

A PROGRESS REPORT ON THE RHENEN INDUSTRY (CENTRAL NETHERLANDS) AND ITS STRATIGRAPHICAL CONTEXT

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ABSTRACT: In this paper a preliminary review is given of what is currently known about the stratigraphical context of the Rhenen industry. The Rhenen industry comprises Middle Palaeolithic finds from gravelly river-laid deposits in the central Netherlands. It is suggested that most of these finds date from only one interstadial of the Early Saalian, which possibly can be correlated with the Hoogeveen Interstadial. However, there are indications that part of the finds are older, perhaps dating from the Holsteinian.

KEYWORDS: Rhenen industry, Middle Palaeolithic, fluvatile deposits, Urk Formation, Early Saalian, Hoogeveen Interstadial.

1. THE RHENEN INDUSTRY

Great river valleys have always played an important role in Lower Palaeolithic archaeology. Since the second half of the last century, many thousands of Acheulian finds have been recovered from deposits laid down by large rivers such as the Somme and the Thames. Only recently have we become acquainted with similar rich Acheulian findspots in the valleys of the rivers Rhine and Meuse in the Netherlands. Since the second half of the 1970s thousands of Middle Palaeolithic finds have come to light at several locations in the central part of the country. Initially the sandpits at the two brickworks near Rhenen: Vogelenzang and Leccius de Ridder, were mentioned as rich findspots (e.g. Franssen & Wouters, 1977; 1978a; b; 1979a; 1980). Later it turned out that many more sites in the central part of the Netherlands yielded similar material. In figure 1 the sites for which we possess some stratigraphical information (scanty in several cases) are indicated, but there are many more sites, especially with surface finds. For example, there are a dozen or so surface sites in Gooiland (finds of J. Offerman-Heykens, A. Boelsma and others: Stapert, 1981c; 1982; Stapert & Offerman-Heykens, in prep.). Some of these finds probably belong to the 'Rhenen industry', predating the period of ice-cover, because they are made of Meuse flint and are rolled, but there are also Middle Palaeolithic finds dating from after the period of ice-cover which are sometimes made of northern types of flint. I have the impression that wherever coarser layers of a later part of the Urk Formation ('Urk II') are exposed, finds of the Rhenen industry can be expected. This is true especially for the Utrechtse Heuvelrug, the ice-

pushed ridge running from Rhenen to the IJsselmeer, and for the pushed ridge of Wageningen-Lunteren, which border the Gelderse Vallei on the west and on the east respectively. It appears that the bulk of the material collected at the sites in figure 1 can be placed in an early phase of the Middle Palaeolithic. The Middle Palaeolithic is defined here as the period in which systematic use was made of prepared cores (Levallois technique), following Bosinski (1967). The Middle Palaeolithic finds can most probably be dated in the Early Saalian (see 3). Lower Palaeolithic artefacts might also be present, mixed together with Middle Palaeolithic ones in the same gravels, but this possibility cannot be demonstrated typologically.

I would like to propose the name 'Rhenen industry' for these finds. The Rhenen industry comprises Middle Palaeolithic finds in the central Netherlands, most probably dating mainly from the Early Saalian, i.e. from before the period of ice-cover (see 2). So far, these finds have only been recovered from gravelly river deposits, which are placed in the Middle Pleistocene Urk Formation. It is possible that comparable artefacts are present in deposits of the contemporaneous Veghel Formation in the province of Noord-Brabant (Stapert, 1981e; see Zagwijn & van Staaldunin, 1975; Zagwijn, 1985, for an overview of the Pleistocene stratigraphy in the Netherlands). In this paper I wish to present a summary of what is known about the stratigraphical context of the finds. It should be stressed that the name 'Rhenen industry' is only applied to the group of Early Saalian sites in the central part of the Netherlands. In the southern part of the country too, important sites dating from more or less the same period are known, especially

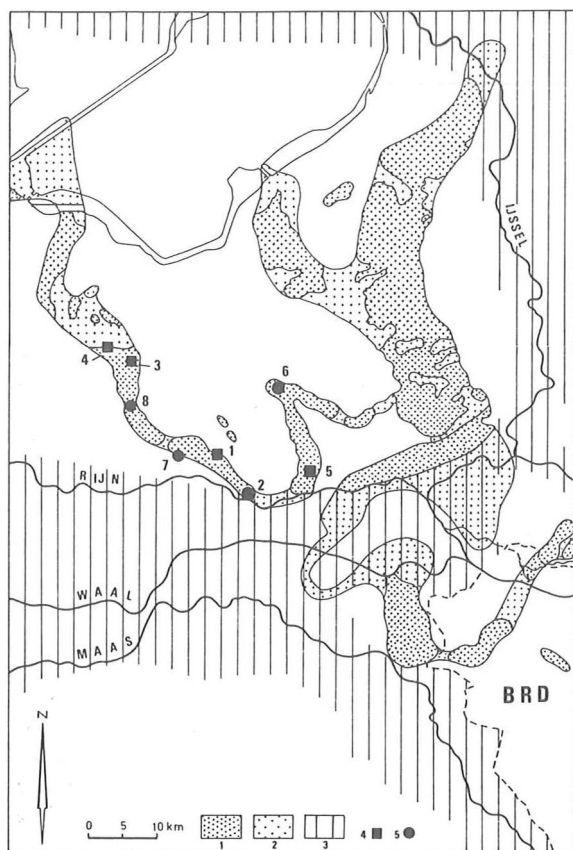


Fig. 1. Map of ice-pushed ridges in the central Netherlands. The map is based on Jelgersma & Breeuwer (1975), with some changes following Verbraeck (1975). More recently a somewhat different reconstruction of the pattern of pushed ridges has been published (see maps in: Zandstra & Ruegg, 1984; Zagwijn et al., 1985). Key: 1. ice-pushed ridges; 2. ice-pushed ridges covered by younger sediments, and/or partly eroded away; 3. geographical distribution of the Kreftenheye Formation: deposits of the rivers Rhine and Meuse dated to the end of the Saalian (after the period of ice-cover), the Eemian and the Weichselian; 4. sites of the Rhenen industry, where systematical archaeological/geological research has taken place; 5. other sites of the Rhenen industry for which some stratigraphical information is available. Sites: 1. Kwinteloijen pit; 2. two neighbouring pits at the brickworks near Rhenen: Leccius de Ridder and Vogelenzang; 3. cutting for the A28 motorway on the Leusderheide; 4. pit de Paltz near Soesterberg (collections of A. Boelsma, J. Offerman-Heykens, B.A.I., and others); 5. Fransche Kamp pit near Wageningen-Hoog; 6. van der Brink pit near Lunteren (collection of M. Franssen jr. (Ede), see Kolen et al., in press); 7. findspot of the handaxe from Leersum; 8. railway gravel pit near Maarn (collections of J. Offerman-Heykens and E. du Maine-Reintjes).

in the Belvédère pit near Maastricht (van Kolfschoten & Roebroeks, 1985). Some of these sites are of high quality, as the finds occur archaeologically in situ, in contrast to the sites near Rhenen.

Layers of the Kreftenheye Formation, deposited by the Rhine and the Meuse after the ice-cover and dated to the end of the Saalian, the Eemian and the Weichselian (Verbraeck, 1984), appear to contain

Mousterian artefacts. Probable examples are the suction-dredged collections of Empel (Verhagen collection: Stapert, 1977; 1978; 1981d) and Nieuwegein (Offerman-Heykens collection).

Archaeologically the finds of the Rhenen industry can be ascribed to the Middle Acheulian of French authors, or to the Upper Archeulian as defined by Bosinski (1967). Both typologically and with respect to find circumstances, the industry shows great similarities to the finds of Markkleeberg (Grahmann, 1955; Mania & Baumann, 1981; Baumann et al., 1983; Mania, 1983; 1984). For the purpose of comparison I shall frequently refer to the recent publications on the finds of Markkleeberg. Statistical work on larger collections of the Rhenen industry is still in progress, and in this paper I do not intend to present an overview of the archaeological material; only a few general statements will be made. The Rhenen industry is characterized by the widespread use of the Levallois core technique: especially striking is the relatively high proportion of blades (see illustrations in: Stapert, 1980; 1981a; 1981b; 1983), as in Markkleeberg. Though frequent use was made of the Levallois core technique, many cores were not exploited in any systematical way. There are, for example, quite a lot of cores from which only a few flakes were removed, after which they were abandoned. This could be taken as an indication that there was no scarcity of good flint at the sites of the Rhenen industry. Moreover, this seems to suggest that a large part of the material at these sites can be considered as waste material, left at 'ateliers'. We get the impression, therefore, that one reason why people were attracted to the valleys near Rhenen was the fact that here a lot of good quality flint cobbles could be collected from the Early Saalian gravels; these were presumably prepared and worked on the spot, in or alongside stream valleys. Much of the material of the Rhenen industry does not seem to derive from 'base camps', but from flint-working ateliers. Of course, this does not mean that other activities did not take place here. It is known that hunter-gatherers often combine several types of 'extraction' activity at any locality (this is expressed by the concept of 'embeddedness' introduced by Binford, 1979). It can be noted in this connection that at some of the Early Saalian sites in the Belvédère pit there was evidence not only of flintworking but also of hunting (van Kolfschoten & Roebroeks, 1985). An unrolled blade excavated in 1979 in the Kwinteloijen pit, between Rhenen and Veenendaal, shows use wear traces that possibly resulted from butchering work (A.L. van Gijn, pers. comm.).

It is interesting in this respect that finished handaxes are scarce at sites of the Rhenen industry (see under 4 for an example), but rough-outs are encountered relatively often (fig. 2; for another

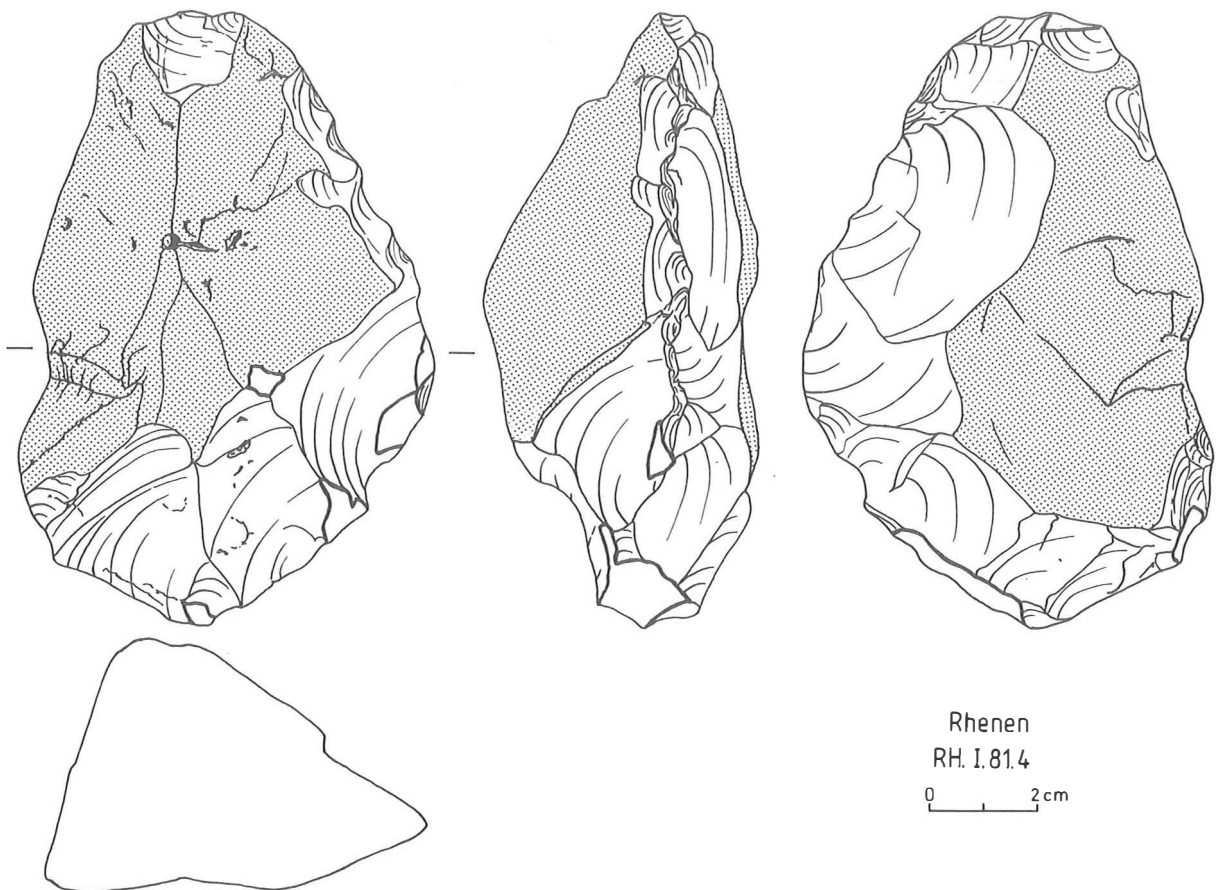


Fig. 2. Hand-axe rough-out, found at Vogelenzang brickworks but originating from Kwintelooijen (Kolen/Rensink/Spieksma collection). Key to drawings of artefacts: blank areas: (sub)recent damage, irregular stippling: remains of cortex, regular stippling: old frostsplitted faces.

example see Stapert, 1981b: fig. 22). This is also the case in Markkleeberg, and one gets the impression that these rough-outs were abandoned because they were considered to be unsuccessful products. A few *Keilmesser* are also present (fig. 3), as in Markkleeberg. Side-scrapers constitute the most numerous group among the tools (for illustrations of tools of the Rhenen industry, reference is made to the publications by Franssen & Wouters, and to previous papers by the author). Interesting are several examples of bifacial scrapers (*blattförmiger Schaber*), and scrapers manufactured from naturally fractured pieces of flint (not from flakes). In Markkleeberg all the finds consist of flint (Baumann et al., 1983); in Rhenen rounded quartzite pebbles were also used though the great majority of the finds consists of flint. From quartzite pebbles mostly choppers and chopping-tools were made (fig. 4). However, in several cases quartzite was also used for tools of other type-classes. One interesting example is the large backed scraper, illustrated in

figure 5. This type is also represented by specimens made of flint (fig. 6). Scrapers with a back formed by retouching are also known from Markkleeberg (*Schaber mit bearbeitetem Rücken*: Baumann et al., 1983). Other tool-types encountered in collections of the Rhenen industry are: *disques*, points and pointed double scrapers (*Spitzschaber*), clacton-notches and retouched blades and flakes. Several specimens are known that combine a scraper edge with a clacton-notch (fig. 7).

Since 1978 several locations have been investigated archaeologically, in cooperation with the Geological Survey of the Netherlands, and geologists of other institutions. At the following sites systematical observations were made regarding the stratigraphical context of the Rhenen industry: the Kwintelooijen pit (between Rhenen and Veenendaal; fig. 1: 1): 1979, 1980, 1986; the Fransche Kamp pit near Wageningen-Hoog (fig. 1: 5): 1987; the cutting for the A28 motorway on the Leusderheide (fig. 1: 3): 1984. At several other sites less decisive

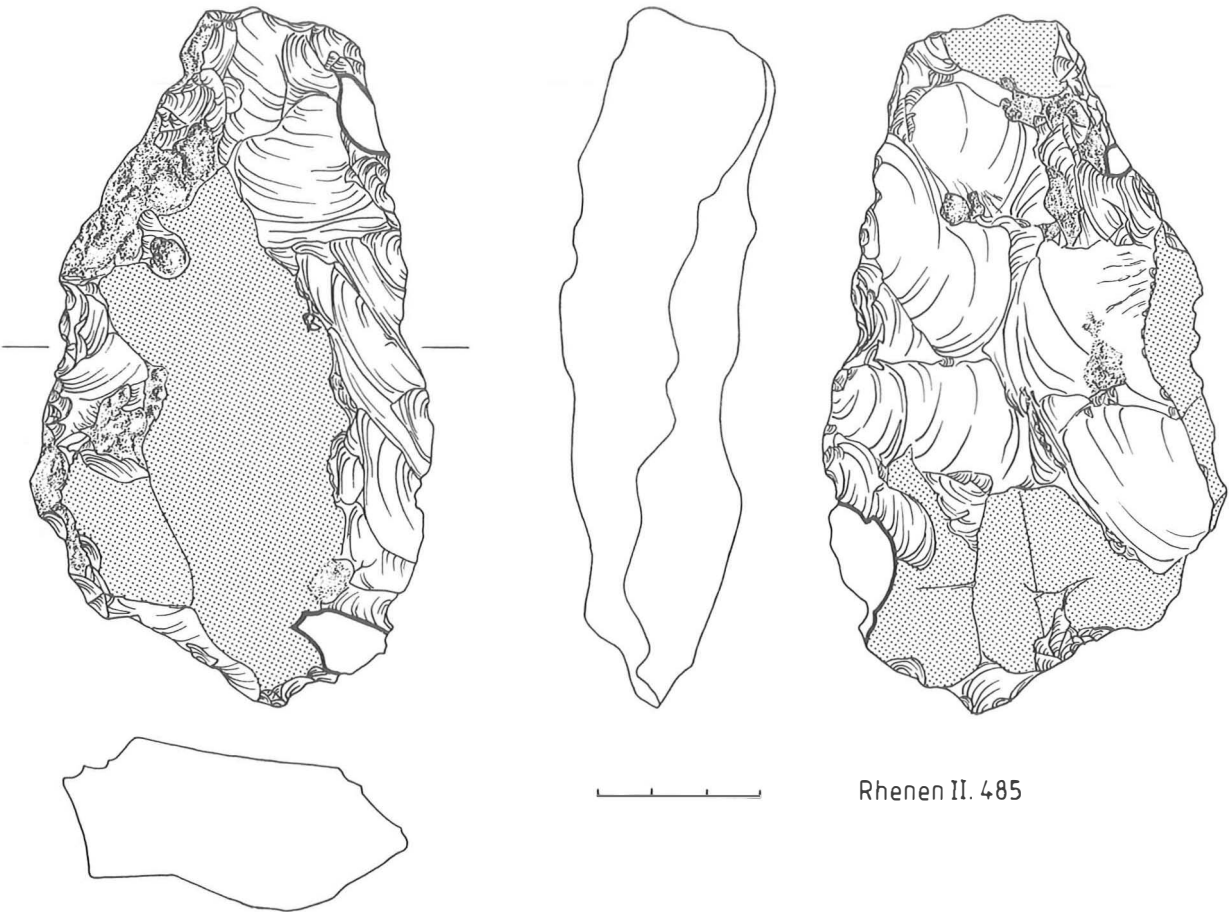


Fig. 3. *Keilmesser*, originating from Kwintelooijen (Franssen jr. collection). In some cases it is difficult to decide whether *Keilmesser*-like forms were intended as such; some of them could also be handaxe rough-outs. Scale in cm.

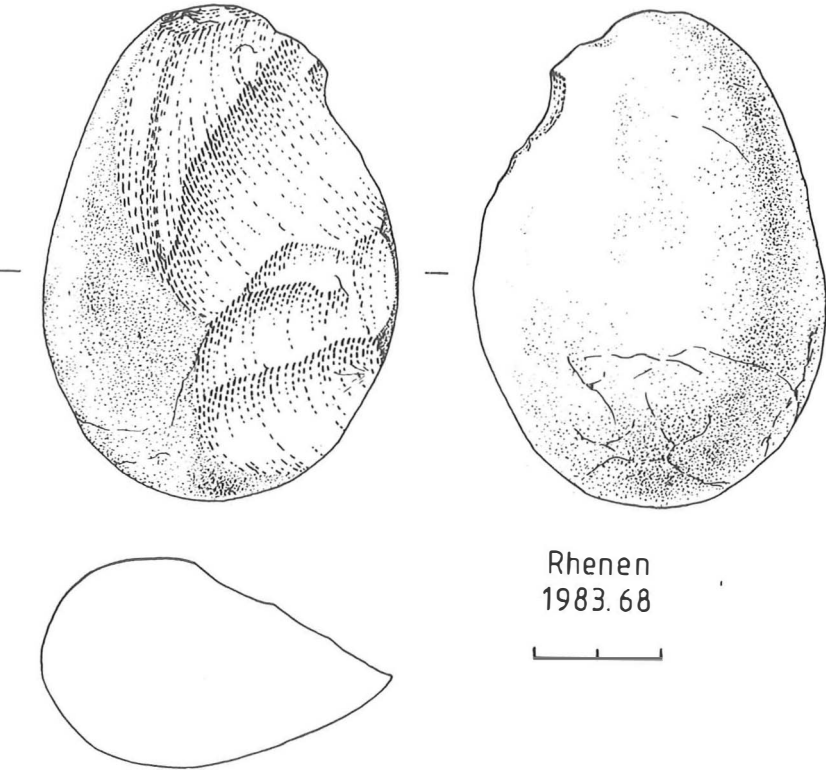


Fig. 4. Chopper made of quartzite, originating from Kwintelooijen (Kolen/Rensink/Spieksma collection). Scale in cm.

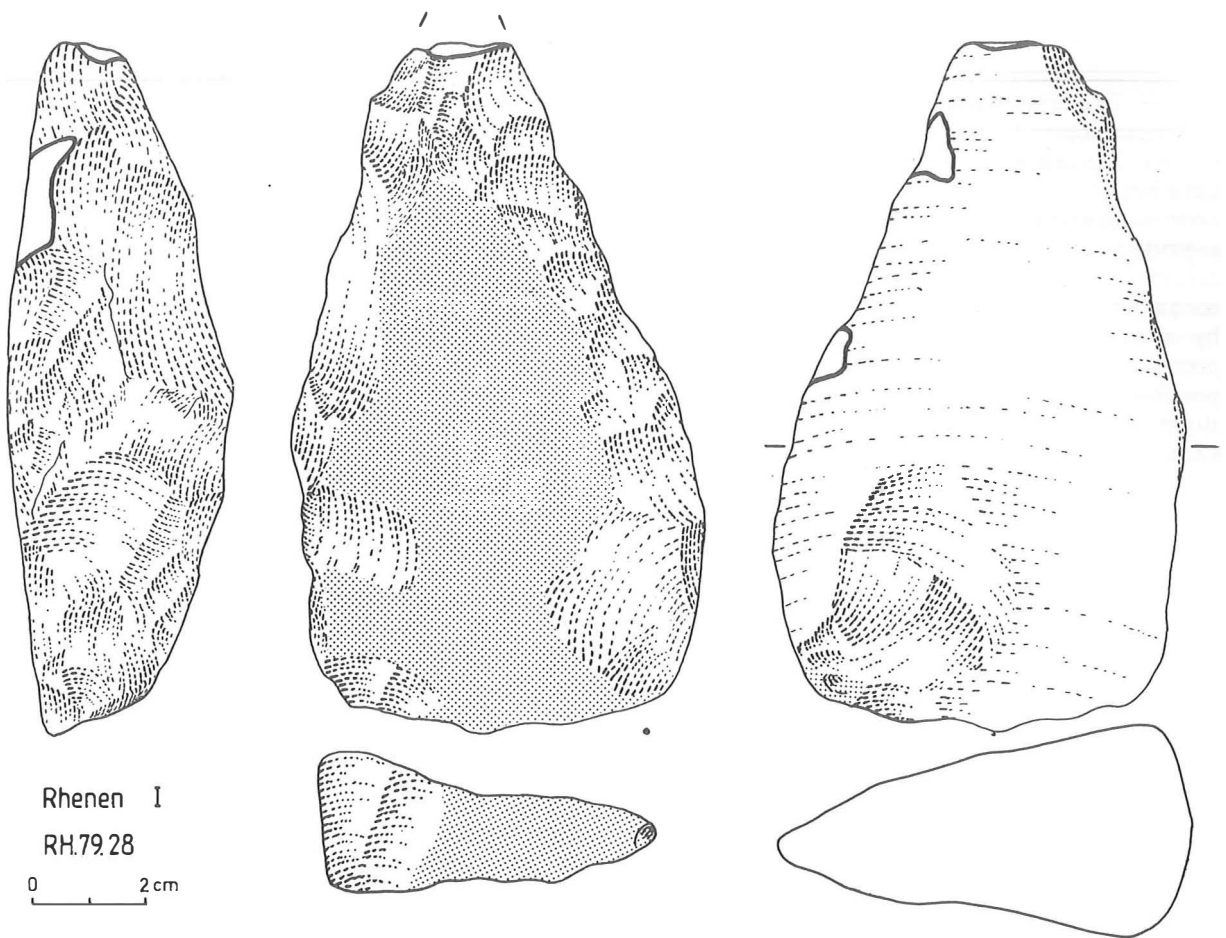


Fig. 5. Large scraper with a worked back (*Schaber mit bearbeitetem Rücken*: Baumann et al., 1983), manufactured from a quartzite flake, originating from Kwintelooijen (Kolen/Rensink/Spieksma collection). Scale in cm.

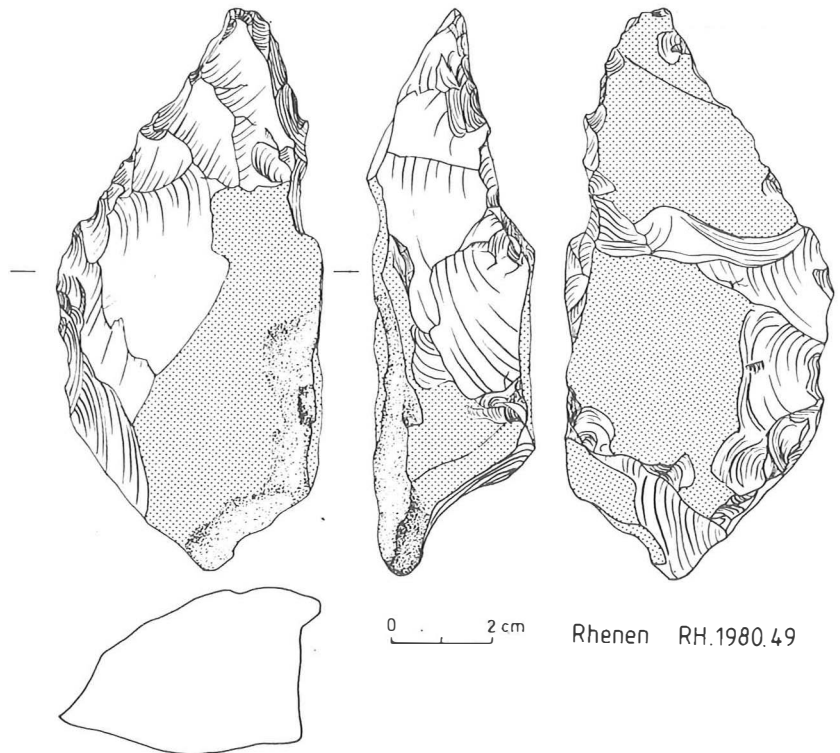


Fig. 6. Large scraper with worked back that alternatively could be called a *Keilmesser*, originating from Kwintelooijen (Kolen/Rensink/Spieksma collection).

stratigraphical observations were made, for example in the pit de Paltz near the airport of Soesterberg (fig. 1: 4), and at the findspot of the handaxe of Leersum (fig. 1: 7; see under 4).

Archaeologically the situation is somewhat frustrating. Though we know that thousands of finds have been collected at the various localities, so far no sites are known where the material was present in a primary *in situ* situation. In all cases where excavations have produced artefacts, these were encountered in gravel-bearing deposits laid down by a river. Though, geologically speaking, the preservation of archaeologically *in situ* sites is a possibility, for example in loams, this seems to be a slight one and such sites have not been demonstrated with certainty up till now. What we have, therefore, are collections of artefacts that cannot be split up into archaeologically meaningful assemblages. This means that we can give only rough descriptions of the Rhenen industry as a whole. We are therefore presented with an 'average' picture, which is biased in several ways. It is clear that the collections consist of residues of many occupations, maybe covering a time range of thousands of years. Because of fluvial erosion and transportation after the periods of occupation, commercial sand extraction techniques, selective collection of larger pieces at the brickworks by the many amateur archaeologists, and other processes, we can make no inferences about the character of the individual original sites. Therefore, only general statements on

the technology and typology of the Rhenen industry are possible.

Our investigations so far have produced the impression that most of the finds placed in the Rhenen industry derive from only one interstadial of the Early Saalian, which perhaps can be correlated with the Hoozeveen Interstadial (see 3). However, there are some indications that part of the finds encountered in Saalian gravels are older and could date from the Holsteinian. In my opinion there are not yet convincing data to support the proposition by Franssen, Wouters, Peeters, and others (e.g. Franssen & Wouters, 1979a; 1980; Peeters, *in press*) that several find levels in loams are also present in the sites near Rhenen, apart from the known find levels in gravels. Moreover, claims relating to very old finds from these sites (from Lower Pleistocene loams, with ages of over 1,000,000 years: e.g. Bosscha Erdbrink, 1981; Franssen & Wouters, 1979b; Peeters, *in press*) are so far without sound foundation (see 3).

2. GENERAL GEOLOGICAL ASPECTS

In the central Netherlands a series of ice-pushed ridges are present (fig. 1), which were pushed up by the ice-sheet during the Saalian. They have a maximum height of about 100 m above sea level. These ridges surround glacial basins which in some cases extend to depths of more than 125 m below sea

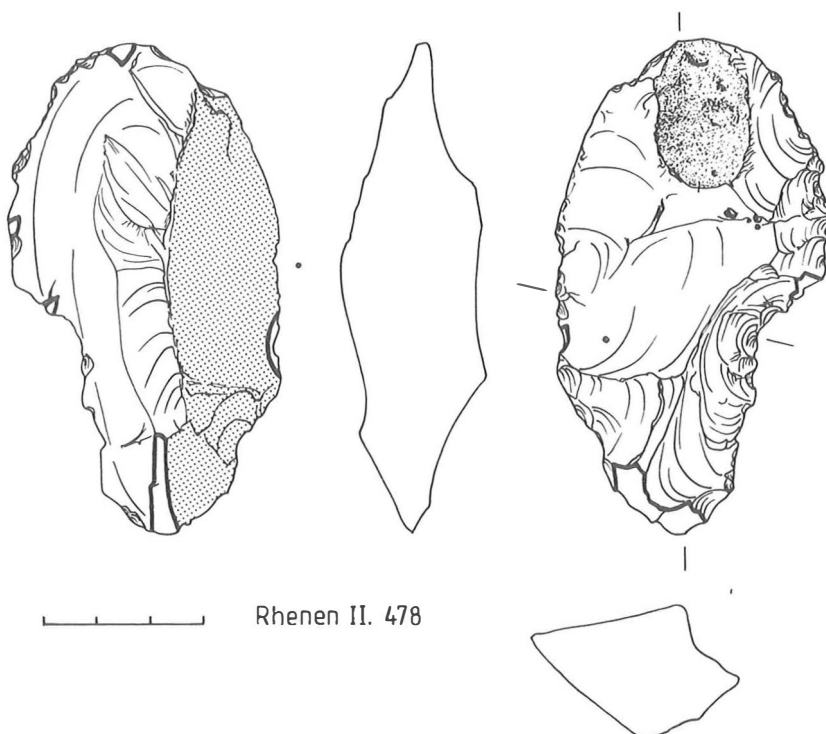


Fig. 7. Tool on a thick flake, combining a scraper edge and a clacton-notch, originating from Kwintelooijen (Franssen jr. collection). Scale in cm.

level (Jelgersma & Breeuwer, 1975). Some remains of till (ground moraine) are still present locally on the floor of these glacial basins which were subsequently filled up with several dozen metres of lacustriglacial clays, partly with a varve structure. These strata are overlain by marine deposits dating from the Eemian, and deposits dating from the Weichselian.

The ice-pushed ridges themselves consist of material that was pushed away laterally and frontally out of the glacial basins. In the central Netherlands this mainly consisted of Lower and Middle Pleistocene fluvial deposits of the Rhine and the Meuse, and to a lesser extent of Saalian meltwater deposits (see Zagwijn & van Staaldunin, 1975, for a survey of Quaternary formations in the Netherlands). The occurrence of extensive thrust planes, such that the sediment is stacked in thrust sheets, mostly several dozens of metres in thickness, with an imbricate structure, indicates that the material was pushed up by the ice in a frozen state. Several phases of ice-pushing can be distinguished (ter Wee, 1962; Jelgersma & Breeuwer, 1975; Maarleveld, 1981; van den Berg & Beets, 1986). Further north, several stationary phases of the limit of the ice can be discerned, which locally gave rise to ice-pushed moraine hills (ter Wee, 1962; 1981).

Dutch geologists place the entire period of Saalian ice-cover in the Netherlands, including all pushing and stationary phases, in the last stadial of the Saalian. During the first part of the Saalian, before the ice-cover, in the northern as well as the southern Netherlands, thick layers of mainly fine sands were deposited in a periglacial environment (Eindhoven Formation; see Ruegg, 1975; ter Wee, 1979; Zagwijn & van Staaldunin, 1975). Incorporated within these eolian or fluvio-periglacial deposits are several thin clay and gyttja layers, which were formed during interstadials. On the basis of pollen analysis of these layers in the northern Netherlands, Zagwijn (1973) was able to discern two distinct interstadials, the Hoogetveen Interstadial and the Bantega Interstadial. These must be interstadials within the Saalian, as below these layers deposits dating from the Late Holsteinian have been distinguished. Although the Bantega Interstadial was relatively cool, the older Hoogetveen Interstadial was more pronounced, and shows characteristics of an interglacial. So far no other interstadials within the Saalian have been discovered in the Netherlands. Of course, this does not mean that there may not have been more interstadials. For example, deposits dating from Early Saalian interstadials predating the Hoogetveen Interstadial could have been removed completely by later erosion.

At present, the Saalian in the Netherlands can be subdivided into 3 stadials (I-III), separated by the

two known interstadials. During the first two stadials the ice-sheet did not reach as far as the Netherlands. The second stadial was relatively brief and not very cold, but stadials I and III are characterized by phenomena such as cryoturbation and large frost-wedges (see e.g. van der Meer & Smeijjn, 1981). Pollen analysis of deposits in the glacial basin near Amsterdam has shown that between the retreat of the ice-sheet and the beginning of the Eemian, there were no significant climatic fluctuations, which supports the view that the ice-cover in the Netherlands occurred at the end of the Saalian (Jelgersma & Breeuwer, 1975). The climatic development during the Saalian as it has been determined for the Netherlands is shown in figure 17 (after Zagwijn, 1975). A recent discussion of the Dutch climatic curve for the Pleistocene is given by de Jong (1988). He suggests that both the Bantega and Hoogetveen Interstadials could be correlated with isotope stage 7 in the deep-sea curves (Shackleton & Opdyke, 1973), and the Holsteinian with stage 9. Unfortunately, there are not yet enough reliable data to support this view. Moreover, though stage 7 indeed shows two 'warm' peaks, the uppermost of these seems to be more pronounced than the lower one, which is the opposite of what one would expect if they were to be correlated with the Hoogetveen and Bantega Interstadials.

Severe problems relating to interregional correlations for the Middle Pleistocene clearly will stay with us for many years to come. For example, at present it is not at all clear how the Dutch subdivision of the Saalian should be correlated with the Saalian sequence as established by German geologists for the region of Hamburg (e.g. Ehlers, 1981; Grube, 1981; and other papers in: Ehlers & Zandstra, 1981). In the Hamburg area at least three Saalian tills are found (from bottom to top: Drenthe, Niendorf-Lamstedt, Fuhlsbüttel-Warthe), separated by 2 interstadials, but some published sequences are more complicated. German geologists tend to correlate the oldest till (confusingly named 'Drenthe') with the ice-cover in the Netherlands, but this would lead to a greatly extended 'Saalian' with four or more interstadials. Zagwijn (discussion appended to Ehlers, 1981) suggests that it is possibly the Warthe stage that can be correlated with the Dutch tills; this would at least present us with a more consistent solution.

Though the Rhenen industry as a whole is typologically quite comparable to the Markleeberg finds, and both are roughly dated to the 'Early Saalian' or the '*Saale Frühglazial*', this does not necessarily mean that they are of more or less the same age. It is unclear to me how the Dutch sequence should be correlated with the one in the Saale/Elbe region as described by Mania (1983;

1984). He distinguishes a 'Holstein Complex', made up of the Holstein Interglacial s.s. (in which sites such as Wallendorf are placed), the Fuhne Glacial, and the Dömnitz Interglacial (in which Bilzingsleben is placed; at Bilzingsleben in deposits supposed to be of Dömnitz age *Arvicola cantiana* is found); and a 'Saale Complex', composed of the 'Frühglazial' (with at least two interstadials – the presumed period of the Markkleeberg industry), the Saale Glacial s.s. (three tills), the Treene Interglacial, and the Warthe Glacial. Elsewhere, before the Treene Interglacial yet another cycle is postulated, consisting of the Rügen Interglacial and the Lausitz Glacial. According to van Kolfschoten (pers. comm.), the *Arvicola cantiana* present in Bilzingsleben is the same as the one found at Neede in the Netherlands (now renamed as *Arvicola terrestris cantiana* by van Kolfschoten: see below); therefore, van Kolfschoten places Bilzingsleben in the Holsteinian. As according to van Kolfschoten *Arvicola terrestris cantiana* is not known from other localities in the Saale-Elbe region, the Dömnitz Interglacial could possibly be correlated with the Hoozeveen Interstadial. A good impression of many other problems relating to the correlation among local sequences in western Europe can be gained from Tuffreau & Sommé (1986). It is clear that at least one interglacial occurred between the classic Holsteinian and Eemian, but we are still far from having solved the chrono-stratigraphical puzzle.

The ice-pushed ridges in the central Netherlands provide geological 'windows' into Middle and Lower Pleistocene deposits that otherwise would be covered by thick layers of younger sediments. As stated above, it is in layers of the Middle Pleistocene Urk Formation that artefacts of the Rhenen industry are encountered. These layers were pushed by the ice, so that we have a certain terminus ante quem for these finds: they must be older than the period of ice-cover. By definition the period of ice-cover is called the Middle Saalian in the Netherlands (Zagwijn, 1975), so that we may conclude that the Rhenen industry must be older than the third stadial of the Saalian. Locally (e.g. the Kwintelooijen pit), however, some pushed fluvial layers of the Urk Formation, containing artefacts, are placed in the Middle Saalian by geologists, because these layers incorporate some elements of northern origin (Zandstra & Ruegg, 1984), suggesting that the ice-sheet was already present in the area.

Both of the pits near Rhenen (Leccius de Ridder, Vogelenzang) as well as the Kwintelooijen pit (and other pits) yielded mammalian fossils, which have been studied by van Kolfschoten (1981). Most probably they all derive from the same coarse layers of the Urk Formation that contain artefacts. Van Kolfschoten found the following species to be

present: *Mammuthus primigenius*, *Elephas antiquus*, *Equus* sp., *Equus* cf. *hydruntinus*, *Dicerorhinus mercki*, *Dicerorhinus hemitoechus*, *Coelodonta antiquitatis*, *Sus scrofa*, *Hippopotamus* sp., *Megaloceros giganteus*, *Cervus elaphus*, *Ovibos* aff. *moschatus*, *Bison priscus*, *Trogontherium cuvieri*. This list differs somewhat from the list published by van Kolfschoten in 1981. The list given here is taken from the thesis by van Kolfschoten (which is in press). In his thesis van Kolfschoten also renamed the *Arvicola* series: *Arvicola terrestris cantiana* instead of the former *A. cantiana*, *A. terrestris* ssp. A instead of *A. cantiana/terrestris*, and *A. terrestris* ssp. B instead of *A. terrestris*, but this has no consequences for the evolutionary interpretation. Half of the material studied by van Kolfschoten comes from the mammoth; the occurrence of *Hippopotamus* and *Ovibos* is striking. The fauna includes both cold and warm elements, thus suggesting that we are dealing with a mixture of at least two faunas. The cold elements most probably date from the Saalian, and may therefore be more or less contemporaneous with the deposits in which they are found. This is less evident for the warm elements, some of which according to van Kolfschoten could date from the Holsteinian or from interstadials of the Saalian (e.g. the Hoozeveen Interstadial). However, *Trogontherium* and *Hippopotamus* could be older than the Holsteinian, and may date from a late part of the Cromerian Complex (van Kolfschoten, pers. comm.). Already in the 1930s a mammoth mandibula from the railway pit at Maarn (fig. 1: 8) was described by van den Broek (1939), which showed traces of butchering.

Bosscha Erdbrink et al. (1979) described a proximal fragment of a human femur that they attributed to a 'neanderthaloid'. The bone was found in 1967 in one of the two pits near Rhenen. They suggested that the bone might have been broken intentionally to extract the marrow. The femur (property of the Museum voor het Onderwijs, Den Haag) has recently been subjected to radiocarbon analysis in Groningen. The result was: 1330 ± 110 BP (GrN-12079). It now seems clear, therefore, that the bone dates from the Middle Ages (Stapert, 1986). The same is true for some other finds of human bone, attributed by Bosscha Erdbrink to Pleistocene man (Gowlett et al., 1987).

3. DATING THE RHENEN INDUSTRY: PROBLEMS AND POSSIBILITIES

3.1. The Kwintelooijen pit between Rhenen and Veenendaal

At the sites where systematic research was carried out, the find level was invariably lithologically the

same: a gravel-bearing coarse sand layer with angular cobbles and boulders at its base. During our field research artefacts were never found in clays or loams, though these were investigated at several spots.

From the sandpits in the Rhenen area (Vogelenzang, Leccius de Ridder, Kwinteloijen) several thousands of artefacts have been collected by at least ten amateur archaeologists. These collections result almost exclusively from the searching of gravel dumps at the brickworks of Vogelenzang and Leccius de Ridder in Rhenen. Here the gravel is sifted from the sand; part of the sand from Kwinteloijen is sifted here too. It is obvious that the stratigraphical origin of these finds can no longer be traced. Therefore, our initial investigations (1979, 1980) were mainly concerned with establishing from which layer(s) in the sandpits the finds originated. Due to finds made in situ by C. Lagerwerf and M. Köppen in the Kwinteloijen pit, our first excavations were carried out in that sandpit, in cooperation with the Geological Survey (G.H.J. Ruegg, J.G. Zandstra, J. de Jong), and T. van Kolfschoten (University of Utrecht). The results of the geological and archaeological investigations in Kwinteloijen during 1979-1980 have been published elsewhere (de Jong, 1981; van Kolfschoten, 1981; Ruegg, 1981; Stapert, 1981b; van der Wateren, 1981; Zandstra, 1981); here only a few summarizing remarks will be made. Ruegg (1981)

distinguished a total of 10 lithological units. Units 1-3 at the base of the sequence are, on the basis of the petrological (Zandstra, 1981) and pollen-analytical (de Jong, 1981) findings, placed in the Kedichem Formation; unit 2 is dated to the Lower Pleistocene Waalian Interglacial. Unit 1 consists of fine sand, unit 2 of grey clay (in some places with a peaty layer at the top), and unit 3 of brown loam. Units 2 and 3 are assumed to be backswamp deposits. Unit 4 consists of fluviatile sands that are placed in the Urk Formation ('Urk I'), and that can probably be dated to the upper part of the 'Cromerian Complex' (Zandstra, 1981). Unit 5 starts with an erosion level at its base. It consists of gravels and gravelly coarse sands, with angular cobbles and boulders at the base. Many stones have been frost-split in situ, pointing to cold conditions during or immediately after deposition. Units 6-8 are gravelly sands, upwards gradually becoming finer. Units 5-8 can be placed in a later part of the Urk Formation ('Urk II') and are dated in the Saalian. Within the most complete thrust sheet in Kwinteloijen (B), units 5-8 are dated to the Middle Saalian because of the presence of some northern gravel particles in the basal part of unit 5 (Zandstra, 1981). In other thrust sheets locally a sandy silt layer is present within the gravelly sands of units 5-7, 2 to 5 m above the base of unit 5; its thickness varies from 0.5 to more than 2 m. This silt layer was not present in the sections studied archaeologically in 1979 and 1980; it was

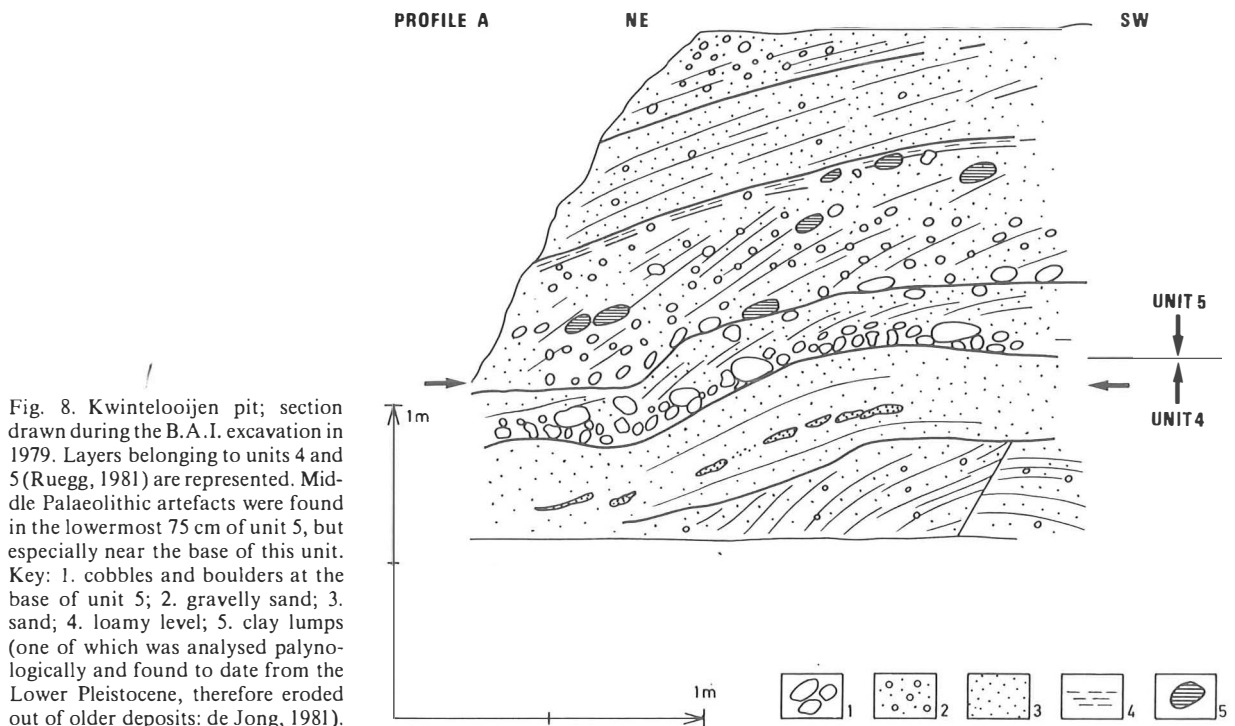


Fig. 8. Kwinteloijen pit; section drawn during the B.A.I. excavation in 1979. Layers belonging to units 4 and 5 (Ruegg, 1981) are represented. Middle Palaeolithic artefacts were found in the lowermost 75 cm of unit 5, but especially near the base of this unit. Key: 1. cobbles and boulders at the base of unit 5; 2. gravelly sand; 3. sand; 4. loamy level; 5. clay lumps (one of which was analysed palynologically and found to date from the Lower Pleistocene, therefore eroded out of older deposits: de Jong, 1981).

investigated in 1986 (see below). Finally, units 9 and 10 are sands and gravelly sands deposited as ice-contact sediments (mass flow deposits and *sandur* deposits, respectively), placed in the Drente Formation and dated to the Middle Saalian (see for sedimentological descriptions of these types of sediments: Ruegg, 1977; 1981; 1983).

In 1979 and 1980 the gravel of the lowermost 1-2 m of unit 5 was sifted (mesh width mostly 0.8 cm, but initially 0.4 cm) in three different places in the Kwintelooijen pit (within thrust sheets A and Y). This resulted in the retrieval of c. 30 artefacts from these gravels. The average density of finds was quite low, approximately 1 artefact per 1.5 cubic metre of sediment (see Stapert, 1981b for details on these excavations). At some other spots, however, find density seems to have been somewhat higher (Lagerwerf, pers. comm.; see Stapert, 1981b). Most of the finds were present immediately above the base of unit 5 (fig. 8). The scarce finds occurring higher in the sections were mostly smaller than the finds in the basal part of the gravel. Higher than 1 or 2 m above the base of unit 5 hardly any artefacts were encountered.

Most of the finds collected from the basal gravels of unit 5 are patinated brown, rolled and scratched. However, about 17% of these artefacts are not or hardly rolled, and scarcely patinated. This general pattern is very similar to what was found during the recent excavations near Markkleeberg (Baumann et al., 1983). Those finds were also encountered in river gravels, laid down by the rivers Pleisse and Gösel and dated to the Early Saalian. Again, most artefacts were present at the base of the gravel, while artefacts occurring higher up were mostly smaller (see Baumann et al., 1983: especially Abb. 20).

The uppermost 1 m of unit 4 in Kwintelooijen was also sifted at two spots, but these sands appeared to be sterile archaeologically. Also the clay or loam layers of units 2 and 3 were inspected in several places, but no artefacts could be detected in these layers. Various authors, however, claim to have collected artefacts from these Lower Pleistocene clay layers (e.g. Bosscha Erdbrink, 1981; Franssen & Wouters, 1981; Peeters, in press; pers. comm.). We have the impression, however, that these reports are not based on careful stratigraphical and archaeological observations. For example, the chopping-tool described by Bosscha Erdbrink and Franssen & Wouters, which presumably originated from either unit 2 or 3 (depending on which publication is referred to), was collected not in situ, but in loose material at the base of a profile. Moreover, most if not all of the finds reported by Franssen & Wouters, judging from their illustrations, could be (natural) pseudo-artefacts. Finally, at the top of unit 3 gravel-lenses are present locally in shallow depressions in the surface of this loam layer, which when observed

only superficially could be interpreted as belonging to unit 3. Some 60 to 70% of the stones in these gravel lenses are fractured and damaged (Zandstra, 1981), some of which to the not too critical observer could resemble artefacts. I have collected several large samples from these gravel lenses, and in my opinion definite artefacts are absent within these lenses. Geologists of the Geological Survey have never come across gravel particles of any kind whatsoever within the clays and loams of units 2 and 3 during their extensive field research in the Kwintelooijen pit (Ruegg, pers. comm.). Therefore, it is my opinion that so far no conclusive evidence has been produced for the occurrence of artefacts in layers older than those of unit 5 in the Kwintelooijen pit. Nevertheless, the reports by Franssen & Wouters constituted one of the arguments for preserving the part of the Kwintelooijen pit from which their finds presumably came, as a listed geological and archaeological monument.

Wouters & Franssen (1978a; 1978b; 1979a; 1979b; 1981) claimed that 3 or 4 artefact-bearing levels are present in the sand pits near Rhenen, of which 2 or 3 are loam layers (the paper by Peeters is essentially based on the reports by Wouters & Franssen). The widespread occurrence of a number of phenomena on most of the flint artefacts from the pits near Rhenen, however, appears to conflict with an origin in loam or clay layers: signs of rolling, scratches (sometimes very coarse, see also under 4), brown patina. Artefacts enclosed in loam layers will in general be neither rolled nor scratched. The frequent occurrence of the mentioned phenomena rather indicates a layer of gravel as the artefact-bearing level. It is therefore not surprising that the B. A. I. excavations have shown that the lowermost 1 to 2 metres of unit 5 contain artefacts: these sandy gravels are the coarsest layers exposed in the Kwintelooijen pit (for further comments on the stratigraphical allocations by Franssen & Wouters: see Stapert, 1981b). Furthermore, it can be said that the collections from the gravel dumps at the brickworks, the isolated finds made in the Kwintelooijen pit, and the excavation finds (from unit 5 in Kwintelooijen) are reasonably comparable, both as far as the patination, scratching and degree of rolling are concerned and typologically, though the collections from the excavations are quite small due to the low find densities. This means that it is not necessary to postulate several find levels in the Kwintelooijen pit, though of course this possibility cannot be completely ruled out. Unfortunately, it is impossible to prove that any layer is totally devoid of artefacts. I am still of the opinion that the presence of artefacts in layers older than those of unit 5 has not been convincingly demonstrated.

At the moment our research is directed especially towards pinpointing the chrono-stratigraphical po-

sition of the Rhenen industry. The gravelly deposits that are artefact-bearing most probably date from the Early Saalian (defined as the part of the Saalian before the arrival of the ice sheet), though part of these layers seem to date from Stadial III. This does not necessarily imply that the artefacts also date from the Early Saalian: theoretically they could date from earlier periods; in that case they would have been reworked from older sediments during the Early Saalian, and would now be part of these gravels secondarily. Leaving aside this possibility for the moment, we can state that the find-bearing deposit itself dates from the Early Saalian and partly from the Middle Saalian. The Early Saalian consists of at least 2 stadials and 2 interstadials. The question is therefore: is it possible to narrow down the dating for the artefact-bearing gravel within this rather long period? To this end we have selected for investigation a number of locations where clay, loam or silt layers are incorporated within the Early Saalian gravels and sands. So far, in three locations such fine-grained layers have been found: the Kwinteloijen pit near Rhenen, the Fransche Kamp pit near Wageningen, and the pit de Paltz near Soesterberg. In the first two of these, combined geological/archaeological investigations have been carried out in the last few years. At the moment at

least two stratigraphically distinct clay or silt layers have been recognized within the Early Saalian. This can only be a provisional statement, as much work, especially palaeontological and palynological research, is still in progress (see below for a contrasting opinion of de Jong).

In 1986 in the Kwinteloijen pit an exposure was studied in which a sandy silt layer was present within the gravelly sands of unit 5 (see figs 9-11). This section was studied archaeologically and geologically, in cooperation with the Geological Survey. The coordinates of this location were estimated as follows: Topographical Map of the Netherlands, sheet 39E: 165.75/444.80. The silt layer was sampled by T. van Kolfschoten (University of Utrecht); it proved to be devoid of remains of smaller mammals (van Kolfschoten, pers. comm.). Fortunately, it was possible to extract pollen from it, which is being studied by J. de Jong. According to de Jong (pers. comm.), the silt layer must have been deposited during a relatively cool interstadial, or during a later part of a warmer interstadial. In view of the stratigraphy as a whole, this must be an interstadial within the Early Saalian. Within the silt layer several thin sand layers are present, of which at least one contains quite a lot of remains of fluvial molluscs; these are being studied by T.

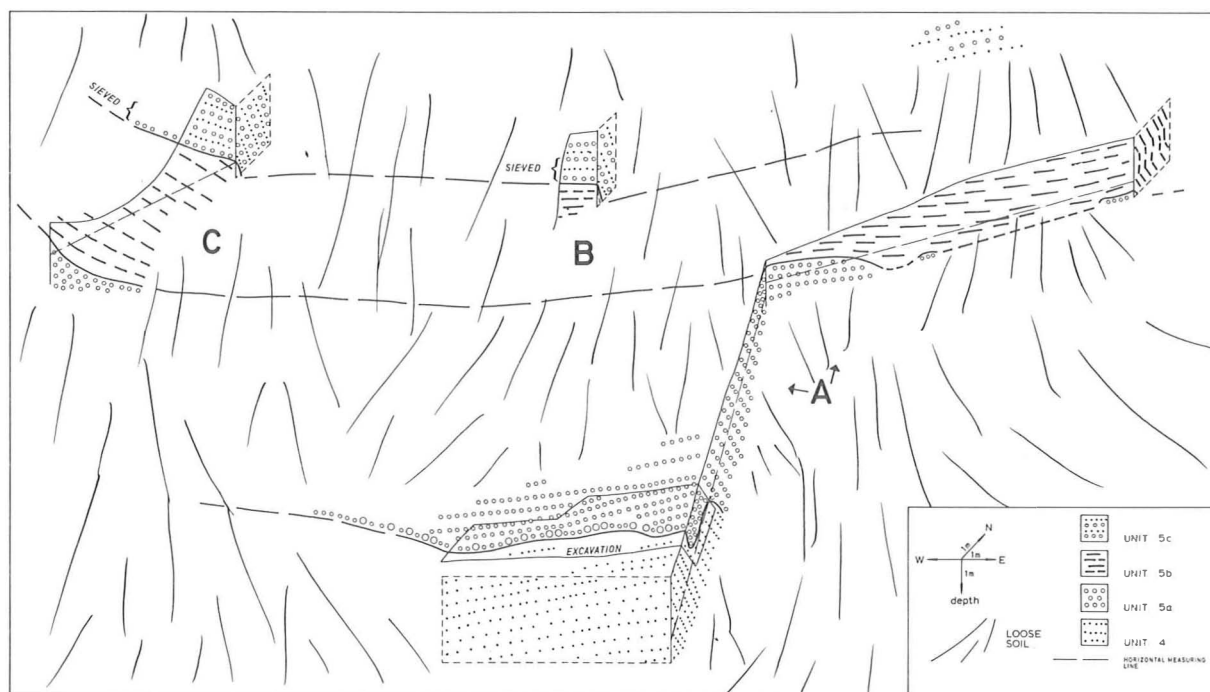


Fig. 9. Kwinteloijen pit, investigation of 1986. Here within the gravelly sands of unit 5 (Ruegg, 1981) a silt layer was present, allowing unit 5 to be divided into three subunits. The various sections that were inspected and drawn are indicated in this diagram, showing their positions with respect to each other. The gravels at the base of unit 5a were sifted, and proved to contain Middle Palaeolithic artefacts (see figs 12, 13). The gravelly sands at the base of unit 5c, on top of the silt layer, were also sifted, but appeared to be archaeologically sterile.

Meijer. Locally, we have divided the sediments belonging to unit 5 into three subunits:

Unit 5a: from the base of unit 5 up to the base of the silt layer. Maximum thickness c. 3 m. Coarse gravel-bearing sands, at the base sandy gravels with cobbles and boulders.

Unit 5b: silt layer with intercalated sand levels. Maximum thickness 2.5-3 m. In the middle a 30-60 cm thick sand layer contains many small molluscs, especially in its lowest 10 cm.

Unit 5c: coarse gravelly sands, at the base at most 0.5 m of sandy gravels.

During the investigation in 1986 the sandy silt layer was inspected carefully, but no artefacts were found in it. From the lowermost 0.5 m of unit 5a we sifted approximately 11 cubic metres of gravel, resulting in the retrieval of 10 certain Middle Palaeolithic artefacts (figs 12-13). From the lowermost 0.5 m of unit 5c approximately 5.5 cubic metres of gravel

were sifted, but no certain artefacts were found in this gravel.

The finds from unit 5a comprise 2 retouched tools (fig. 12), and 8 flakes or flake-fragments that are mostly quite small (fig. 13). The first tool (fig. 12: 1) is a fine side-scraper, not made on a flake, but on a core-like piece of flint. The second tool (fig. 12: 2) is a cortex flake with scraper-like retouch on the left side, though some of its retouches could well be of natural origin. The find density in unit 5a was approximately: 1 artefact per 1.1 cubic metre of gravel. This is somewhat higher than the density found during the excavations of 1979 and 1980, but this can be explained by the fact that in 1986 we only sifted the lowermost 0.5 m of the gravel, and during the earlier excavations a thicker layer of gravel: we know that the density of finds quickly decreases going upwards from the base of unit 5. With respect to patination and rolling, the finds of 1986 are comparable with the finds recovered earlier from

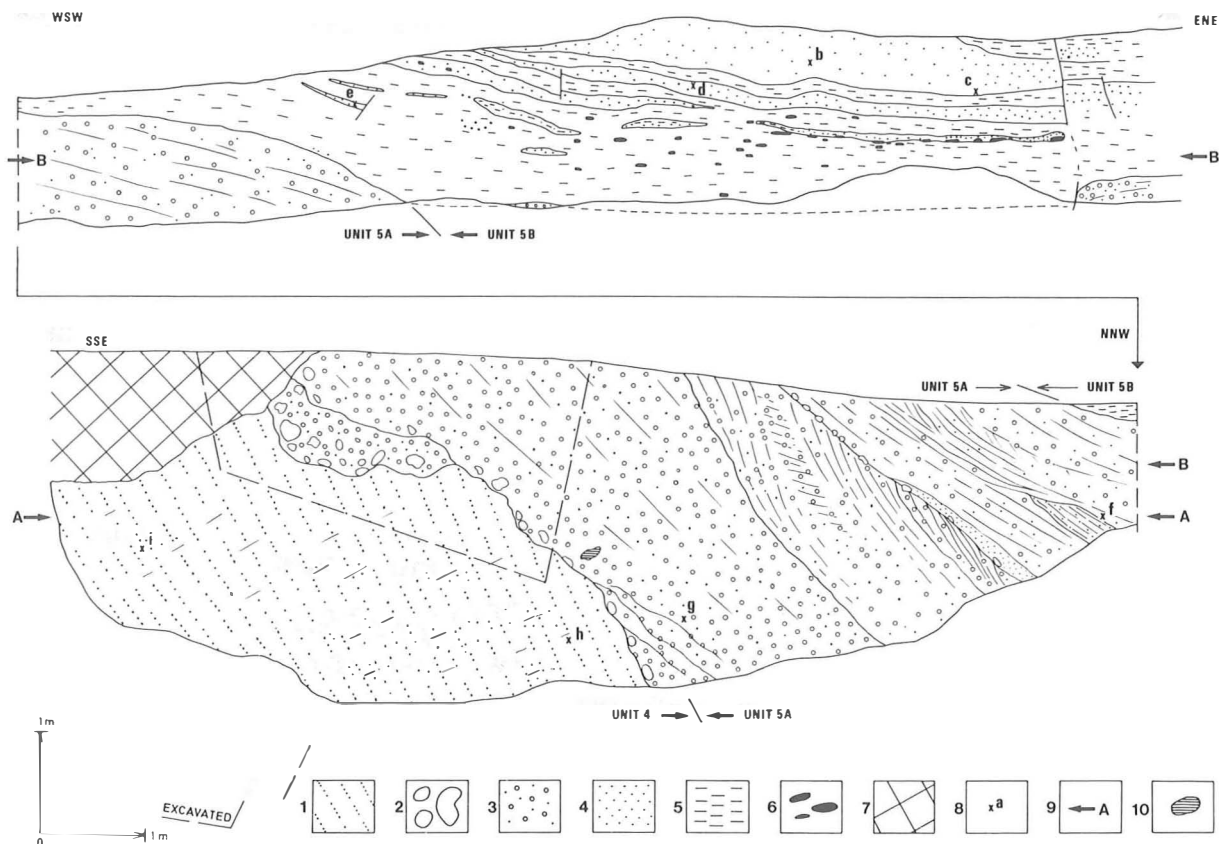


Fig. 10. Kwintelooijen 1986. Section A (for position see fig. 9). Key: 1. laminated sands of unit 4 (Ruegg, 1981), probably dating from the 'Cromerian Complex' (Zandstra, 1981); 2. cobbles and boulders, occurring especially at the base of unit 5a; 3. sandy gravels; 4. coarse sands; 5. sandy silt; 6. limestone concretions; 7. disturbed; 8. petrological samples taken by the State Geological Survey; 9. horizontal baselines; 10. clay lumps. Part of the basal gravel at the base of unit 5a was sifted during the excavation (indicated in the figure); here an erosion gully could be observed at the base of unit 5. From the lowermost 0.5 m of unit 5a, 10 Middle Palaeolithic artefacts were recovered (figs 12, 13).

the basal gravel of unit 5 in the Kwintelooijen pit. Apart from the flint artefacts, a piece of red ochre (max. diameter 1.8 cm) was collected from the basal gravel of unit 5a.¹

3.2. The Leusderheide and the pit de Paltz near Soesterberg

During the summer of 1984 sections in a cutting for the A28 motorway on the Leusderheide were studied geologically (Ruegg, 1986; Zandstra, 1985) and archaeologically (fig. 1: 3). One large profile was drawn (fig. 14). As in the Kwintelooijen pit, clear-cut thrust planes could be observed here. Fluvatile deposits were pushed over meltwater deposits (fig. 14: C) formed in immediate contact with the ice-sheet. The fluvatile sediments can be divided into two parts (fig. 14: A and B): an older unit (probably

Sterksel Formation) consisting of sands with only a little gravel (A), and a younger unit (B) of gravel-rich coarse sands. Unit B is comparable in all essential aspects with the gravelly sands of unit 5 in the Kwintelooijen pit. On the Leusderheide too, these layers are characterized by the presence of angular cobbles or boulders. Unit B contained three gravel-rich levels, indicating three erosion phases during the period of deposition. The excavation showed that these gravelly levels contained artefacts, while in sediments of the other two units no artefacts were encountered. This result presents us with basically the same picture as in the Kwintelooijen pit: artefacts in gravelly sands at the base of coarse sands belonging to a younger part of the Urk Formation ('Urk II'). On the Leusderheide the find density was somewhat lower than in the Kwintelooijen pit, but the finds are similar, both typo-

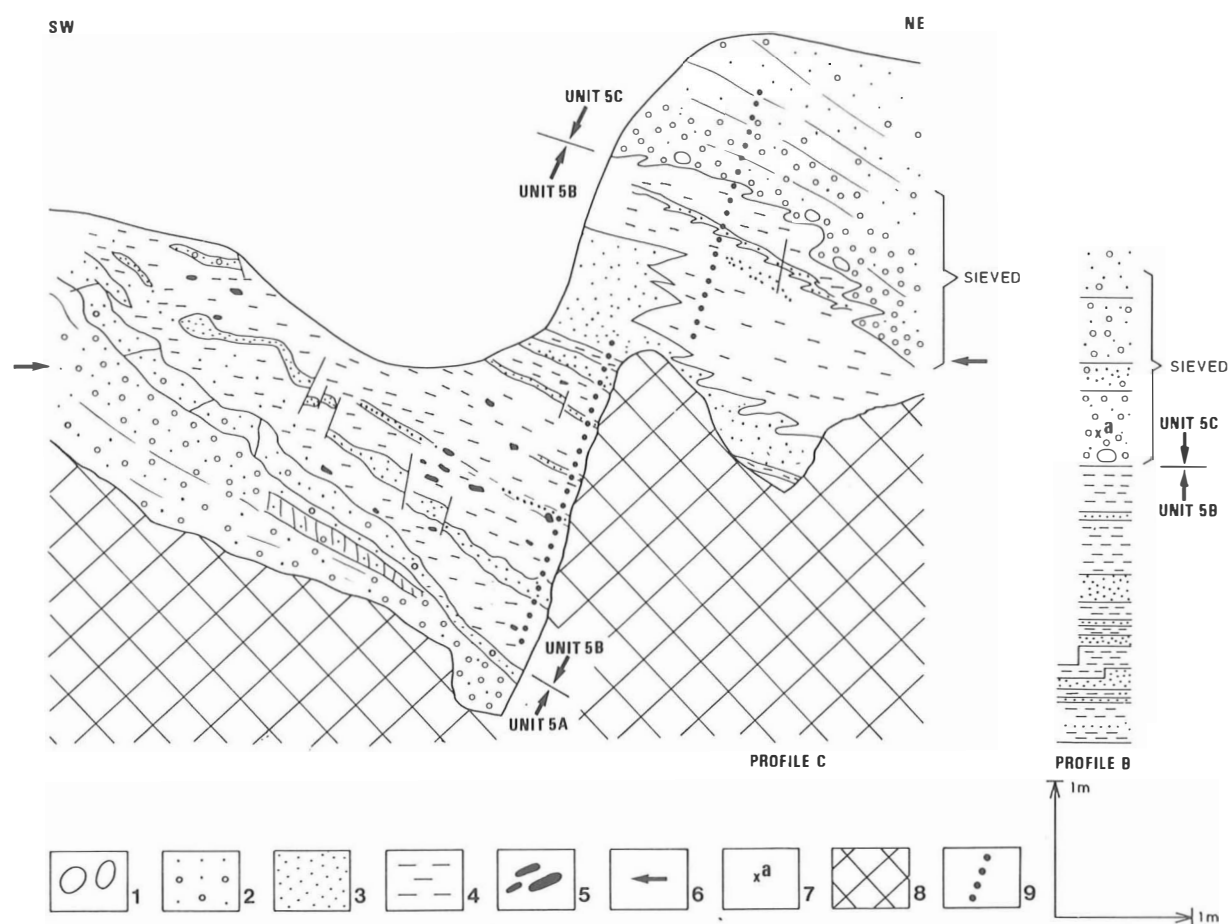


Fig. 11. Kwintelooijen 1986. Sections B and C (for position see fig. 9). Key: 1. cobbles and boulders; 2. gravelly coarse sands; 3. sands; 4. sandy silt; 5. limestone concretions; 6. horizontal baseline; 7. petrological sample taken by the State Geological Survey; 8. disturbed; 9. sequences sampled for palynological analysis (de Jong, State Geological Survey). It can be seen that unit 5b in fact consists of an alternation of silty and sandy levels; in the middle is a somewhat thicker sand layer that contains quite a lot of molluscs (studied by Meijer, State Geological Survey). The lowermost 0.5 m of unit 5c was sifted by the B.A.I., both in section B and C, but these gravels appeared to be devoid of artefacts.

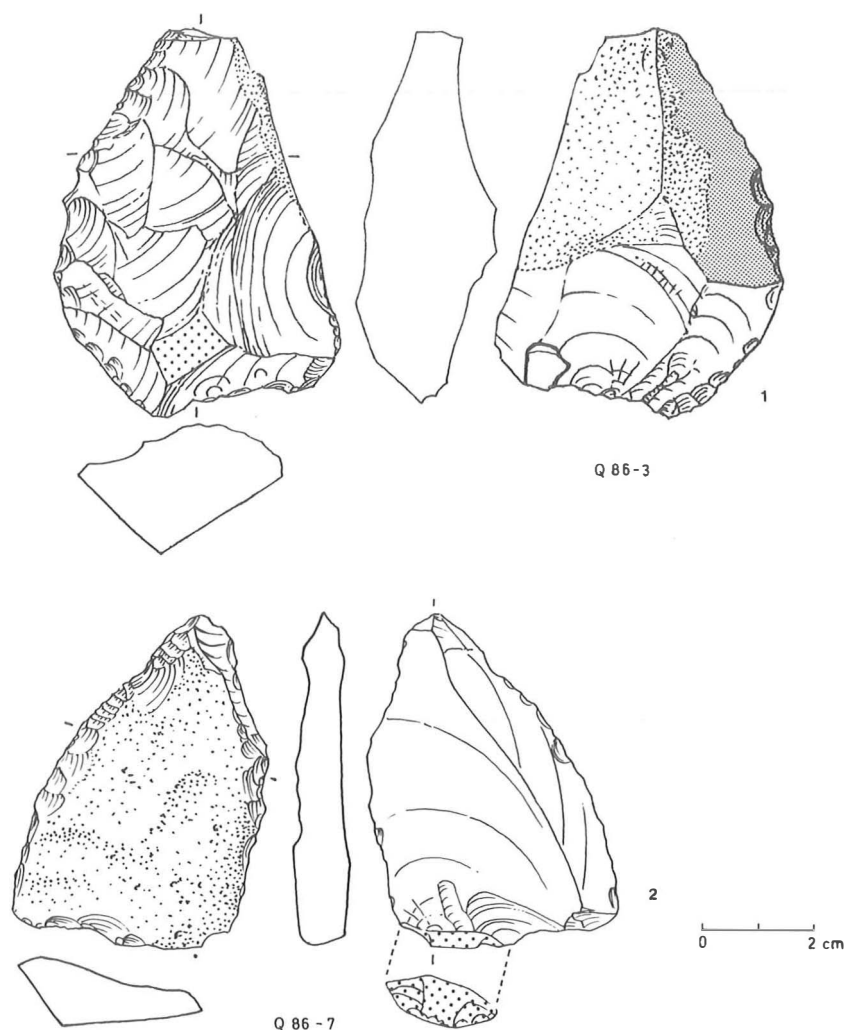


Fig. 12. Two artefacts recovered from the lowermost 0.5 m of unit 5a in Kwintelooijen during the excavation of 1986 (see figs 9, 10). 1. scraper on a core-like piece; 2. retouched flake (some retouches could be natural in origin).

logically and with respect to their surface modifications (a report on the results of this excavation is in preparation for a next volume of *Palaeohistoria*). Several dozens of Middle Palaeolithic artefacts have been collected at this site by amateur archaeologists A. Boelsma, J. Offerman-Heykens, and others.

In the pit de Paltz near Soesterberg more than hundred Middle Palaeolithic finds have been collected by A. Boelsma, J. Offerman-Heykens, and others. Here sandy gravels occur at the base of deposits that can be placed in a later part of the Urk Formation. Almost at the base of these gravels I collected a side-scraper in situ (figs 15, 16); nearby J. Offerman-Heykens collected a flake in situ from a gravel layer (pers. comm.), which is probably the same layer from which the scraper was collected. In the pit a clay layer is present locally. Remains of small mammals from this layer are being studied by T. van Kolfschoten. He suggests that this clay layer could be of the same age as the one in Wageningen-

Hoog (see below), but the sample was much too small to be certain of this (pers. comm.). The exact stratigraphical position of the clay layer with respect to the Saalian gravels is not yet known (the clay layer was not present in the section from which the scraper was collected); the stratigraphical interpretation in figure 17 should be considered as provisional.

3.3. The Fransche Kamp pit near Wageningen-Hoog

An important site is the Fransche Kamp pit in Wageningen-Hoog (fig. 1: 5). As most exposures in the pushed ridges of the central Netherlands, it features not only pre-Saalian fluvial sediments, and meltwater deposits of the Drente Formation, but also gravelly coarse sands placed in the later part of the Urk Formation ('Urk II'). Within these coarse layers again a clay layer is present – the main

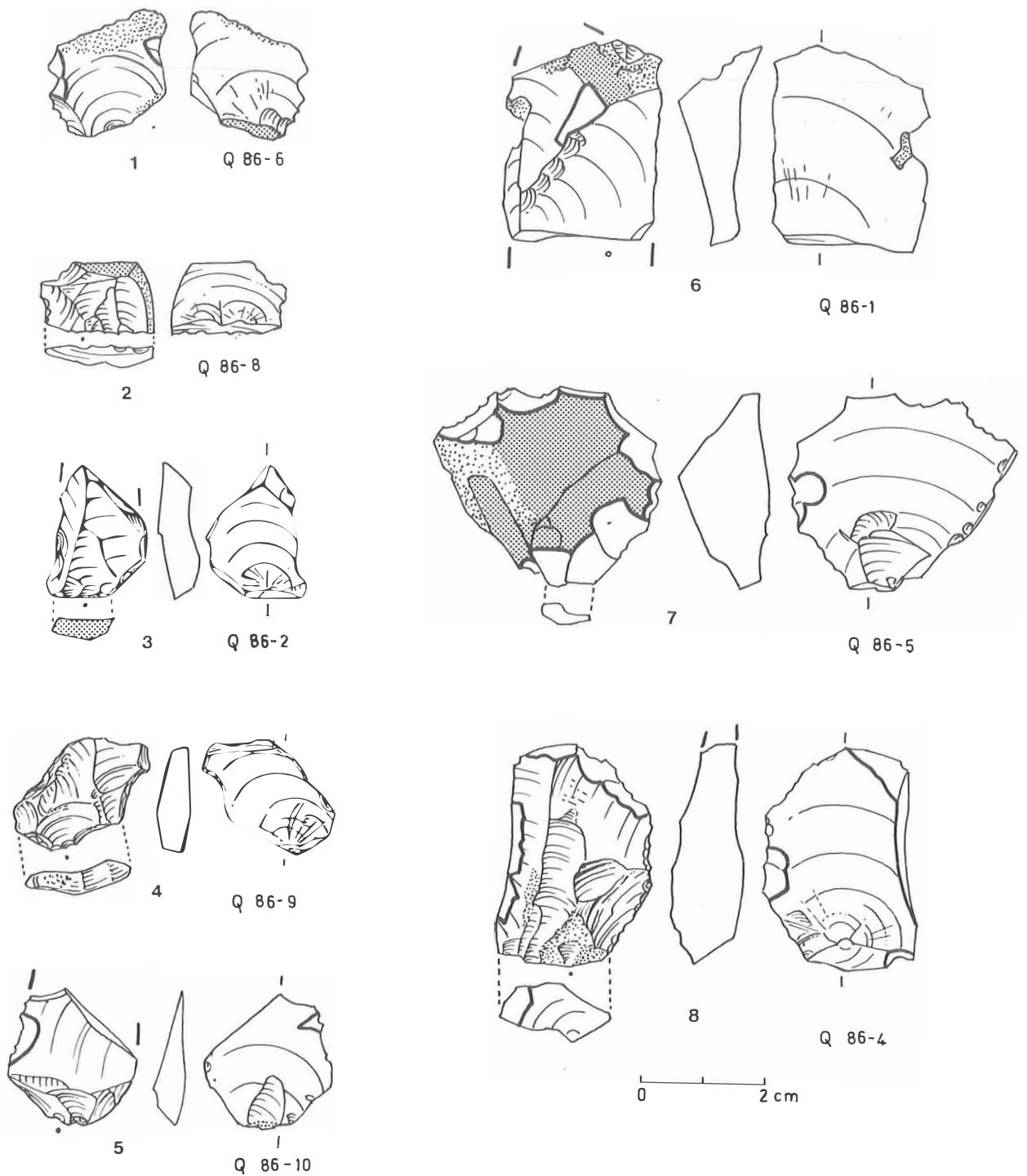


Fig. 13. Flakes, excavated from the lowermost 0.5 m of unit 5a in Kwinteloijen, 1986 (see figs 9, 10).

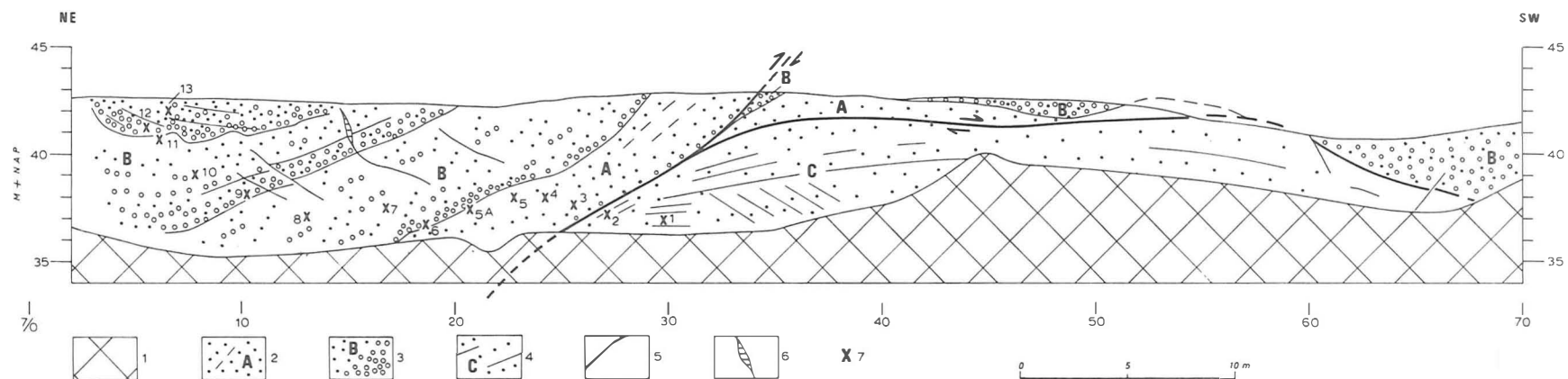


Fig. 14. Section drawn during the archaeological/geological investigation in the cutting for the A28 motorway on the Leusderheide, 1984. Key: 1. disturbed; 2. older fluvial deposits; 3. coarse gravelly sands placed in a later part of the Urk Formation (within these sands three gravelly levels can be seen – these contain Middle Palaeolithic artefacts); 4. meltwater deposits of the Drente Formation; 5. thrust planes; 6. faults filled up with clay; 7. samples taken by the State Geological Survey.



Fig. 15. Section in the pit de Paltz near Soesterberg, 12-VI-1987. Length of jointer: 30 cm. Left is c. NW, right is c. SE. The upper half of the exposed layers consists of coarse gravelly sands that can be placed in a later part of the Urk Formation ('Urk II'). At the base of these, two 10-20 cm thick gravel layers are present (slightly folded), separated by fine sand 10-20 cm in thickness. In the uppermost of the two gravel layers a side-scraper was encountered in situ (indicated by an arrow; the scraper is illustrated in fig. 16). Below the gravel layers, sands are present that can most probably be placed in an older part of the Urk Formation; they resemble the sands of unit 4 in Kwintelooijen (Cromerian Complex?). Photo D. Stapert.

reason for an archaeological investigation at this locality. The sandpit is located on the highest part of the Wageningen-Lunteren ridge; in it a section of c. 200 m long, which was studied geologically and archaeologically, has the following coordinates: Topographical Map of the Netherlands, sheet 39F: 176.90/445.50-177.18/445.57. Only a few Middle Palaeolithic finds have been collected in this pit. Eight artefacts were collected by J. Offerman-Heykens, J. Kolen, E. Rensink and A. Spieksma in 1984 and 1985. A.M. Wouters and C.J.H. Franssen claim to have collected 5 other artefacts in the pit in 1978 and 1979. The thirteen artefacts comprise 2 cores, a partly retouched levallois flake, 2 unretouched levallois flakes, one levallois blade, one blade-like flake, and 6 other flakes (Rensink & Spieksma, 1987). None of these artefacts had been collected in situ; the same applies to 2 flakes that I myself found.

The section is being studied by a team of the Geological Survey (G.H.J. Ruegg, J.G. Zandstra,

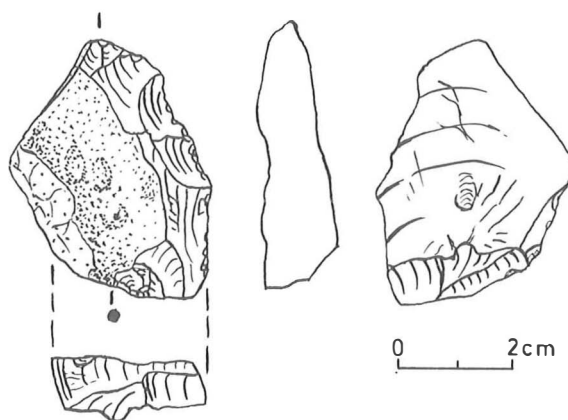


Fig. 16. Side-scraper, collected in situ from a thin gravel layer near the base of gravelly sands that can be placed in a later part of the Urk Formation (see fig. 15). Pit de Paltz near Soesterberg. Drawing D. Stapert.

J. de Jong, T. Meijer, A.W. Burger), and by the palaeontologist T. van Kolfschoten (University of Utrecht). Within the pushed sediments five thrust masses have been distinguished by G.H.J. Ruegg (1987), labelled A-E, going from east to west. The thrust sheets have on average a thickness of 40 m and they dip towards the west, indicating that the pressure was from the west. Within the various thrust masses the same stratigraphical sequence is repeated. Ruegg (1987) distinguished 5 lithological units, numbering them 1-5 from bottom to top:

Unit 1. Mostly sands, probably deposited by a braided river system; thickness somewhat more than 8 m. This unit is placed in the Sterksel Formation.

Unit 2 (field name 'Urk a'). Fluvatile sands; thickness 3 to 4.5 m. These sands can be placed in an older part of the Urk Formation (Cromerian Complex?).

Unit 3 (field name 'Urk b'). Fluvatile gravels, sands, loams and clays, probably deposited by a meandering river; thickness 9 to 15 m. From bottom to top the layers within this unit gradually become finer. At the base, an erosion level, cobbles and angular boulders are present, followed by sandy gravels, gravelly sands and sands with intercalated loam layers. At the top is a clay layer (field name 'fossiliferous clay') that has a maximum thickness of 1.5 m.

Unit 4 (field name 'Urk c'). This unit is texturally comparable to the lower part of unit 3: fluvatile gravels and gravelly sands, in this case possibly deposited by a braided river system. At the base are cobbles and angular boulders, followed by gravels. The base of unit 4 is less clearly an erosion level than the base of unit 3. Maximum thickness 4 to 6 m. Units 3 and 4 can be placed in a later part of the Urk Formation.

Unit 5. Fluvioglacial sands in *sandur* facies, formed in immediate contact with the ice-sheet, and placed in the Drente Formation. Maximum thickness about 11.5 m.

From the basal gravels of unit 3 a molar fragment was collected in situ by G.H.J. Ruegg. It was determined as *Mammuthus primigenius* by T. van Kolfschoten (pers. comm.). According to van Kolfschoten the specimen cannot be older than the Saalian. This is a very important piece of evidence, because it shows that the fossiliferous clay layer must date from the Early Saalian.

The fossiliferous clay layer at the top of unit 3 contains pollen, studied by J. de Jong, remains of small mammals, studied by T. van Kolfschoten, and molluscs, studied by T. Meijer. Van Kolfschoten (1986) is of the opinion that the clay layer possibly can be correlated with the Hoogetveen Interstadial; this is based mainly on the occurrence of *Arvicola*

cantiana/terrestris (now named *Arvicola terrestris* ssp. A by van Kolfschoten). The same *Arvicola* type is known from the main find level (fauna 3-4) in the Belvédère pit near Maastricht (van Kolfschoten & Roebroeks 1985). The later form *Arvicola terrestris* (now named *Arvicola terrestris* ssp. B by van Kolfschoten) is known from a clay layer in Leccius de Ridder which documents a relatively cool temperate phase, and which van Kolfschoten suggests might be correlated with the Bantega Interstadial. According to van Kolfschoten, the climate during the deposition of the clay layer in Wageningen-Hoog must have been somewhat warmer than today, and therefore interglacial in character. Also the molluscs collected from the clay layer point to rather warm climatic conditions (T. Meijer, pers. comm.). As the clay layer is underlain by gravels and sands that must date from the Early Saalian, this warm phase must be placed also in the Early Saalian. The palynological work is still in progress, but the results so far again point to a warm phase (de Jong, pers. comm.). Though de Jong does not yet wish to make a definite statement on the chronostratigraphical position of the clay layer, he does not rule out that it may date from the Hoogetveen Interstadial, as suggested by van Kolfschoten.

The basal gravels of both unit 3 and unit 4 were investigated archaeologically by the Biological Archaeological Institute in 1987. From the lowermost 0.5 m of unit 3 a total of c. 10.5 cubic metres of sediment were sifted in three spots in the pit; one of these spots was the place where the mammoth molar was collected from the gravel. No artefacts were found in these gravels.

From the lowermost 1 m of unit 4, immediately on top of the fossiliferous clay layer in thrust mass B, approximately 17.5 cubic metres of sediment were sifted. This resulted in the retrieval of 8 definite Middle Palaeolithic artefacts, all of them flakes. Near the excavation another flake (levallois-like) was found in situ in the gravel, about 90 cm above the base of unit 4. About 0.5 m above the base of unit 4 a rod-like piece of red ochre was encountered (max. length c. 6.7 cm, diameter c. 1 cm); some scratches can be seen, but it is impossible to establish whether or not the ochre was used by man.¹ The find density is relatively low, which was already suggested by the scarcity of isolated finds made in the sandpit. The results of the investigation in Wageningen-Hoog make it very improbable that the finds are derived by erosion from layers older than the Saalian. This supports the view that we are possibly dealing with only one archaeological tradition.

The proportion of flint with respect to other kinds of stone was calculated for the basal gravels of both unit 3 and unit 4. In the category of stones larger than 8 mm (the mesh width of our sieves) the

following figures were found:

Unit 3, basal part: 8 flints among a total of 2330 stones (3.4 0/00).

Unit 4, basal part: 32 flints among a total of 2070 stones (15.5 0/00).

It is clear, therefore, that unit 4 is about 4.5 times as rich in flint than unit 3, indicating a stronger influence of the River Meuse as the source of the gravel. However, the comparative scarcity of flint in the basal gravels of unit 3 cannot be used as an explanation for the absence of artefacts within these gravels, as the latter still contain plenty of large flints suitable for tool production. The results of the various investigations at Wageningen-Hoog will be published in the *Mededelingen R.G.D.*

3.4. Provisional interpretations

There are two basic weaknesses in our data that prevent us from arriving at definitive statements on the chrono-stratigraphical position of the Rhenen industry. The first is that the two different types of fine-grained layers that we now know within the Early/Middle Saalian gravelly sands – one representing a relatively cool interval with boreal forests incorporating pine and spruce: part of an interstadial or a later part of an interglacial (Kwintelooijen 1986), the other representing an interval with broad-leaved forests as known from interglacials with a temperate climate (Wageningen-Hoog; perhaps also present in the pit de Paltz near Soesterberg) (de Jong, pers. comm.) – have up till now not been found within a single sequence. This means that correlating the various sections with each other is a hazardous task. The second problem has been mentioned already: it is impossible to demonstrate that a certain layer nowhere contains any artefacts. Moreover, we have to face the problem that it may never be possible to extract large quantities of in situ finds under controlled conditions. The find densities found so far are quite low: they range from 1 artefact per 1 to 3 cubic metres of gravel. The collections resulting from several weeks of sifting at any site will therefore always remain very small. This means that it is not really possible to determine whether the collections from different locations represent the same archaeological tradition in every case. For the moment, however, I have the impression that all finds of the Rhenen industry made so far could very well all derive from one tradition; in any case, there are no convincing arguments to conclude that several traditions must be represented among the finds. For the sake of argument, therefore, I will assume that we are dealing with only one archaeological tradition. Of course, this does not mean that I would

exclude the possibility of several traditions, possibly deriving from different stratigraphical units (see below). In my view, however, convincing evidence for the latter has so far not been produced in the Rhenen area.

Again for the sake of argument, and given our earlier assumption that only one archaeological tradition is represented, I will assume that the find levels demonstrated in the various locations are more or less contemporaneous. This can be nothing more than an assumption, however. Though the find-bearing gravels in all cases are very similar, this certainly does not prove that they belong to the same stratigraphical level, as coarse deposits within the later part of the Urk Formation can resemble each other to a great extent, even when they are not precisely of the same age.

The correlations suggested in figure 17 on the basis of the above assumptions is preliminary. If it is assumed that the find level in Kwintelooijen (1986) is the same as the one in Wageningen-Hoog (1987), then the two types of fine-grained layers described above can be put in stratigraphical order: the one in Kwintelooijen must be younger than the one in Wageningen-Hoog. This would present us with the following sequence within the Early/Middle Saalian, from old to young: 1. a stadial (gravelly sands of unit 3 in Wageningen-Hoog); 2. an interglacial (clay layer at the top of unit 3 in Wageningen-Hoog); 3. a stadial (gravelly sands of unit 4 in Wageningen-Hoog, gravelly sands of unit 5a in Kwintelooijen); 4. a relatively cool interstadial (silt layer of unit 5b in Kwintelooijen); 6. a stadial (gravelly sands of unit 5c in Kwintelooijen); this stadial probably is the one that saw the arrival of the ice-sheet somewhat later.

This correlation, though perhaps the best we can offer for the moment, incorporates several uncertainties. In the first place, we cannot be sure that erosion (the bases of all three gravel layers mentioned are erosion levels) during various periods has not removed deposits dating from other temperate intervals than the two known to date. This possibility must always be taken into account. In the second place, we cannot be sure that the base of unit 5 in Kwintelooijen in sections that do not show the silt layer studied in 1986, is the same level as the base of unit 5a in the section of 1986: it could also be contemporaneous with the base of unit 5c. This possibility seems to be suggested by the presence of northern gravel particles at the base of unit 5 in the sections studied in 1979 and 1980. Similarly, the base of unit 4 in Wageningen-Hoog could alternatively be correlated with the base of unit 5c in Kwintelooijen.

These alternative correlations would imply that artefacts (and bones) could have been reworked several times since their disposal. Only by studying

sections as at Wageningen, which show a more 'complete' picture of the Early Saalian, will it eventually become possible to date the Rhenen industry more accurately.

So far my reasoning has been based on empirical data, though it must be admitted that these data are scarce and weak. The next step is much more speculative, and carries the danger of circular reasoning (Roebroeks, 1986). As described above, Zagwijn (1973) subdivided the Saalian into 3 stadials separated by two interstadials. The Hoogetveen Interstadial is the older of the two, and could be described as an interglacial, while the younger one (the Bantega Interstadial) was relatively cool. It now seems obvious that we could correlate the interglacial represented by the clay layer (top of unit 3) in Wageningen-Hoog with the Hoogetveen Interstadial, and the interstadial represented by the silt layer (unit 5b) in Kwinteloijen with the Bantega Interstadial. An argument for this correlation is the fact that in the sandpits of the central Netherlands we seem to be presented with a sequence of a warm temperate phase followed by a cooler one during the Early Saalian. Nevertheless, this correlation should not be considered as proven, but as a possible one on the basis of the available data: there still are problems. Though nothing seems to prevent us from placing the clay layer of Wageningen-Hoog in the Hoogetveen Interstadial, correlating the silt layer in Kwinteloijen with the Bantega Interstadial is more problematical. According to de Jong (pers. comm.) the pollen diagram of unit 5b in Kwinteloijen 1986 does not fit very well into the Bantega Interstadial; he suggests that it could represent a later part of the Hoogetveen Interstadial. If this should be true we would be more or less forced to assume several find levels within the Early Saalian gravels. The finds from unit 5a in Kwinteloijen 1986 would in that case predate the Hoogetveen Interstadial, and therefore have a greater age than the finds of Wageningen; for example, they could in that case date from the Holsteinian. Archaeologically, this possibility cannot be excluded: the number of artefacts collected from the basal gravels of unit 5a is very small (10), and there are no clear indications for the presence of the Levallois core technique among these finds. However, if the fine-grained layers in Kwinteloijen and Wageningen should be of about the same age, then the results of the archaeological investigations would become somewhat difficult to comprehend: in one case (Kwinteloijen) artefacts below the silt layer and no artefacts on top of it, in the other case (Wageningen) artefacts on top of the clay and none below it. Though this situation certainly cannot be excluded, it seems somewhat improbable in my view, because our experience indicates that artefacts are scattered widely through the find-bearing gravels (see under

4). If de Jong's correlation should be correct, it is surprising that we did not find anything both in the gravel on top of the silt layer in Kwinteloijen and in the gravels below the clay in Wageningen. Assuming that de Jong's correlation is correct, it is possible that the finds from unit 5a in Kwinteloijen date from the Holsteinian. In the case of Wageningen-Hoog, however, we may assume that the finds must date from the Early Saalian. It is interesting to note in this connection that in the Belvédère pit near Maastricht at least one flake was recovered from gravels below the main find level in loam which can possibly be dated in the Hoogetveen Interstadial, indicating here too the possible existence of finds dating from the Holsteinian (van Kolfschoten & Roebroeks, 1985).

If the correlation given in figure 17 should be correct, we might conclude that the Rhenen industry was not yet present in this area during the first stadial of the Saalian. The finds occur in gravels deposited after the Hoogetveen Interstadial, at least in Wageningen-Hoog. Since they were transported by a river during an erosional phase, and occur at

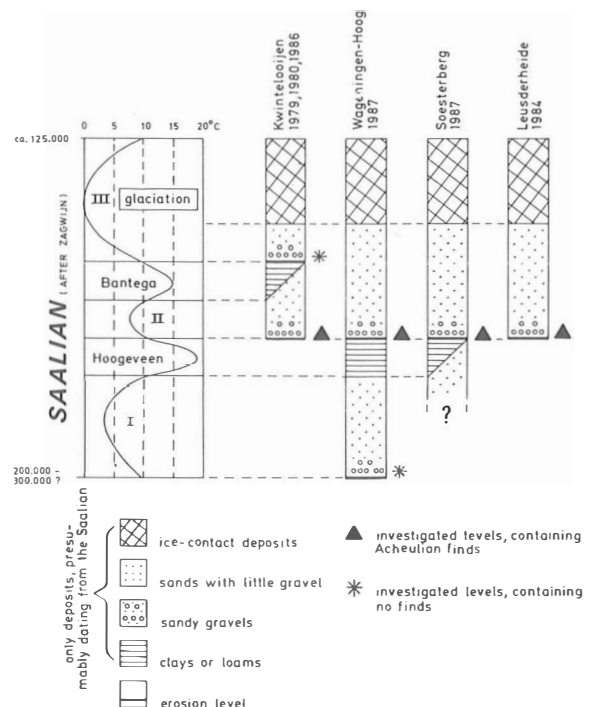


Fig. 17. Possible correlation between several sections in the central Netherlands from which artefacts of the Rhenen industry have been recovered, and the subdivision of the Saalian as proposed by Zagwijn (1973; 1975; 1985). Only deposits that can be placed in the Saalian have been indicated (older parts of the sections have been ignored). The sections are drawn schematically and not to scale. The correlation with the sequence of Zagwijn is only tentative and should not be considered as proven.

the base of these gravels immediately on top of the clay, it seems reasonable to suppose that the people who produced the Rhenen industry inhabited the area during the Hoogetveen Interstadial. As the gravels on top of the presumed younger silt layer in Kwintelooijen, perhaps deposited during the Bantega Interstadial, appear to be devoid of artefacts, we have no indication that people visited the area during that interstadial. Therefore, my provisional conclusion is that the period in which the Rhenen industry can be dated seems to be restricted to the Hoogetveen Interstadial. This is the hypothesis that I favour at the moment as being the most likely one on the basis of available data, but, as stated before, the possibility of reworked artefacts dating from the Holsteinian that are now present in gravels deposited during the Early or Middle Saalian, cannot be excluded. Further results of the palynological analyses by de Jong will be of considerable interest.²

4. 'GRAVEL PARTICLES'

The title of this section is derived from one of the reports of the geologist G.H.J. Ruegg (1980), in which he mentioned 'gravel particles recognized as palaeolithic artefacts'. This phrase nicely conveys the fact that these artefacts were found in a stratigraphical situation where they should be considered as sedimentary particles, transported by a river just

as the other gravel particles in the same layer: the finds are in a secondary position. This is true for all the finds of the Rhenen industry made so far during the systematical investigations by the Biological Archaeological Institute: in Kwintelooijen, Wageningen, Leusderheide and Soesterberg. It applies also to the bones found in the same gravelly layers. This situation should make us very cautious. For example, it cannot be assumed that when bones and artefacts are found in more or less the same place, they are associated in any archaeological sense. This assumption was made repeatedly by Franssen & Wouters, and also by Peeters (in press) who suggests interpretations about the character of some of these sites, for example in terms of 'kill sites'. As far as I can see, such interpretations suffer from a misconception concerning the stratigraphical context of the finds, and should be avoided unless reliable associations are demonstrated in the field during controlled excavations of artefacts and bones from loams. This, in my opinion, has not been done convincingly.

Another aspect is that when artefacts have clearly been rolled in a gravelly riverbed, they should not be interpreted as possibly deriving from loams or from eolian sands. A case in point is the handaxe from Leersum, published by Bosscha Erdbrink & Berendsen (1984). This handaxe (fig. 18) was found in 1982; it came to light during digging work in a garden. A section of the findspot is presented by

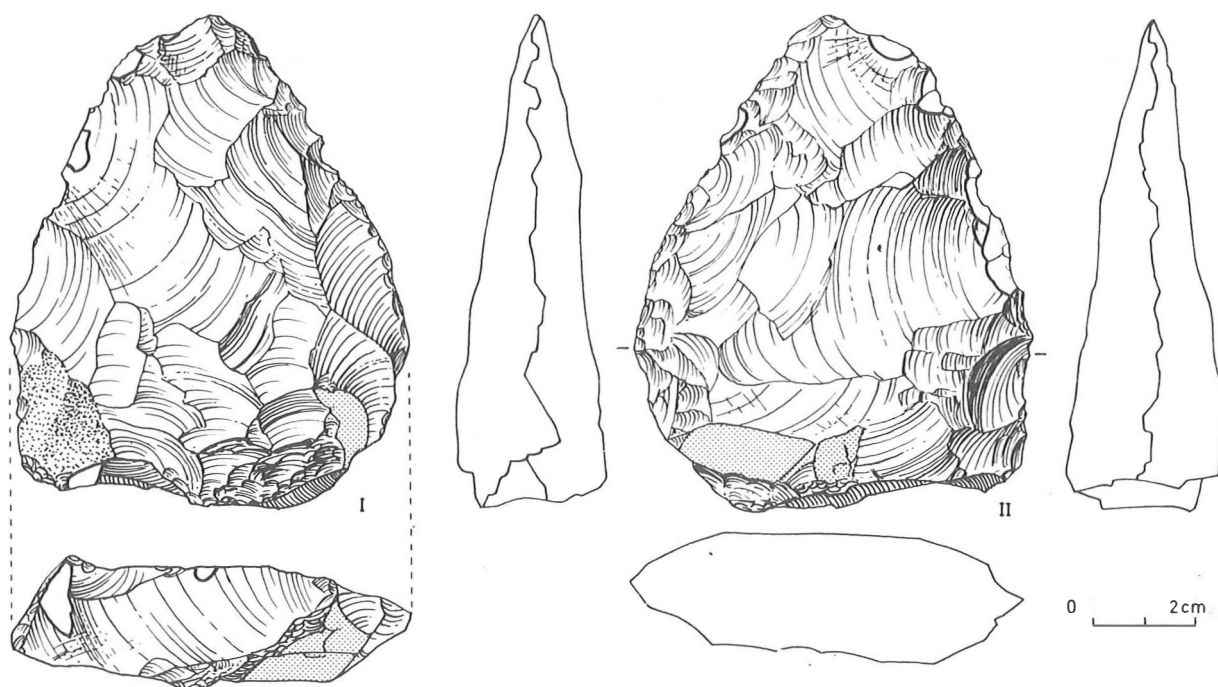


Fig. 18. The handaxe from Leersum (fig. 1: No. 7). See text under 4.

Bosscha Erdbrink & Berendsen (1984). The site was, unfortunately, not shown to geologists of the Geological Survey, who just before had completed an exhaustive analysis of the stratigraphy in the Kwinteloijen pit, not far from Leersum. In the section described by Bosscha Erdbrink & Berendsen a gravelly sand layer is present at the base, and above that a layer of coversand. The authors assume that the handaxe derived from the coversand, which they date in an early part of the Weichselian. However, the handaxe is slightly but clearly rounded due to fluvial rolling. It therefore must originate from a gravelly fluvial deposit, for example from the gravelly layer illustrated in their drawing of the profile, which could belong to the Urk Formation. It is impossible that the handaxe should have occurred in eolian coversand. Furthermore, they incorrectly assume that the handaxe typologically belongs to the *Moustérien de tradition acheuléenne*: it clearly is an Acheulian handaxe, similar to several handaxes found near Markkleeberg. Finally, it is not at all certain that the coversand at the findspot dates from the Early Weichselian: it is much more probable that it dates from the Late Glacial (Ruegg, pers. comm.). The most important problem with the paper by Bosscha Erdbrink & Berendsen, however, is their failure to recognize the effects caused by fluvial rolling in a gravelly riverbed, which (given some experience with this kind of phenomena) could easily have been detected with the aid of a stereomicroscope; the piece also shows a few coarse scratches of the type described below. In my opinion the handaxe is one of the few of its type belonging to the Rhenen industry.

Near Markkleeberg the artefacts occurred in three different positions stratigraphically: (a) on top of a terrace-remnant, (b) in the fill of erosion gullies below the base of the main gravel layer, (c) in the main gravel layer (*Hauptterrasse*), especially at its base (Baumann et al., 1983). The finds in situations a and b are hardly rolled or patinated and appear to occur almost in a primary situation. For example, *Fundkomplex 2* probably consists of the residue of a flintworking station on the floor of a 2.5 m wide erosion gully. The 410 flints were unpatinated and unrolled, and occurred in a relatively high density: approximately 40 artefacts per square metre (Mania & Baumann, 1981). The artefacts within the main gravel layer, however, are in a secondary context: their density is much lower, and many of these artefacts are patinated and clearly rolled.

At the sites of the Rhenen industry, so far only situations of type c have been found. Though unpatinated and unrolled artefacts occur, the majority is patinated and rolled, mostly lightly to moderately. It is clear, therefore, that the find

situations known to date are all secondary. Still, as about 17% of the excavated finds are not noticeably rolled, and only about 4% heavily, I think that in most cases the distances over which the artefacts have been transported were quite small. In the case of Markkleeberg most of the known sites appear to be located along the sides of broad valleys (Baumann et al., 1983: Abb. 9). As most of the sites of the Rhenen industry are located on the pushed ridges bordering the Gelderse Vallei (fig. 1), it seems possible that the Gelderse Vallei already was a river valley before the arrival of the ice-sheet, determining to a certain degree the place and form of the glacial basin formed subsequently.

Many artefacts of the Rhenen industry show coarse scratches that are often visible to the naked eye. In many cases these scratches are relatively broad, with a flat bottom. Initially I attributed these scratches to glaciotectionic action, connected with the pushing. However, from sites outside the region of ice-pushed ridges rolled artefacts are known that show exactly the same type of coarse scratches. Another problem is that a correlation seems to exist between the degree of rolling and the occurrence of these scratches: the more heavily a flint has been rolled the more scratches it has, on average. This cannot be explained by the hypothesis of glaciotectionic action, because rolling and pushing are independent processes. It is now proposed that these coarse scratches originated as a result of creeping icebergs in the rivers during cold periods (Stapert & Zandstra, 1985). This theory would account for the observed correlation between rolling and scratching: flints that were in the active riverbed for a long time had a greater chance of becoming incorporated into icebergs. That icebergs were a recurrent phenomenon in the rivers during the Saalian is also suggested by the presence of large angular boulders in these deposits, which must have been transported by icebergs. It is to be expected that not only flints could acquire scratches through the process of creeping icebergs, but also bones. It will therefore be very difficult to demonstrate man-made cutmarks on these bones. The criteria formulated by Potts & Shipman (1981) for identifying man-made cutmarks on bones probably do not apply in this context, as scratches due to creeping icebergs could have been produced on bones by flints.

Can primary find situations be expected within the Early Saalian gravels? As suggested under 3, I think that people inhabited this area especially during the Hoogeveen Interstadial. During this interstadial, stream velocities locally became much lower than during the preceding stadial as a result of a different river regime, resulting in sedimentation of clays or loams, as we know from Wageningen. A reasonable proposition seems to be that people

liked to camp along the borders of these water-bearing gullies or lakes. Therefore, primary find situations could be expected in places where these clay or loam layers wedge out. Along the borders of depressions archaeological residues could have become embedded in loam, remaining protected from later erosion. Unfortunately, such situations have not yet been found in the pits studied so far. In my opinion, the fringes of loam layers deposited during the Hoogetveen Interstadial are promising locations from an archaeological point of view, and it can only be hoped that such sites will be discovered in the future.

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6. NOTES

- Both in the Kwinteloijen pit (1986, basal part of unit 5a) and in the Fransche Kamp pit (basal part of unit 4), pieces of red ochre were encountered in the find-bearing gravels. Red ochre is extremely scarce in Pleistocene river gravels in the central Netherlands. Moreover, it seems to be very improbable that ochre could have survived transport in a gravelly riverbed over more than a few kilometres (Zandstra, pers. comm.). Therefore, it seems to be excluded that these pieces of red ochre were transported by the River Meuse from known sources in Belgium. This makes it possible to think that these pieces of ochre were carried to the central Netherlands by man. However, the two specimens do not give any clue as to whether or not they were used by man, as both had been subjected to rolling. In this connection it can be noted, that in the main Early Saalian find level in the Belvédère pit (Site C) ochre was also encountered (van Kolfschoten & Roebroeks, 1985).
- For Middle Pleistocene deposits in the central Netherlands, no 'absolute' datings are available, though attempts have been made that were so far unsuccessful. For the Belvédère pit near Maastricht TL dating is available for the main find level in Early Saalian loam: $285,000 \pm 45,000$ (Aitken et al., in: Tuffreau & Sommé, 1986; see also van Kolfschoten & Roebroeks, 1985). None of the finds of the Rhenen industry studied by the author shows traces of burning. Even if burnt flints would turn up, it can never be proved that the burning was the result of human activities, as the finds derive from river gravels. Dating such artefacts can only result in tentative estimates of minimum age.

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