ROYAUME DE BELGIQUE

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**N. VANDENBERGHE and J. VANDENBERGHE**

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# THE STRUCTURE OF THE BOOM CLAY AT RAMSEL

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Samenvatting

De interpretatie van een antiklinale struktuur in de Boomse klei te Ramsel (C. Stevens 1931, 1933, 1938) is gebaseerd op een foutieve interpretatie van boorgegevens. Bovendien wordt de regelmatige struktuur van de Boomse klei in dit gebied aangetoond a.h.v. elektrische sonderingen en boorgegevens. De vervormingen van kleine afmetingen kunnen gezien worden in samenhang met de insnijding en het toesedimenteren van een getijdengeul tijdens het Diestiaan.

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This paper was presented at the occasion of a fieldtrip during the special session of the Belgium Geological Societies in 1974 organised by Prof. Dr. F. Gullentops.
At that time both authors were at the Laboratorium voor geomorfologie en sedimentologie, Katholieke Universiteit te Leuven, Belgium. The junior author (N. V.) was sponsored by the Nationaal Fonds voor wetenschappelijk Onderzoek.

Résumé

Il est démontré que l'anticlinal de Ramsel (C. Stevens 1931, 1933, 1938) est basé sur la mauvaise interprétation d'un sondage.
Au contraire, des sondages électriques montrent que l'allure des couches tertiaires entre Westmeerbeek et Aarschot est régulière.
Les déformations de petite dimension peuvent être interprétées en rapport avec l'incision et le remplissage d'un chenal de marée Diestien.

Abstract

It is shown that the anticlinal structure at Ramsel, proposed by C. Stevens (1931, 1933, 1938) is based on a wrong interpretation of borehole data. On the contrary the structure of the tertiary layers in the area is very regular as shown by electrical sounding. The undulations in the clay are related to the incision and filling up of a Diestian tidal gully.

## An anticlinal structure at Ramsel ?

In northern Belgium the tertiary deposits are gently dipping to the north, north-east. However C. Stevens (1931, 1933, 1938) claimed that between Aarschot and Westmeerbeek an anticlinal structure is present.
At Ramsel the Diest sands are indeed outcropping both to the north and to the south of the younger Boom clay. A main argument for the anticlinal structure is the interpretation of samples in a borehole near the river Demer at Aarschot in which F. Halet (1926) recognized a Rupelian clay (Het Elzen, boring nr 76W/188 of the Geological Survey Brussels). C. Stevens argues that the tectonic structure of the region has an east-west direction and according to him this is reflected in the actual course of the rivers Demer and Grote Nete. C. Stevens mentions that to the north as well as to the south of Ramsel still other boreholes have hit the Boom clay.
The observation of a southwards dip of the clay on a north-south directed exploited wall in a clay pit at Ramsel (Batjes 1958, N. Vandenberghe 1974) is related to the hypothesis of C. Stevens.
The dip amounts to a few degrees. Together with this unusual dip of the clay of Boom, undulations of the clay layers occur (photo 1) ; the clay can even be very heavily disturbed as is seen on the east-west wall of the clay pit.
If there would really be an anticlinal structure at Ramsel, this would be an isolated structure as was already recognized by P. Cogels and O. Van Ertborn (1886).

We intend firstly to comment on the interpretation of the borehole samples used by C. Stevens, secondly to describe the real structure of the tertiary deposits between Westmeerbeek and Aarschot with the aid of geoelectric sounding controlled by borehole data and finally a hypothesis will be formulated about the origin of the disturbances seen in the claypit at Ramsel.

The interpretation of the boring at Het Elzen, Aarschot.

The grain size and the heavy mineral content in three samples from the boring between -44,40 m and -70,45 m below the surface, which part was considered by C. Stevens as having a Rupelian age, were investigated.

- grain size

The samples have a sandy nature. The only Rupelian sands that occur beneath the Boom clay are the Lower Rupelian sands (R1b, Berg sand). Between the clay of Kleine Spouwen and the clay of Boom other sands occur indeed but their occurrence is restricted to the south-eastern part of Belgian Limburg. What is called R2b in the region of Boom and Mechelen (F. Halet 1936, M. Gulinck 1965) probably represents the sandy, silty base of the Boom clay (N. Vandenberghe 1974) or the upper part of the Lower Rupelian sands ; analyses show a clear difference between the Lower Rupelian sands (Fig. 1) and the sandy, silty, base of the Boom clay as the latter contains only very fine grains in the sand fraction.
The grain size analyses of some samples of the Lower Rupelian sands (Fig. 1) have in common a well sorted sand saltation population that is accompanied by maximum 25% of suspension material and in most samples by a surface creep population, of varying importance. The modal size (Fig. 1) is always in the same range ; in the area Leuven-Tienen (Sands of Berg) the modal size is shifted to slightly coarser values. Compared with the grain size distributions of the "Rupelian sands" in the boring at Aarschot (Fig. 2), it is quite evident that these sands do not belong to the Lower Rupelian sands. Hence they are not of Rupelian age because these Lower Rupelian sands are the only sands of Rupelian age found below the clay of Boom in that area.

- heavy mineral analysis.

The heavy mineral content of the "Rupelian sands" from the boring at Aarschot is compared with the composition of the Lower Rupelian sands and the sands of Diest (Table 1).
According to R. Tavernier (1947) the heavy mineral compositions of the sands of Berg in the Land of Waas (Sint-Niklaas) and in Limburg (Berg) are different ; the former containing more garnet, less parametamorphic minerals and the latter very little hornblende if any at all. F. Gullentops (1963) showed that intraformational solution of garnets occurs in the Berg sands around Leuven. The heavy minerals in the Lower Rupelian sands around Mechelen and Boom are comparable to those of the Land van Waas, with lower hornblende amounts however. The sands in the boring are not entirely different from the Lower Rupelian sands ; however they show a higher tourmaline content less

rutile and more parametamorphic minerals. There is no direct agreement with the Diest sands neither since the Diest sands contain lower amounts of garnet and tourmaline.
From these analyses, especially the grain size analysis, we conclude that the "Rupelian sands" from the boring are in fact not Rupelian in age ; therefore the main argument of C. Stevens for supposing an anticlinal structure at Ramsel was based on a wrong borehole interpretation. In the original borehole description by F. Halet, the Rupelian age of the deposit was in fact already quoted with a question mark.

The structure of the Boom clay between Westmeerbeek and Aarschot.

Electrical soundings have been made in a north-south direction between the Demer valley and the Grote Nete ; borehole data complete the profile (Fig. 3).
The Boom clay is characterized by specific resistivities of 8 to 16 Ωm. The normal specific resistivity of the Diest sands varies between 35 and 50 Ωm ; some Diest sands which are rich in glauconite or clayey or smaller grained may have a better conductivity and hence show resistivities between 20 and 26 Ωm. (J. Vandenberghe 1973).
In general the quaternary sediments are characterised by higher specific resistivities (excepted C 14) ; this is especially the case where these sediments are above the ground water level or where coarse sands are involved. Beneath the Boom clay a sediment occurs with specific resistivities between 25 and 49 Ωm ; they are described in borings as grey silty fine sands of Lower Rupelian age. The deepest formation is the sands of Lede, reached in the Demer valley ; its specific resistivity (86 Ωm) is higher than in the overlying tertiary deposits.
The quaternary deposits occur in general as a thin cover, but in this profile they reach greater thicknesses in four broad gullies. The sands of Diest occur at Ramsel hill and to the north near Westmeerbeek ; in the south they occur in a very deep incision which continues into the Hageland ; the Boom clay as well as the underlying sands have disappeared there and the incision reaches into the sands of Lede.
The base of the clay of Boom is very regulary dipping to the north ; to the south of Ramsel the dip amounts $\pm$ 6,2 ‰ whilst it increases slightly to the north (8,5 ‰ ). Consequently there is no anticlinal structure present at Ramsel and it is impossible to find at Aarschot Boom clay or Rupelian sediments at the depth recorded by Stevens (1933) or O. Van Ertborn (1901). The large thickness of the Diest sands at Aarschot is clearly caused by a deep incision as was already recognised by O. Van Ertborn and P. Cogels (1883, 1886). More precisely the incision is caused by tidal currents parallel to the coast (F. Gullentops 1957).
For the sake of completeness it should be reported here that the interpretation of boring results in the subsoil of Aarschot has been a matter of discussion at the last century. For example a borehole at Aarschot was published by O. Van Ertborn in 1878 describing clayey layers till a depth of -19 m. These clayey layers were difficult to interprete (G. Vincent, A. Rutot in O. Van Ertborn 1878). In 1883 O. Van Ertborn and P. Cogels stress that no Boom clay was recognised in that boring, a claim repeated in 1886 ; these authors already express the idea that the Boom clay

at Aarschot is eroded during the Diestian (dénudation Diestienne) ; besides a Rupelian age of these clays in the boring at Aarschot was rejected just because this would have supposed an anticlinal structure to the north of Aarschot.
In 1888 A. Rutot interpreted the clays as Oligocene without giving a definite argument however, no more than O. Van Ertborn who finally in 1901 seems to attribute a Rupelian age to these clays as well.

The southwards dip of the clay and the undulations in the clay at Ramsel.

In the Boom clay around Ramsel compaction occurred already before the Diestian (Lower Pliocene) ; this is proved by the presence of upper to middle miocene sands of the Bolderberg southwards of Aarschot-Diest ; an overburden of a few tens of meters seems reasonable. The top level of the Boom clay in the area to the north of Ramsel is a transgression level of the upper miocene sands of Antwerpen (Fig. 3).
The position of the deformed clays in the pit at Ramsel at the moment of the incision of the tidal gully during the Diestian was almost near the seabottom and just a side of the gully. During the incision a decompression of the clay towards the gully probably took place ; at the lower levels of the incision some clay might have been lost by outflowing into the gully and consequently the clay may have bent down, showing now the gentle southwards dip (photo 1).
Differential compaction, due to the progressing sedimentation in the gully, can have been partly responsible for the undulating deformations on the border of the gully. It should be remembered that a clay consisting of alternating clayey and silty layers, as is the case with the Boom clay (Vandenberghe N. 1974), lends itself very easily to important lateral water flow in the case of compaction. This pore water is under high hydrostatic pressure and it will discharge sidewards of the pressure surplus, causing in this way undulating deformations (photo 2) (K. Terzaghi, R.B. Peck 1967).
During the pre-Weichselian Pleistocene the sands of Diest were partly eroded and the main features of the present relief were shaped.
The resulting relief in the immediate vicinity of the clay pit has not played a role in the deformation of the clay because the Ramsel hill is only the record of the state of progress of the reliefforming processes at this very moment ; so in the past the hill was certainly extending more northwards and we should expect deformed clay in the whole area if the relief played a role.
This is apparently not the case as proved by the undisturbed clay in a clay pit at Herselt about 700 m to the north of the clay pit at Ramsel.

Conclusion

The deformation of the clay of Boom and its apparent southwards dip at Ramsel, seem both to be related to the incision and the filling up of the tidal gully during the Diestian. The precise mechanism of the deformation is not clear however.
The structure of the tertiary layers in the region Aarschot-Westmeerbeek is in general very regular without a conspicuous tectonic influence.

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TABLE I

| | heavy minerals | opaque | alterite | transparent | zircon | rutile | anatase | sphene | brookite | chloritoïde | tourmaline | andalousite | kyanite | staurolite | garnet | epidote group | hornblende |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| borehole Het Elzen, 75W/188 "Rupelian sands" | | | | | | | | | | | | | | | | | |
| 75W 188/ 9 | 0,3 | 77,5 | 2,3 | 20,2 | 15,2 | 8 | 10 | 1 | - | 0,5 | 22,9 | 0,5 | 3,3 | 3,8 | 16,7 | 14,3 | 3,3 |
| 75W 188/10 | 0,2 | 67,6 | - | 32,4 | 25,5 | 5,8 | 6,7 | - | - | - | 23,1 | 1,5 | 3,4 | 5,3 | 20,2 | 6,7 | 1,5 |
| 75W 188/11 | 0,7 | 80,6 | 1,6 | 17,8 | 10,6 | 5,3 | 7,2 | - | - | - | 24,6 | 1 | 3,9 | 3,4 | 21,7 | 12,6 | 9,2 |
| Berg Sand, "Rib Sands" | | | | | | | | | | | | | | | | | |
| Aardebrughoef (Gullentops 1963) | | | | | 8-45 | 10-18 | | 1-15 | | | 3-18 | | 2,5 | | 4-18 | 9-33 | - |
| Berg (Tavernier 1947) | | 42 | | | 26 | 8 | + | - | 1 | - | 27 | 1 | 11 | 3 | 8 | 14 | 1 |
| St.-Niklaas (Tavernier 1947) | | 38 | | | 17 | 9 | 2 | - | - | - | 4 | 1 | 3 | 1 | 18 | 29 | 16 |
| Mechelen 58E - 212/10 | 0,5 | 46,1 | 1,8 | 52,1 | 3,9 | 8,2 | 7,8 | 0,5 | - | - | 9,2 | - | 1 | 3,9 | 20,9 | 29,1 | 15,5 |
| Willebroek, Ruppeltunnel 3 | 0,6 | 52,9 | 1,1 | 46 | 20,5 | 12,5 | 5,5 | - | - | - | 9,5 | - | 3 | 3,5 | 27,5 | 15,5 | 2,5 |
| Willebroek, Ruppeltunnel 10 | 0,4 | 48,5 | 2 | 49,5 | 16,7 | 11,4 | 4,3 | 1 | - | - | 13,8 | 0,5 | 1,9 | 5,7 | 25,2 | 16,2 | 3,3 |
| "R2b Sands" | | | | | | | | | | | | | | | | | |
| St.-Niklaas (Tavernier 1947) | | 26 | | | 25 | 10 | 3 | - | - | - | 2 | - | 1 | - | 25 | 24 | 9 |
| Boom (Tavernier 1947) | | 41 | | | 40 | 27 | 4 | - | - | - | 6 | - | 1 | - | 3 | 17 | 1 |
| Bonheiden-Keerbergen 59W-83/4 | 0,5 | 53,5 | 2,1 | 44,4 | 17,5 | 13,2 | 7,5 | - | - | - | 11,8 | - | 1,4 | 2,4 | 23,6 | 19,8 | 2,8 |
| Diest Sands | | | | | | | | | | | | | | | | | |
| Betekom | 0,1 | 67 | 1 | 30 | 30,1 | 5,8 | 7,7 | 3 | - | - | 10,7 | 3 | 8,7 | 3 | 13,6 | 10,7 | 3,9 |
| Betekom | 0,1 | 39 | 0,7 | 59,3 | 36,7 | 15 | 10,2 | 0,6 | - | - | 7,8 | 5,4 | 6,6 | 1,8 | 1,8 | 12,6 | 1,2 |
| Opitter (Gullentops 1963) | | | | | 52-69 | 11-20 | | 0-2 | | | 6-13 | | 2-10 | | 0,1 | 6-8 | 0-2 |
| Kessel berg (Gullentops 1963) | | | | | 22-53 | | | 0-5 | | | 9-21 | | 7-30 | | 0,8 | 5-21 | 1-24 |

TABLE I. Heavy mineral composition of the "Rupelian sands" in the Aarschot borehole, the Berg or "Rib" Sand, the "R2b Sand" and the Diest Sand.

Fig. 1

Grain-size analyses of Berg or "Rib" Sand.
(nr 1, 2, 3, 4, 5, 6, 7, 11 obtained from the Geological Survey, Brussels).

| nr. | locality | borehole and sample number Geol. Survey | | modal size | |
|---|---|---|---|---|---|
| 1 | Bonheiden | 59W | 88/4 | 126 | µm |
| 2 | Bonheiden | 59W | 133/15 | 100 | µm |
| 3 | Mechelen | 58E | 29/26 | 90 | µm |
| 4 | Grootlo | 59E | 37/5 | 96 | µm |
| 5 | Aarschot-Mechelen | 58E | 212/10 | 89 | µm |
| 6 | Aarschot-Mechelen | 58E | 33/15 | 90 | µm |
| 7 | Aarschot-Mechelen | 58E | 32/21 | 90,5 | µm |
| 8 | Kleine-Spouwen | | | 112,7 | µm |
| 9 | Willebroek Rupel-tunnel | | | 125-135 | µm |
| 10 | Vertrijk (Tienen) | | | 157 | µm |
| 11 | Bonheiden-Keerbergen | 59W | 83/4 | 134 | µm |

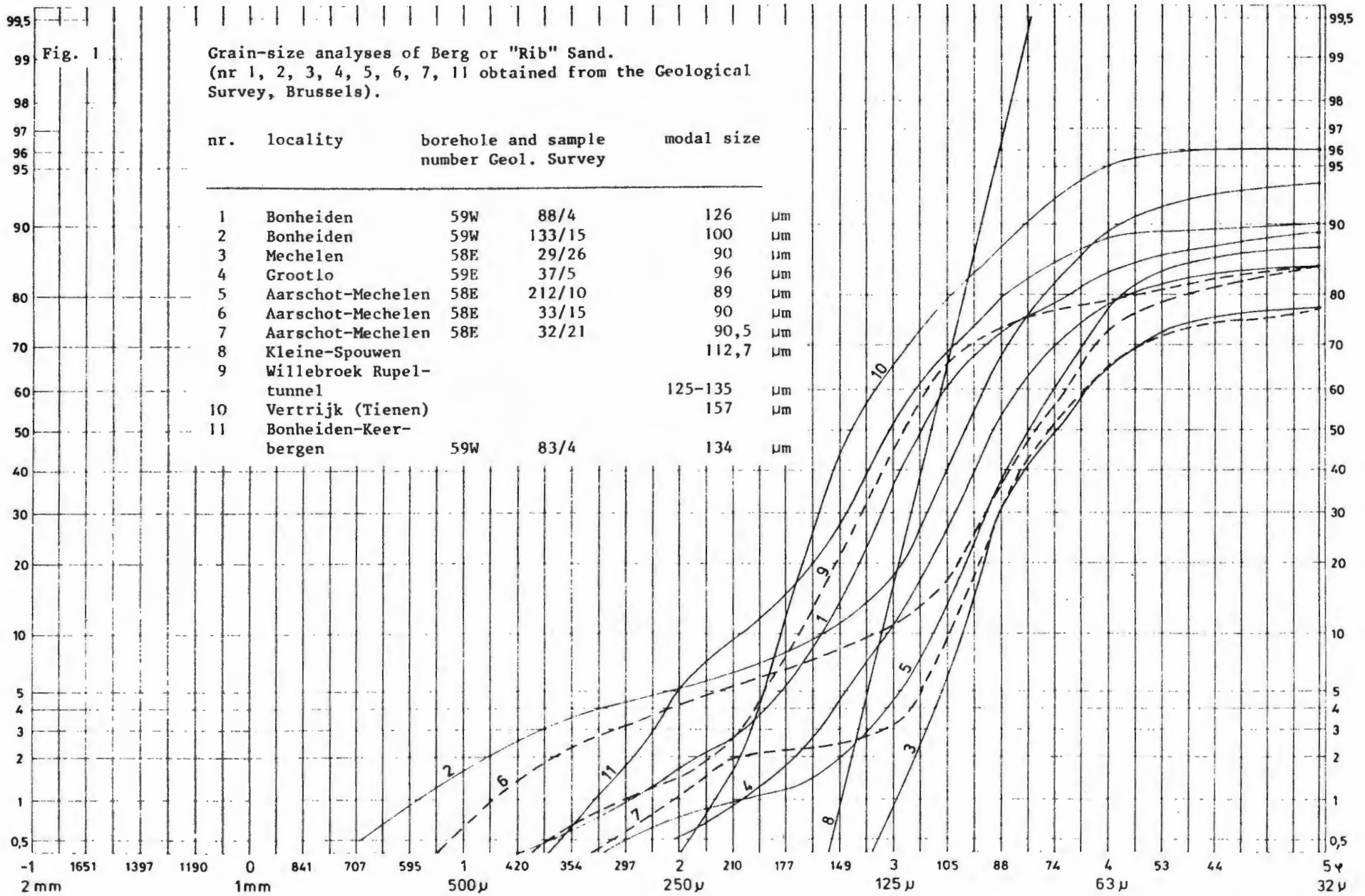

Fig. 2 Grain-size analyses of the "Rupelian sands" in the Aarschot borehole (-44,4 m - -70,45 m).

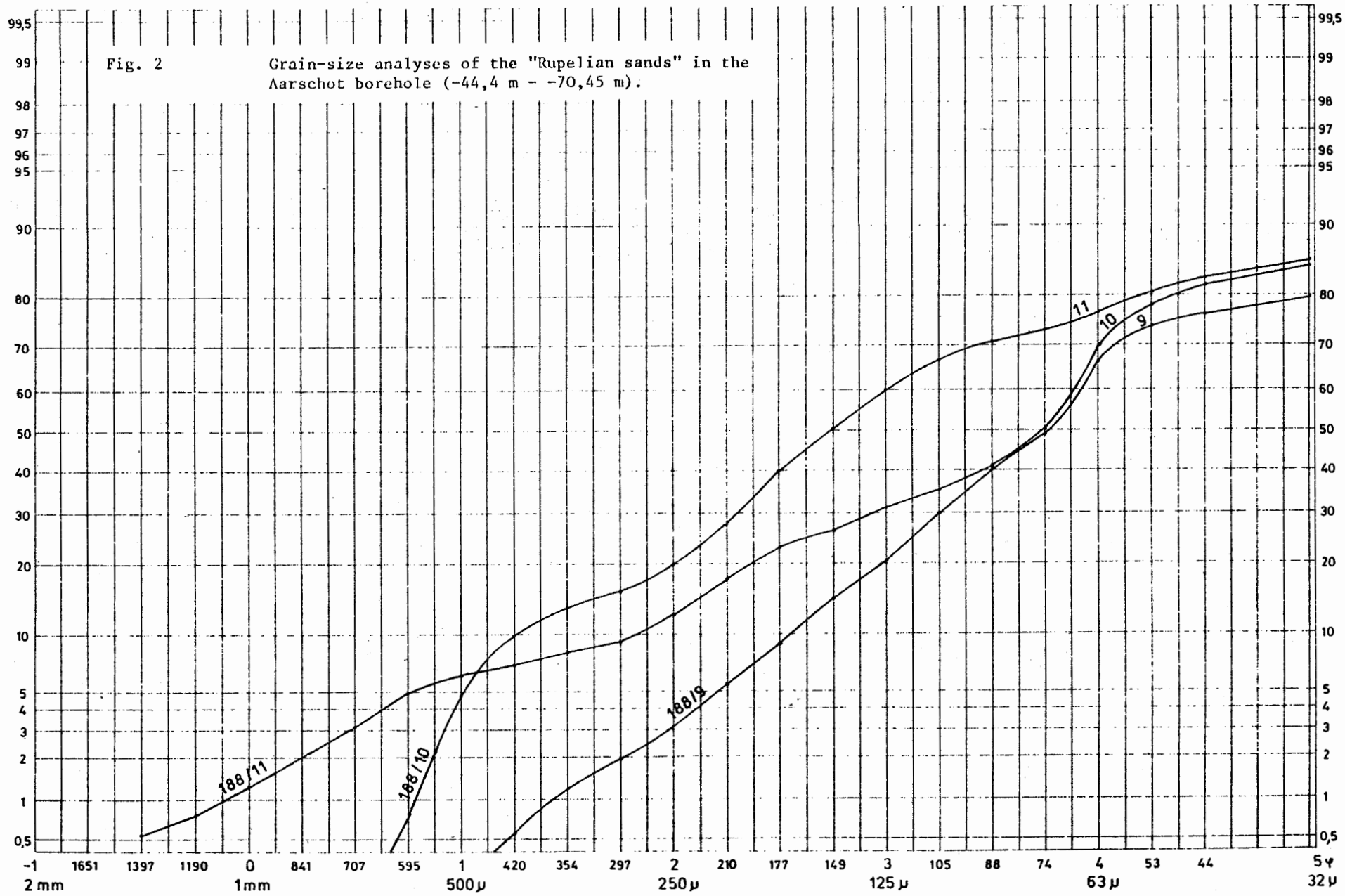

Fig. 3 A profile between Westmeerbeek and Aarschot, based on borehole data (GD, Geological Survey) and geoelectrical soundings.
The clay pit shown in photo 1 and 2 is situated between C12 and C10.

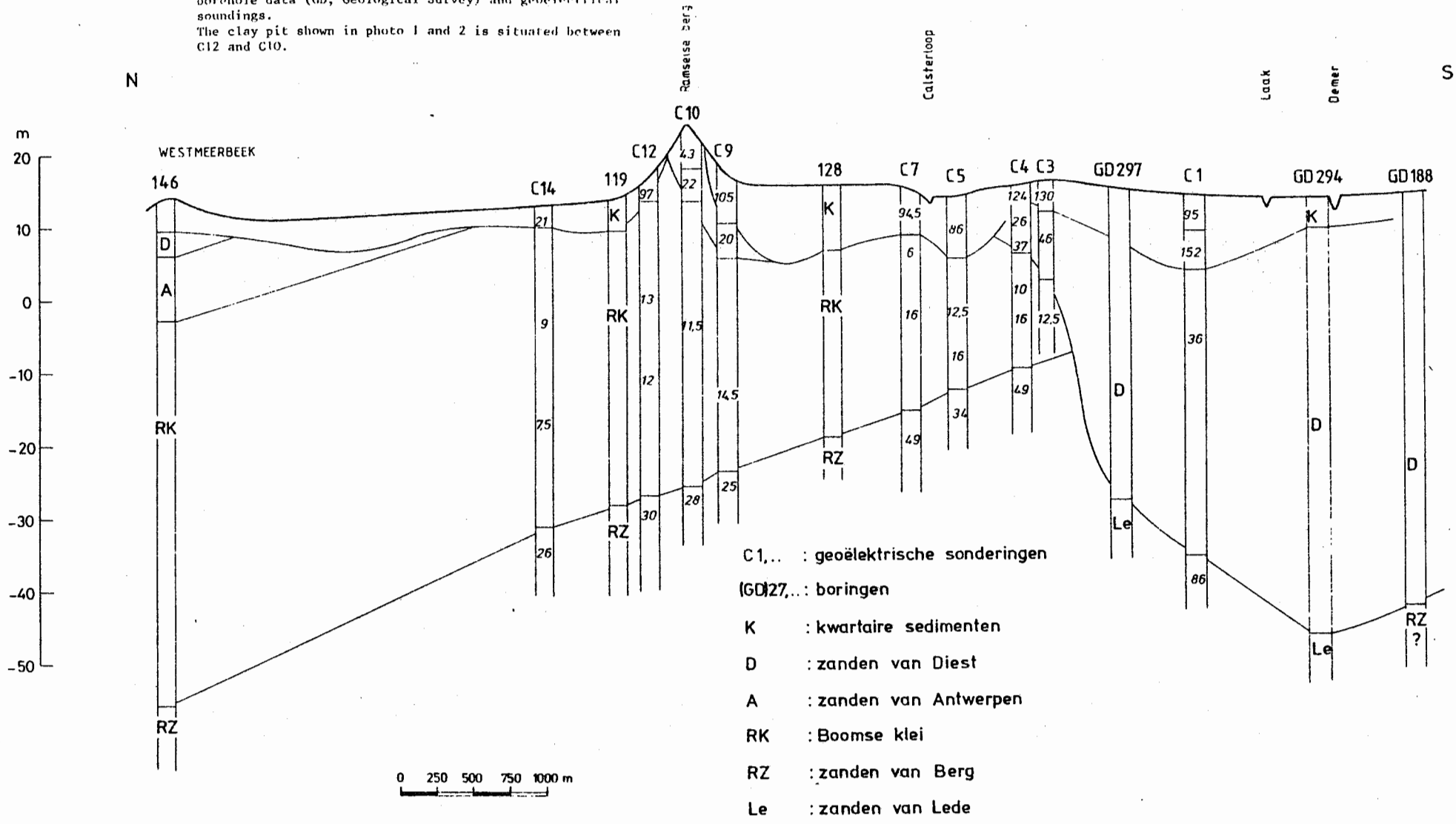

photo 1 Soudwards dipping Boom clay (the south is to the right). The organic matter rich dark layers in the clay show the stratification plane of the clay. Overlying the Boom clay are the Diest sands, eroding the clay to the south.

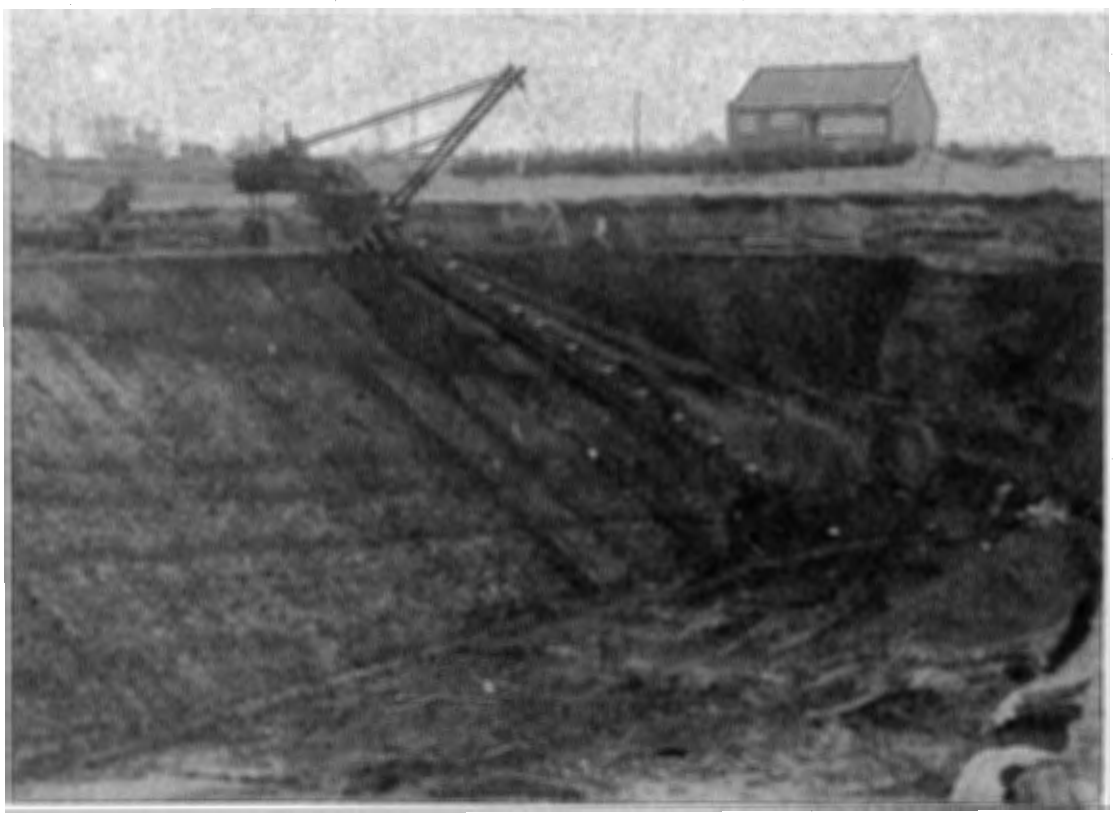

photo 2 Undulations in the Boom clay at Ramsel (the south to the right).