THE SITES OF WEZEP AND OLDEBROEK (PROVINCE OF GELDERLAND. NETHERLANDS)

by

D. P. ERDBRINK

(Netherlands Military Geological Service)

General remarks

Some time ago a paper was published by BROUWER (1954) on the geological interpretation of a vertical section through Pleistocene deposits near the village of Wezep in the northeastern corner of the province of Gelderland, in the central part of the Netherlands. The exact locality [1], known locally as the "Moordenaarshoek" (murderer's corner), is situated on a heath along the edge of a pine forest, which grows on the lower slopes of the northeastern tip of the great Pleistocene pressure ridge or moraine along the western border of the valley of the river Yssel. The locality was described for the first time by BURSCH, FLORSCHÜTZ and VAN DER VLERK (1938) who made an excavation there on the instigation of the late Colonel MALLINCKRODT, an ardent amateur archaeologist. It was believed that the numerous flint objects which could be found in a peculiar kind of boulderclay there and at other localities in the neighbourhood, might be interpreted as artefacts of a primitive, somewhat Clactonian, type; a belief which was also accepted by the present author until some five years ago.

With the object of collecting more data on these somewhat enigmatic phenomena [2], an excavation at approximately the same locality as that described by BURSCH, FLORSCHÜTZ and VAN DER VLERK was made in the autumn of 1948 by the Biologisch-Archaeologisch Instituut of Groningen University (director Professor A. E. VAN GIFFEN) under supervision of Dr. A. BOHMERS

[1] According to information obtained from the authorities of the community (Gemeente) of Oldebroek, to which the village of Wezep belongs, the site is situated in the cadastral section F, number 1859. Owner of this tract of land is Mr J. VAN DER KROL, a timber merchant living at De Bilt (Utrecht). I want to express my thanks to Mr VAN DER KROL for his very helpful and kind cooperation by giving full permission to make the excavation at Wezep on his property. I should also like to thank the authorities at Oldebroek for their cooperation and help in obtaining the necessary preliminary information and in getting the local labourers which were needed for the three excavations.

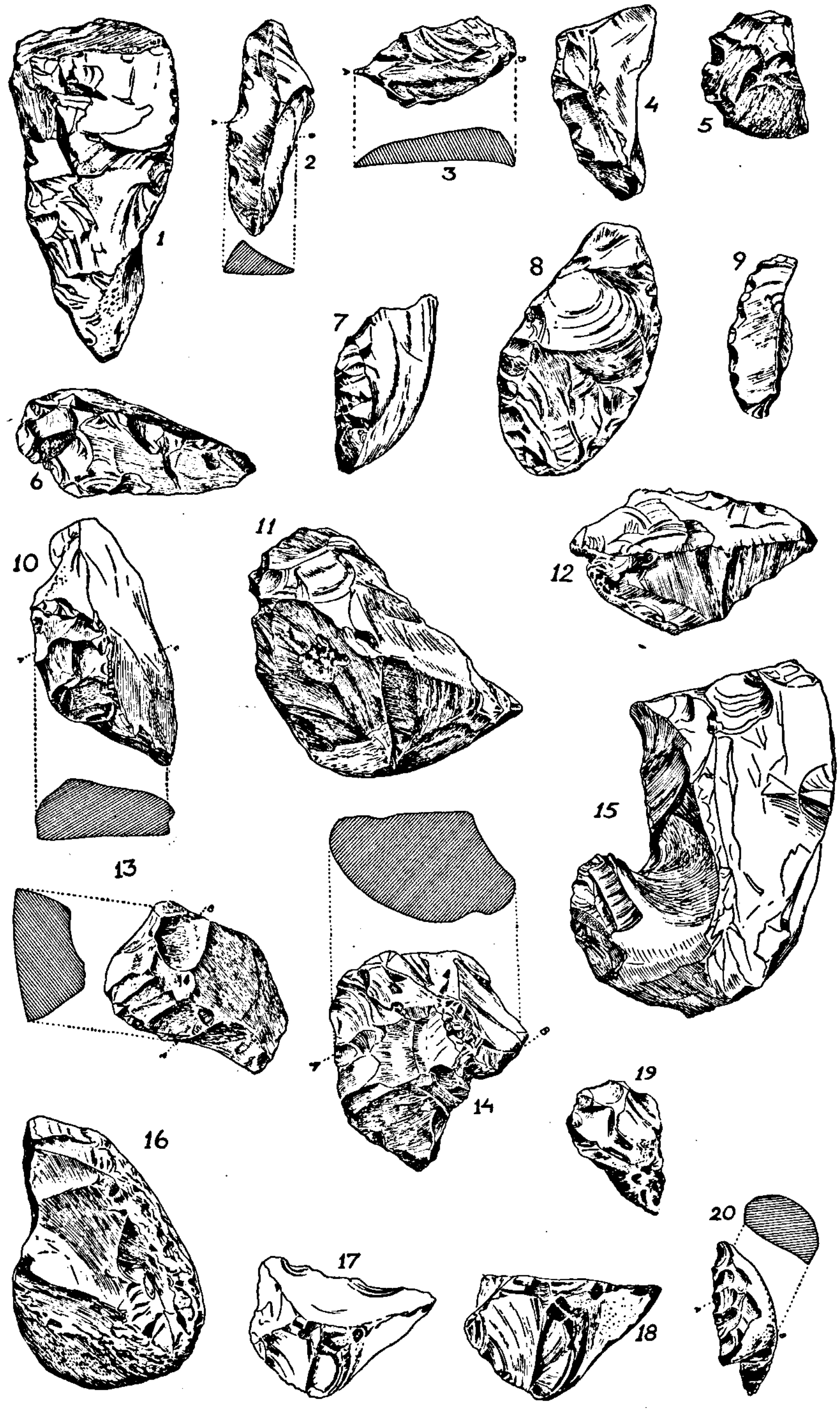
[2] Enigmatic because it seemed hardly possible that artefacts of such a primitive type could occur in such quantities, and without visible signs of having been transported over some distance from older deposits elsewhere, in a boulderclay-like deposit of the Penultimate or Riss glaciation.

PLATE 1.

Pseudo-artefacts from Wezep and Oldebroek.

Figs. 1—6, 8—12: objects from Wezep. 5: seen obliquely from above; 6 and 12: identical objects, seen obliquely and from above.

Figs. 7, 13—20: objects from the Oldebroek artillery range. 17 and 18: identical objects, seen obliquely and from above. All objects 2/5 natural size.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

and the present author. Thanks to the energetic help of the late Colonel MALLINCKRODT two other localities, situated more to the West, on the Oldebroek artillery range, were also excavated. Here again the same flint objects, interspersed in either gravel and coarse sands, or in a loam comparable to that found at Wezep, were recovered. The layer of loam at one of the two Oldebroek localities was found to be much thinner than that encountered at Wezep, although not differing from it in any other aspect.

Photographs of the three sites appear as illustrations in this article.

Archaeological data and facts resulting from the excavations in 1948

The material collected during the 1938 and 1948 excavations (belonging to the collections of the Rijksmuseum van Oudheden at Leiden and to the Biologisch-Archaeologisch Instituut of Groningen University, respectively), together with that in the private collections of the late Colonel MALLINCKRODT, Professor VON KOENIGSWALD (Utrecht University), and the present author, comprises several thousands of so-called flint artefacts. Many of these have been collected as surface finds; the loam that contained them has been, and still is being excavated at the mentioned localities for use as hardening material in the construction of bicycle paths and gravel roads.

Some of the most intrigueing flint objects have been reproduced here as figures 1—20 of Plate I [3]. At first sight their appearance often strikingly resembles that of genuine artefacts. Even hinge-fractures have been encountered (one case is the awl-like object of fig. 3; another, a larger piece collected by Professor VON KOENIGSWALD, is not figured here). Fig. 16 brings to mind the East Anglian "Rostrocarinates". Especially important is the fact that the flaking on these objects has happened in such a manner, that wide angles, and, for the largest part, unfaceted striking platforms (which very often are absent altogether) have resulted. As has recently been remarked by LEAKEY (1953, p. 82) this was formerly regarded as the "hall-mark" of the Clactonian culture, but it is really only evidence of the use of the "block-on-block" technique, also much in use by the makers of implements of other Lower Palaeolithic cultures.

Several inspections of some of the collected material by the Abbé BREUIL and by Dr. Harper KELLEY, of the Musée de l'Homme in Paris, resulted in the expression of serious doubt by both authorities with regard to the artificial nature of the flint objects from Wezep and Oldebroek. It was felt that more probably the objects had been formed and given their present appearance by natural agencies. This point of view was held also by Dr. BOHMERS, who published a short note (1950) on the subject, in which the very important observation was made that almost in every instance a little scar could be detected on the surface of each flake of the retouche. The presence of this scar was explained (oral communication by Dr. BOHMERS) by assuming that, after the moment of impact of one block against the other, a small flake was severed from the main block at the striking point as a result of repercussional forces in the block receiving the blow. Allowing for the fact that such a minute flake may also have been formed when a Palaeolithic toolmaker struck a block of flint with too much force, it nevertheless is perfectly understandable that this little flake would fall away instantly

[3] I want to thank Miss COR ROEST for the exact way in which she has made the drawings of these flint objects.

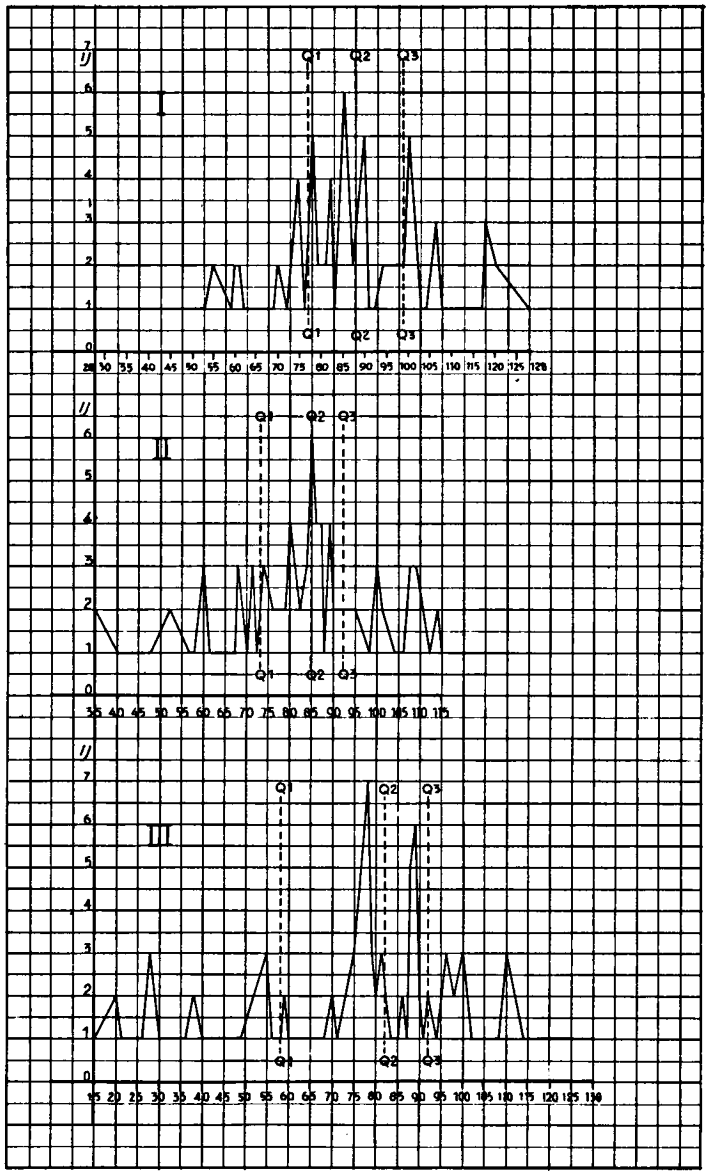


Fig. 1. Measurements of the angle platform-scar, set out horizontally against the occurrence of the number of similar angles, which is set out vertically (along the Y-axis) for material from:

I. Oldebroek (Rijksmuseum van Oudheden, Leiden; coll. BURSCH, MALLINCKRODT, a. o., 1938); 24 artefacts were measured in order to obtain 100 measurements;

II. Wezep (Rijksmuseum van Oudheden, Leiden; coll. BURSCH, MALLINCKRODT, a. o., 1938); 38 artefacts measured;

III. Wezep (Biologisch-Archaeologisch Instituut, Groningen University; collected during the excavation in 1948); 25 artefacts measured.

Q 1, Q 2, Q 3: quartile lines.

and that it would not leave a trace on the surface of the retouched area of the flint implement. On the other hand, in a naturally "made" flint pseudo-artefact, the minute repercussion flake would often remain near the position of its origin if the block of flint was imbedded in some surrounding material such as clay or loam. Subsequent movement, even very little of it, of the parent block of flint would then result in a scratch made by the minute flake on the retouched flake surface of the block which lay opposite it. And exactly this phenomenon could very often be observed in the flints from Wezep and Oldebroek, thus indicating that their origin most probably has been due to natural causes.

A second method which may give a clue to the answer to the question whether these collected objects have been formed in a natural or in an artificial manner, is that used and published by BARNES (1939) [4].

This method has been followed by the present author while measuring material collected at Wezep in 1938 and 1948 and at Oldebroek in 1938. The three graphs (fig. 1) giving the combination of measurements of the angle between platform and scar, show clearly that the decisive quartile line, Q 3, lies beyond 90 degrees, thus indicating that the flint objects have been formed by natural fractures (BARNES, op. cit.). The observations made by BOHMERS, and the conclusion reached by him, are fully supported.

It seems therefore, that the belief that these flint objects might be very primitive man-made tools, although occurring in a stratigraphical level which is much younger than appears to be feasible for such primitive objects, is no longer tenable; it should be abandoned.

Geological data obtained from the excavations at Wezep and Oldebroek in 1948

A somewhat simplified view of the section made in 1948 at Wezep appears here as Plate 2 [5]. It may be seen that the division of the different

[4] According to BARNES (op. cit.): "... the angle platform-scar is the dihedral angle formed by the intersection of the surface on which the blow has been struck or the pressure applied and the surface of the scar left by the flake removed. It is measured on flaked tools. Subject to the conditions set out below, all angles platfom-scar found in a tool are measured whatever their position on the piece may be. The angles are measured with a simple form of goniometer reading in degrees. One hundred angles platform-scar are measured for each industry and these will probably be furnished by about thirty tools.

Only those angles are measured which show on one side or the other the pit of percussion or pressure, for it is only in this way that one can be sure that the surface of origin has remained intact and has not been replaced by a flake-scar starting from some other point. The measurement is made at the center of the pit for a distance of about 1 cm along the long axis of the flake; in this way the change in curvature shown along the axis of length in many flakes is avoided. The measures are confined to flake scars not less than about 1 cm in length.

Whatever flints are examined, whether they have been collected as being of human workmanship or as examples of naturally flaked flints, what is known to statisticians as a "true sample" should be taken. This is done by mixing the specimens in question thoroughly together and spreading them evenly on a table. A sufficient fraction of them is taken for examination (say one-half or one-third) so that the sample is fortuitous and represents the group as a whole." And (op. cit., p. 111) "... When the angles platform-scar are arranged as a frequency distribution and the quartile points are determined, it is found that in human work Q 3 is always less than 90°, while for eoliths and natural fractures Q 3 is always more than 90°."

[5] My thanks are due to Sergeant N. DEN HAAK, of the Netherlands Military Geological Service, for the way in which he has made the three graphs of fig. 1 and the simplified section of the Wezep excavation, pictured on Plate 2, according to my directions. I also want to thank my assistant, Mr J. J. SCHELLINK, for his help in making some minor alterations in Plates 1 and 2.

layers into: rough sand with some gravel at the top, followed by fine sand; below this, a thick complex of layers of loam containing the flint objects together with some cristalline erratic boulders, interspersed with small lenses of fine sand ,and finally, at the bottom (approximately 2½ metres below the

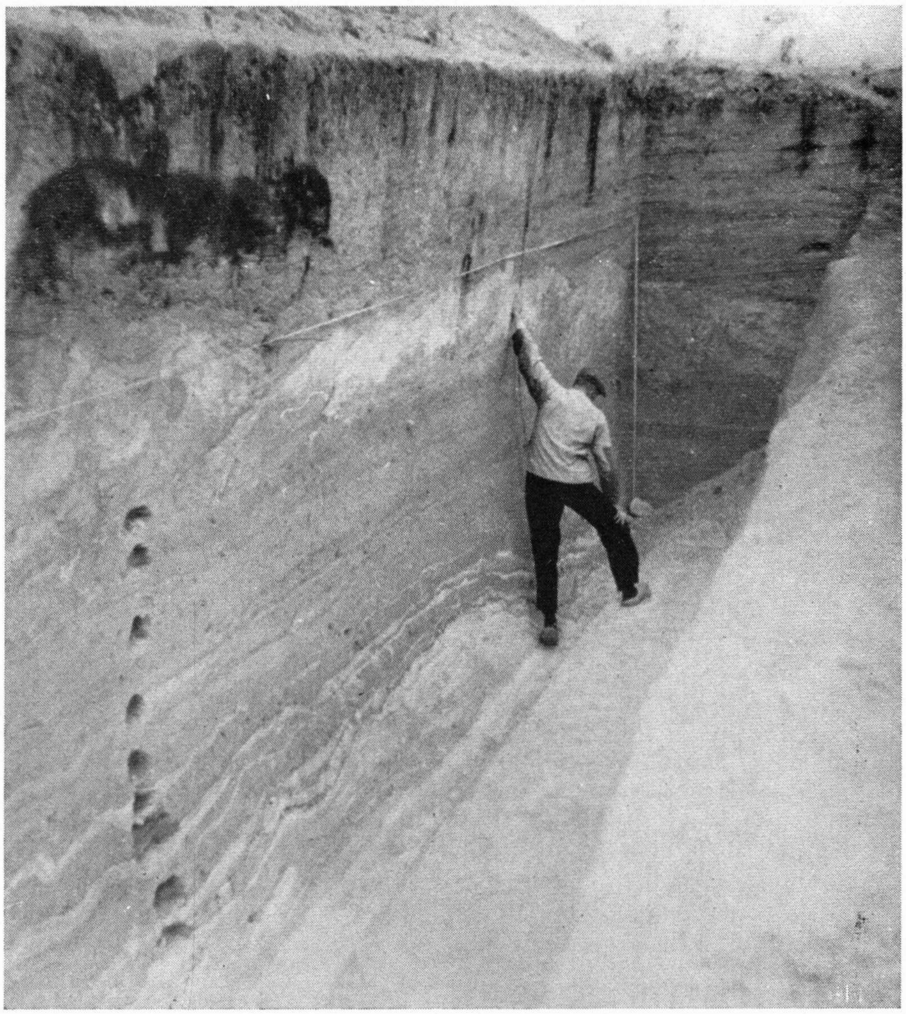


Fig. 2. The section at Wezep (Moordenaarshoek), seen to the NNE. 28-X-1948.

actual surface) a system of layers of fine, white sand with here and there a little gravel, can also be recognized in the schematical representation of almost the same section as given by BROUWER (1954, fig. 1). This last figure, however, does not sufficiently indicate the two intensely reworked and kneaded layers at the top and at the bottom of the loam, visible in the figure of the section given in the present paper. On the other hand I have not encountered any of the several boulder-horizons (pointing to temporary intermissions of sedimentation) observed by BROUWER. A detailed description of the kneaded horizons, which should be termed (in accordance with BROUWER) as solifluction layers, may be found later on in this paper.

The Geological map (*Geologische kaart van Nederland*, Scale 1:50.000, Sheet 27 Hattem, Quartersheet I, The Hague, 1932) gives the information that the site at Wezep lies in a deposit of boulderclay with a varying number of boulders (symbol: II 3), surrounded by preglacial sands (symbol: II 2) with varying quantities of gravel and stones, and with some northern boulders strewn over the surface, the whole being termed a "reduced moraine". The southernmost of the two excavations on the artilleryrange of Oldebroek (directly to the South of the railway line Amersfoort—Zwolle, near post 69 on the map) is represented on the Geological map as "Fluvioglacial cover of less than 20 dm on moraine deposit" (symbol: $\frac{\text{II 4}}{\text{II 3}}$). The other Oldebroek site, a gravel deposit in medium to rough sands, lies to the NW of a hill called the Heesberg, directly at the edge of a local occurrence of boulderclay (symbol: II 3), again in deposits mapped as $\frac{\text{II 4}}{\text{II 3}}$ (fluvioglacial cover of less than 20 dm on top of the moraine).

All three localities, according to the Geological map, therefore contain sediments which stand in a definite connection with morainic-, and boulderclay deposits. Only in one case, that of the site near the Heesberg, the information supplied by the Geological map appears to be entirely correct. The other two localities contain a certain kind of loam or boulderclay, which however is clearly stratified (which normal boulderclay never is). The same quantities and kinds of erratic boulders (crystalline rocks, sedimentary rocks and flints, of foreign, usually Scandinavian, origin) may be found in this stratified loam, and in the normal boulderclay at the Heesberg.

The following table, partly used in a publication by DE WAARD and ERDBRINK (1949), shows the results of an analysis of the heavy minerals of the boulderclay taken at the spot marked II 3 (on the Geological map) directly to the North of the Heesberg, Oldebroek; of the loam from the "Moordenaarshoek" at Wezep; and of three of the loampits near Hattem (A, B and C; A is the oldest and largest of the pits, and some fossil antlers have been found in it) which were described in our 1949 publication; while, for purposes of comparison, the standard or "ideal" analysis of the A- and the X-mineral provinces of EDELMAN (1933) are also represented. My thanks are due to Professor DE WAARD, who kindly agreed to let me use this diagram again for this publication.

The numbers in this diagram express the percentual relations of mineral grains in each sample.

It may be seen that the two analyses from the Heesberg and from Wezep show a definite relation to the standard analysis of EDELMAN's A-province. The varved loams from the three pits near Hattem have a different composition (namely, a mixture of the A- and the X-provinces), therefore, in this particular case, a different origin. As was argued by us (op. cit., 1949), they have been deposited before the passage of the icecap, which kneaded and faulted them afterwards, and they contain absolutely no erratic boulders. Boulderclay, and following from this, redeposited (and layered) boulderclay such as encountered at Wezep, must of course have been deposited contemporarily with and posteriorly (respectively) to the passage of the icecap.

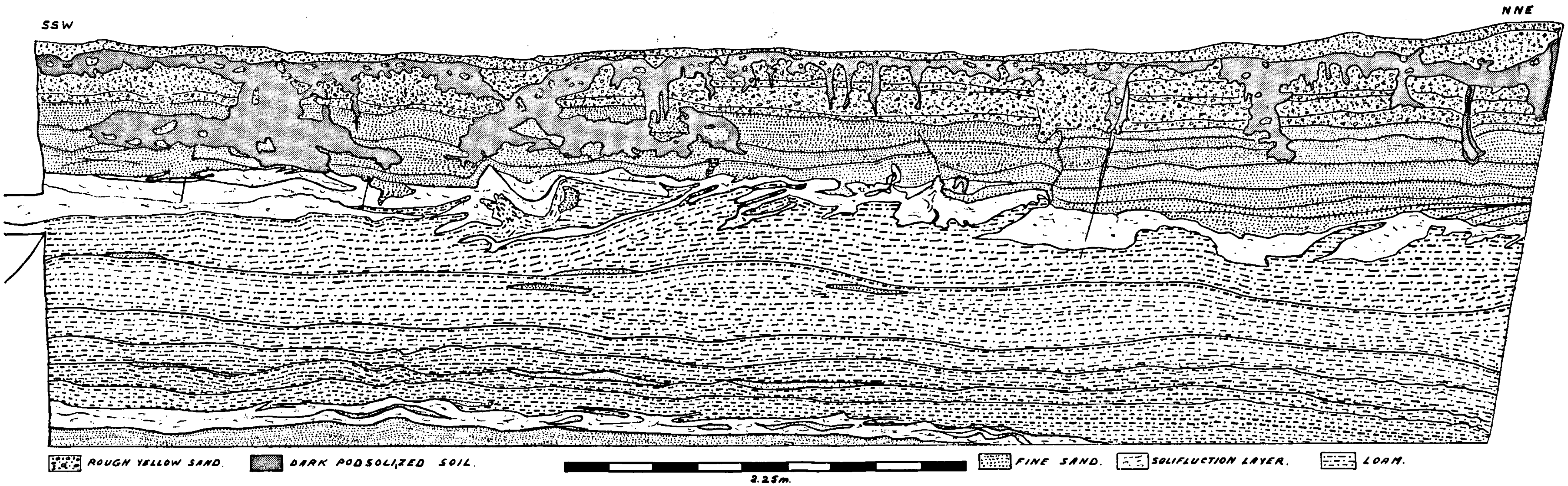


PLATE 2. The SSW—NNE section at the Moordenaarshoek, Wezep, made in 1948.

TABLE I

	Boulder-clay of the Hees-berg	Loam from "Moor-denaars-hoek", Wezep	Loam from loampit A, Hattem	Id., pit B, Hattem	Id., pit C, Hattem	Standard analysis, A-pro-vince	Standard analysis, X-pro-vince
Opaque grains	31	24	25	40	46	25	35
Tourmaline	8	11	5	7	2	2	3
Zircon	4	7	12	17	27	8	15
Garnet	10	5	7	5	—	31	4
Rutile	1	—	—	4	11	2	12
Titanite	—	—	—	1	—	1	1
Staurolite	3	9	3	3	6	2	1
Disthene	3	3	5	9	6	1	4
Andalusite	1	1	—	2	3	—	2
Sillimanite	—	—	1	1	—	—	—
Epidote	29	18	35	33	33	27	54
Saussurite	4	7	8	2	6	1	1
Amphibole	36	39	23	16	6	24	3
Augite	1	—	1	—	—	1	—

The description of the Wezep section, given by BROUWER (1954) seems, in my opinion, to be generally in accordance with the facts encountered during the 1948 excavations, of which no mention has been made by BROUWER in 1954. The uppermost, sandy, deposits (accorded the symbol *e* by BURSCH, FLORSCHÜTZ and VAN DER VLERK, op. cit.) are rough and contain some gravel, while a strong podsolizing action has transformed part of them into irregular black and grey masses. BROUWER has dated this layer to the Last (or Würm) glaciation, which is a logical conclusion seeing that it lies higher than the loam, and must have been deposited later. The occasional occurrence of northern erratica on the actual surface, intermingled with gravel and pebbles of Belgian and German origin, might be thought an argument against the acceptance of a Würm age for these sands. But the presence of these stones may be explained by assuming that they have been transported down from the adjacent hills and ridges by the action of surface erosion on the original morainic or boulderclay cover, instead of accepting their actual presence on and in the sands as proof that these sands themselves are the original morainic remains ("reduced moraine"), as was done by the maker of the Geological map.

It does not seem in accordance with other facts mentioned in the present paper, however, to accept BROUWER's view that the presence of a solifluction level between these sands and the underlying loam forms an additional strengthening of the supposition that the sands are of a Würm glacial age. The sands themselves show frost action (in the section given here two to three frost wedges may be seen in the NNE part), but this could also be explained without accepting a glacial climate as their origin. Recent research has shown that frostwedges and solifluction phenomena of this magnitude may also occur as a result of our present climate. Frost wedges of moderate size may be formed in soils which have a high or fairly high humus content,

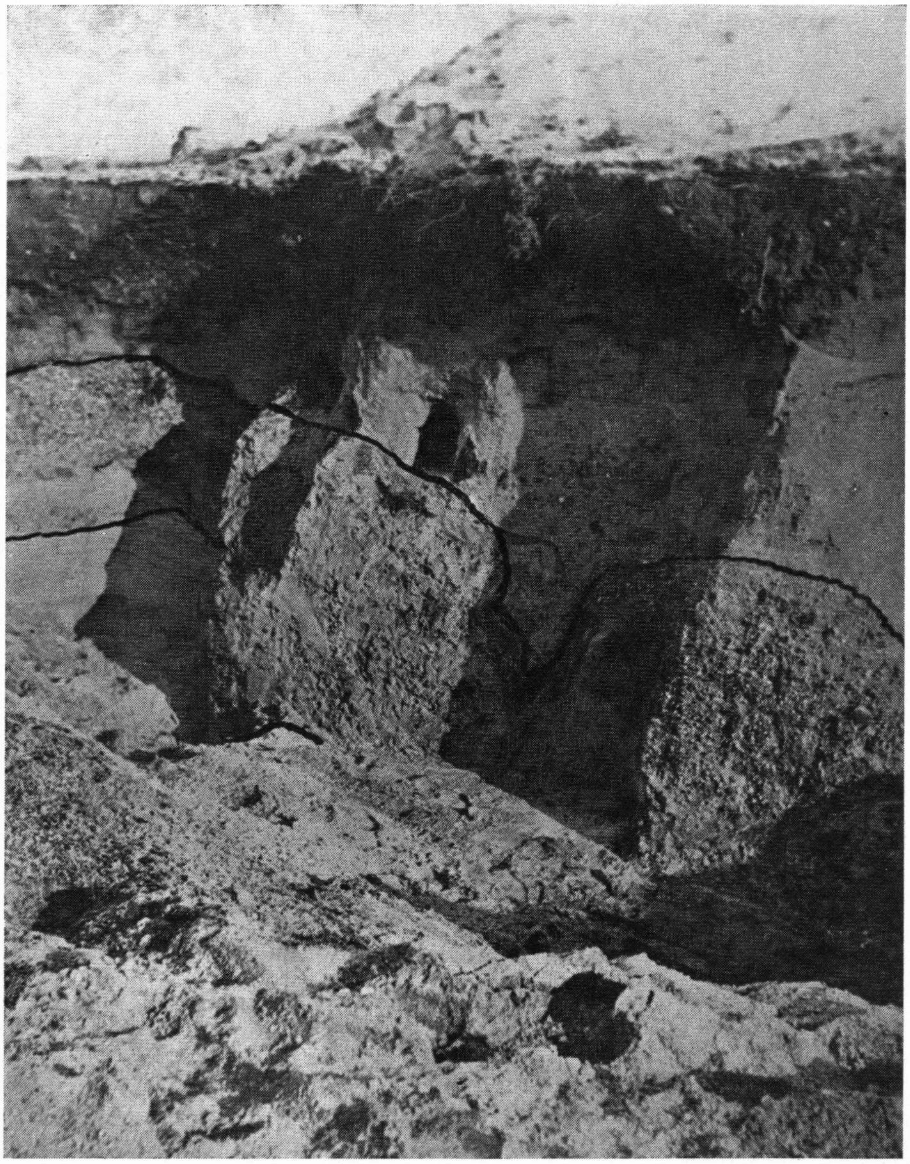


Fig. 3. The faulted gravel bed in the quarry near the Heesberg on the artillery range at Oldebroek. Phot. J. Mallinckrodt, 1938.

a fact well known to pedologists and in soil mechanics. The forming of frost scars and frost wedges under the present circumstances in the Netherlands is mentioned by HUIZINGA (1948, pp. 24, 176 et seqq.). It may be interesting to note that the podsol phenomena in the sands at Wezep are probably due to the presence of pine forests and heath; the dark bodies visible in the section have usually been developed along plant roots (providers of humus?).

Nearing the base of the sandy layer the sands become finer, as was observed by BROUWER. Occasional lenses of rougher material may still be encountered. Below this the first solifluction level occurs. It is the upper part of the loam, which is somewhat sandy and which has a lighter colour than the stratified loam at a still lower level. In the solifluction level one may observe irregularly kneaded sandy enclosures. The whole aspect of this, and also of the other (second) solifluction level at the base of the loam, brings vividly to mind the descriptions given by PFUHL (1932) of sections in a Pleistocene deposit of sand and loam in Mecklenburg (N. Germany). Because of this great similarity I have attempted to check PFUHL's results and explanations of these features for the section at Wezep. A mechanical analysis of the different sandy layers and of the loam, together with a chemical analysis [6] with the object of defining the calcium contents of the deposits, gave the following results, combined in table II.

Two important conclusions may be reached after consideration of the data given in this table:

1. solifluction levels occur only along the border of two different kinds of soil, in this case between loam and sand; the kneaded material itself consists largely of loam;
2. the particle size of the preponderant fractions in the solifluction loam and in that of the immediately overlying or covered sand has a mean difference lying between 0,1 and 0,2 mm, while the $CaCO_3$ content of the loam always surpasses that of the sand by at least 2, but usually even 5 %.

RAMANN (1915) has reached the conclusion that a particle size diameter of 0,1 mm or less suffices to produce flow of a waterlogged soil. If it should be taken for granted that the loam at Wezep and at Oldebroek has been deposited in a freshwater lake or pond, as suggested by BROUWER, it will be clear that, as a large percentage of its particles are smaller in size than 0,1 mm, it has very probably been a soil which could act, and probably has acted, as a kind of quick"sand".

The explanation given by PFUHL for the curiously kneaded and twisted layers which he described, seems to fit the phenomena met at Wezep equally well. The mean difference of particle size in the layers which he measured (op. cit., p. 56), lay between 0,1 and 0,15 mm, whereas the $CaCO_3$ contents of the finest-grained of the two types of sediments of his description, a kind of marl, differed from that of the covering or underlying sands as much as 2 to 7 %.

Both sand and marl, in the Mecklenburg deposits, seem to have been laid down in fresh water. The sand, having a low calcium content, has been

[6] I am much indebted to the authorities of the Government Geological Survey at Haarlem, who let me use their sieve apparatus for a preliminary mechanical analysis in 1949; my thanks are similarly due to Mr J. M. M. VAN NOORT and Mr A. GROENEWEGEN, laboratory assistants of the Netherlands Military Geological Service, who made a second mechanical analysis for me and who also determined the approximated calcium contents.

TABLE II

Depth below surface	Description of material	Solifluction levels	Particle size in mm (percentages) (the preponderant fractions are in bold face)																	CaCO₃ contents (%) approx.
			2	1,4	1	0,6	0,42	0,30	0,25	0,21	0,175	0,15	0,125	0.105	0,09	0,075	0,06	< 0,06	< 0.016	
40 cm	rough sand	—	3,45	2,06	2,89	6,17	**14,65**	**20,71**	10,4	**12,68**	**14,67**	5,45	4,17	0,68	0,81	0,7	0,31	0,17	—	3
63 cm	sandy loam in lens	—	—	—	—	4,6	5,05	8	6,18	**11,08**	**16,25**	9,1	**13,6**	4,4	4,3	3,58	3,8	5,6	3,89	5
72 cm	sandy inclusion in loam	— ×	3,79	2,27	4,41	8,41	**17,13**	**19,27**	9,11	**10,05**	**12,11**	4,37	5,26	1,03	1,21	0,79	0,53	0,31	—	2
86 cm	loam	× —	—	—	—	—	4,8	5,9	5,25	9,6	**17,5**	**10,7**	**14,8**	3,85	6	4,95	—	11,9	3,91	7
122 cm	sandy inclusion in loam	—	0,63	0,79	1,93	5,93	**14,33**	**20,15**	10,91	**13,41**	**15,57**	5,07	5,87	1,21	1,35	1,05	0,69	0,59	—	1
135 cm	loam	—	—	—	—	—	**11,1**	**11,08**	7,55	9,7	**15,1**	**9,6**	**11,35**	3,5	3,85	3,75	—	8,5	4,4	5
193 cm	loam immediately above sand	— ×	—	—	—	—	3,13	1,65	3,3	5,7	**13,3**	**10,35**	**17,35**	5,1	6,1	5,05	—	**17,98**	**10,1**	7
203 cm	sand immediately below loam	× —	2,01	0,88	3,57	7,55	**15,94**	**20,07**	8,91	**10,61**	**11,91**	4,79	5,77	1,73	1,36	2,13	1,15	1,63	—	1
223 cm	sand	—	3,15	1,04	2,17	4,35	**9,79**	**15,18**	8,84	**11,64**	**14,81**	5,88	8,65	2,01	2,43	2,64	2,43	4,71	—	2

deposited as a closely packed sediment (because the surrounding water, owing to the lack of Ca-ions, was almost neutral), but the marl, with a high Ca-content, has been deposited as a loosely packed sediment because its watery surroundings acted as an electrolytic solution (many Ca-ions) and the particles were prevented to come into close contact with each other because of

Fig. 4. Part of the section of the loam layer (which begins at the surface and goes to a depth of 130 cm) near post 69 on the railway line Amersfoort—Zwolle.

their identical electrostatic charge. After the deposition of each separate layer of sand and marl (or, at Wezep: loam) the lake or pond in which the deposition took place, probably has dried up again, thus indicating a perhaps seasonal influx of water. On being saturated with water again, the already deposited layers may have acted (PFUHL, p. 35) as a kind of "syrupy fluid"; when a difference in mean particle size of the preponderant fraction(s) was met by one "syrupy fluid", such as can be expected between loam (the fluid) and sand (more closely packed), the fluid soil layer, possessing the smallest mean particle size and having a higher Ca-content, probably has tried to break through the resisting and more closely packed layer above it. This explains the queerly twisted and twirled "fingers" visible all along the solifluction layers in the section. One may compare it with a layer of oil trying to break through an overlying layer of water which contains many particles of some matter, impeding the upward thrust of the oil below.

Many more details of PFUHL's hypothesis may be found in this cited paper; it would go too far to cite it in its entirety.

It follows from these considerations that the lowermost of the two solifluction levels at Wezep (see the diagram with particle sizes) has come into existence as a result of the difference in mean particle size and in $CaCO_3$ content, not with the underlying sand, but with the covering layers of loam. However, the layers below each of the solifluction levels must have been (temporarily) impermeable for water in order to explain the forming of a saturated layer of sediment. There is no objection against the assumption that the main layer of loam has acted as the impermeable layer during the forming of the upper solifluction layer at Wezep; but in the case of the lower solifluction layer, the subsoil, being the white, sandy layer, must have been permanently frozen in order to have been impermeable for water.

An important thing to note is formed by the fact that solifluction of the described type does not need a sloping surface to explain its origin; it may be encountered in purely horizontal layers. It is true that, at least at Wezep (but not at Oldebroek) the section indicates that a certain slope (to the NNE, at Wezep) has existed. But this is not a determining factor for the explanation of the solifluction layers. Moreover, the section described by BROUWER, which has been made as a partial extension to the NNE of the section dug by us, shows that the upper (rough) sands and perhaps the upper part of the loam, have been deposited in an existing depression of limited size, which had an upward slope again in the extreme NNE.

The loam below the first and above the second (lowest) solifluction layer at Wezep contains a large number of boulders, while the flint pseudo artefacts are only found in this medium. The mineralogical analysis of the loam has shown us already that no appreciable differences exist between it and the original boulderclay near to it. This is also true for the types of crystalline erratic boulders enclosed in both soils [7].

In a material of twelve samples of loam, taken at the section at Wezep, Dr. VAN VOORTHUYSEN (Palaeontologist, Government Geological Survey, Haarlem) has only been able to identify four micropalaeontological specimens (G. S., Haarlem, report nr. 196, Bl. 319, samples nrs. 20850—20862): an *Eponides* sp., a *Cibicides* cf. *voltziana* d'ORB., and a *Bryozoa*, derived (by the boulderclay) from Cretaceous sediments, and a (Pliocene) *Cassidulina laevigata*.

The extreme scarcity of micropalaeontological specimens, which are usually represented in a fair number in most Dutch boulderclays (see VAN VOORTHUYSEN and LAGAAIJ, 1950), points to the fact that the loam at Wezep must

[7] On the insistence of Professor VAN GIFFEN, Mr P. VAN DER LIJN, the well-known Dutch specialist on erratic boulders, kindly agreed to make a superficial survey of the encountered types of crystalline rocks; a count of 100 recognizable specimens, found in the loam at Wezep during the 1948 excavations, resulted in a count-formula of 0550 (using the method propagated by HESEMANN). This indicates a preponderance of material from Central Sweden, South Sweden, Bornholm and the Baltic, an assembly typical for erratic boulders of the Riss or Saale glaciation.

have been a *redeposited*, washed-out sediment derived from a boulderclay. Thus the supposition is strengthened which was made by BROUWER with regard to the way in which the Wezep loam has been formed.

Thes source whence the Wezep loam may have come, must have been a boulderclay slightly higher up the slope of the moraine to the S and SE of the Moordenaarshoek site. As has already been mentioned, it may be supposed that the loam has been redeposited in freshwater ponds or -lakes, in which the water probably has had a temperature of about 4 degrees C (because water has its greatest density at this temperature; see PFUHL, p. 34, for this and other probable exigencies with regard to the sedimentation of solifluction layers). Local depressions, coupled with an initially permanently frozen subsoil, may have sufficed to explain the existence of such ponds. The presence of remains of an icecap is not absolutely necessary, contrary to the supposition made by BROUWER. The boulders and flints in the Wezep loam may have entered the pond together with the loam, as one sticky porridge-like substance which trickled down the gentle slope of the near morainic ridge at the beginning of the spring thaw, or every time when a particularly heavy rainfall occurred. The flaking of the flint nodules may well have taken place during this transport, through bumping against each other and against the crystalline boulders (imitating the "block-on-block" technique). A secondary flaking (the "retouche") may have been caused by the heaving-up of the saturated loam layers during the formation of the solifluction levels.

At Wezep no readily recognizable real boulderclay still exists; only the fact that the surface of the highest prominences of the morainic ridge is still strewn with some boulders indicates the former presence of a boulderclay there. It has alreday been pointed out that the lower lying surfaces of the slopes of this ridge are also strewn with a lesser number of these same boulders, probably washed down at intermittent intervals, a process which is still going on at the present time. This feature should not therefore be used as an indication of the age of the sediments of these slopes.

It has already been remarked that, on the artillery range at Oldebroek, an area still covered by the original boulderclay, the Heesberg, is situated. On the NW slope of this hill there existed a small gravel quarry, which is one of the two Oldebroek sites mentioned in this paper. A section (SE—NW) through this quarry may be seen on the photograph. It appears that an intensely faulted gravel bed, perhaps the bed of a swiftly running brook, has been cut through in this section. Among the gravel of this bed a few occasional flint objects were recovered by Colonel MALLINCKRODT and by the present author at various intervals. This site is probably the best illustration for the contention that the sediments containing the flint pseudo-artefacts must have been derived from the original boulderclay. The intense faulting of the gravel bed (the lower and upper edges of which have been made more clearly visible by a black line on the photograph) probably points to a (local) regression of a lobe of the icecap some time after the deposition and partial crosion of the already deposited boulderclay of the Heesberg. No such faulting phenomena could be observed in the loam layers at Oldebroek, which contain the same assembly of stones and flints as the Oldebroek gravels and the Wezep loam.

The conclusion seems justified that the deposition and formation of the loam- and gravel layers at Wezep and Oldebroek, which contain the pseudo-artefacts, has started immediately after the forming of the boulderclay deposits close by and the regression of the icecap which brought all the necessary material; and that this process has been going on for a considerable time afterwards, perhaps with some intermissions in between.

Theoretically it may even be quite possible that at least the loam at Wezep has been deposited in its entirety in a later cold period, namely during one or more of the Würm stadials. But the medium-grained white sands which occur at the base of the loam deposits at Wezep and at Oldebroek are a common feature of a large part of western Gelderland. They are usually considered to have been deposited at the end of preglacial (i.e. pre-Riss) times (see BROUWER, p. 10). It is therefore slightly more probable that the loam containing the pseudo artefacts has been deposited at the end of the glaciation which formed the morainic ridge, because no traces of a hiatus between sands and loam have been found.

The age of the rough yellow sands on top of the loam at Wezep is more problematical. Whereas BROUWER, and also BURSCH, FLORSCHÜTZ and VAN DER VLERK consider it to be a deposit datable to a period during the last glacial age (Würm), I am not so certain about it. The sand could have been equally well deposited immediately after the loam, and indeed the horizontal layering of it, filling up the depression in which the loam had been deposited first, has been broken through at several places by the "fingers" of the upper solifluction layer, thus creating the faulty impression of a stratigraphical hiatus where only a difference in transported material (perhaps because the local supply of boulderclay had been used up by the erosion) may account for the change. The uppermost part of the yellow sand must have been subjected to deflation of the finer fractions by the wind, something which may have happened during the last glacial stadia.

At Oldebroek the same sand is practically absent; here the loam (as may be seen on the photograph) forms part of the present wooded surface.

Conclusions

The results of this study may be summed up as follows:

1. The flint objects from Wezep, Oldebroek and some other adjacent localities (Heerde, Vollenhove; see BURSCH, FLORSCHÜTZ and VAN DER VLERK) should no longer be considered to be human artefacts.
2. They are found in glacial and immediately postglacial gravels and loams, which are derived from the (Riss) glacial boulderclay in their neighbourhood.
3. Under conditions of a mechanical (particle size) and chemical ($CaCO_3$ contents) nature, identical with those encountered by PFUHL in Mecklenburg and by us at Wezep and Oldebroek, solifluction levels may be formed in perfectly horizontal deposits, above a temporary impermeable (frozen or other kind of) subsoil which causes the deposits in question to become saturated with water and to behave partly as syrupy fluids.

It will be reasonable to suppose that the conditions which are set forth in conclsuion (3) may also be encountered occasionally in recent deposits and in historical times. As an interesting illustration of such a possibility I cite a paper by VAN LIERE and CROMMELIN (1949), who described and photographed a section through a deposit in a waste reservoir near Apeldoorn along the Apeldoorn canal, into which the sand dredged from the bottom of this canal, in order to keep its depth at a permanent level, had been dumped. A section very similar to that described from Wezep was encountered in these recent deposits which had been laid down in a reservoir which was dug in the year 1931.

Thus a fourth conclusion may be formulated here, which may have some significance for that part of Pleistocene stratigraphy which is based on the occurrence of solifluction horizons:

4. Under certain circumstances, described in this paper, and at greater length by PFUHL (op. cit.), solifluction levels may be formed *at any time* during which the fresh water at the actual locality reaches a temperature of 4° C, while the subsoil remains impermeable for water. It is not necessary, and indeed dangerous (because it could lead to erroneous conclusions), to assume that an extremely cold or even glacial climate has existed during the formation of such a solifluction level.

References

BARNES, A. S., 1939. The differences between natural and human flaking on prehistoric flint implements. The American Anthropologist, vol. 41, 1.

BOHMERS, A., 1950. Over Eolithen uit het Onder-Pleistoceen. Symposium Pleistoceen. Geologie en Mijnbouw, new series, The Hague, vol. XII, pp. 45—47.

BROUWER, A., 1954. Een nieuwe interpretatie van het Pleistocene profiel van Wezep (Gelderland). Geologie en Mijnbouw, new series, vol. XVI, pp. 7—11.

BURSCH, F. C., FLORSCHÜTZ, F. and VAN DER VLERK, I. M., 1938. An early palaeolithic site on the northern Veluwe. Proceedings Sect. Sci., Kon. Acad. v. Wetenschappen, Amsterdam, vol. XLI, pp. 909—920.

EDELMAN, C. H., 1933. Petrologische provincies in het Nederlandsche Kwartair. Amsterdam.

HUIZINGA, T. K., 1948. Grondmechanica. Second edition, Amsterdam (Ahrend).

LEAKEY, L. S. B., 1953. Adam's ancestors. Fourth edition, completely rewritten. London (Methuen).

LIERE, W. J. VAN and CROMMELIN, R. D., 1949. Recente kryoturbatie. Publ. VI, Ned. Geol. Vereniging, Zutphen, pp. 151—152, 4 pls.

PFUHL, E., 1932. Ueber die Schichtenstörungen in den Unteren Sanden der Tongruben von Glindow (bei Werder i. M.). Zeitschrift für Geschiebeforschung, Leipzig, Bd. VIII, pp. 21—58.

RAMANN, E., 1915. Die Einwirkung elektrolytarmer Wässer auf diluviale und alluviale Ablagerungen und Böden. Zeitschrift d. Deutschen Geologischen Gesellschaft, Berlin, 76.

VOORTHUYSEN, J. H. VAN and LAGAAIJ, R., 1950. Micropalaeontologisch onderzoek van keileem. Publ. VIII, Ned. Geol. Vereniging, Zutphen, pp. 80—93.

WAARD, D. DE and ERDBRINK, D. P., 1949. Warven in Nederland. Tijdschrift v. h. Koninkl. Nederl. Aardrijkskundig Genootschap, 2, vol. LXVI, pp. 677—687.