkenburg sequence, but, contrarily, the onset of a new transgression. The absence of pollen grains in the lower part of the Henis Clay is the result of deposition in the supratidal zone.

Grimmertingen Sands, Neerrepen Sands and Valkenburg Deposit are NOT time-stratigraphic units: they migrate with the shore (compare Fig. 7).

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Fig. 7

Outline of stratigraphical and chronological relations between Early Oligocene Grimmertingen Sands, Neerrepen Sands, Valkenburg Deposit and overlying strata. Horizontal lines are tentative time-lines. Modified after Winkelmolen, 1972.

Schema van de stratigrafische en chronologische verhoudingen tussen de vroeg-oligocene Zanden van Grimmertingen, de Zanden van Neerrepen, de Afzetting van Valkenburg en de bovenliggende afzettingen. D.m.v. horizontale lijnen wordt getracht de tijd-lijnen aan te geven. Gewijzigd naar Winkelmolen, 1972.

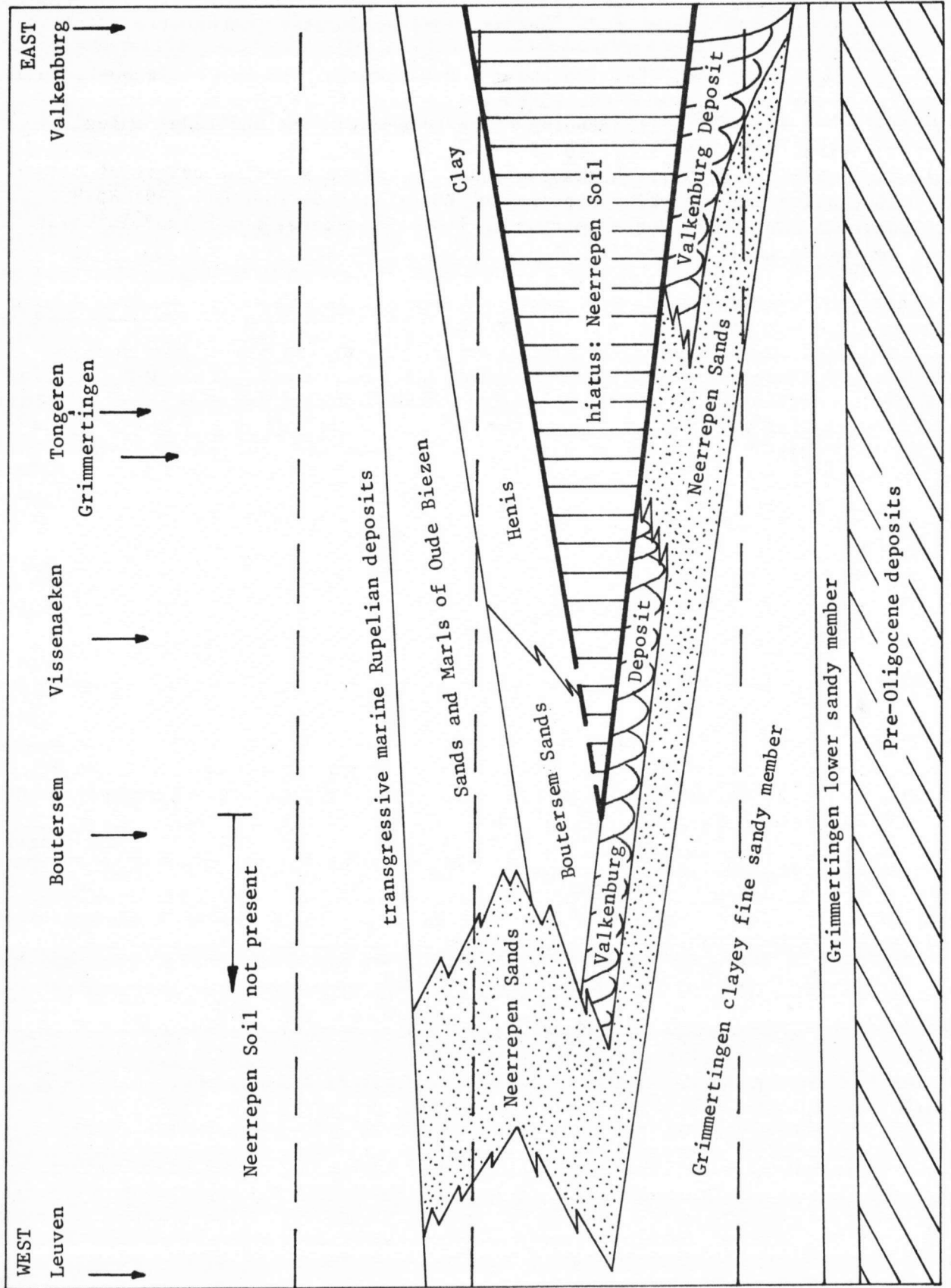


Fig. 7

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