SOME NATURAL SURFACE MODIFICATIONS ON FLINT IN THE NETHERLANDS

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CONTENTS

1. INTRODUCTION

This article has been occasioned by a remarkable forgery affair in the Northern Netherlands, mainly involving a number of complexes of "Middle Palaeolithic finds". The decisive evidence for forgery of this material is the total absence of any kind of natural surface modifications on faces created during manufacture (Stapert, 1975A).

A more important reason for this work is the fact that some of the phenomena described below could easily be interpreted as traces of use. This general problem has long been recognized, and was pointed out for example by Bordes (1967) with reference to Semenov's important book (1973 (1957)), in which too little account of this problem would seem to have been taken. Moreover, traces of use formerly present may be entirely or partly obliterated as a result of surface-modifying processes.

The mode of genesis of many natural surface modifications is not known precisely. The aim of this article is to briefly describe a number of phenomena frequently occurring in the Netherlands, and to suggest possible modes of genesis. In several cases it is attempted to formulate criteria for distinguishing between natural features and traces of use. It is clear however that much further research will be necessary for this purpose. The importance of such research is apparent in view of the fact that all phenomena mentioned in the literature up until now which may be the result of use (scratches, abrasion, gloss and edge damage) may also be the result of natural processes.

The likelihood of the presence of these natural surface modifications generally increases accordingly with the age of the material in question.
While Mesolithic material for example should in most cases present few problems, Lower Palaeolithic objects will often present great difficulties in searching for traces of use, in as much as these are obliterated by or mixed with naturally caused marks.

The features discussed below have been observed on a dozen or so Middle Palaeolithic finds from the Netherlands, several Upper Palaeolithic collections, and a number of natural flints derived from the boulder-sand (see 2) of the Northern Netherlands.

This article could not have been produced without the help of a number of people, to whom I am greatly indebted: Dr. G. Boom (Laboratory of Physical Metallurgy, Groningen) for preparing the scanning electronmicrographs; Dr. W. A. Casparie (B.A.I., Groningen) for taking many photographs through a stereo microscope; Mr. H. L. Leertouwer (Physics Laboratory, Groningen) for taking several photographs with an interference microscope; Mr. H. J. H. Polko (Solid-state Physics Laboratory, Groningen) for help with a sand-blasting experiment; Mr. F. W. E. Colly (B.A.I., Groningen) for taking the remaining photographs; Mr. H. R. Roelink (B.A.I., Groningen) for preparing the drawings; Mrs. Engelien Veger (B.A.I., Groningen) for typing the manuscript; and Mrs. Sheila M. van Gelder-Ottway for the translation into English.

2. NOTES ON THE GEOLOGY

On the plateau of Drenthe in the Northern Netherlands, boulder-clay (ground-moraine from the penultimate glacial) occurs in many places at or near the surface. On top of this there is almost always a layer of bouldersand (usually several decimetres, maximally c. 1 m thick). Boulder-sand can be regarded as a residual sediment of boulder-clay, mixed here and there with cover-sand (Veenenbos, 1954).

The accumulation of this layer must have taken place over a long period especially during the last glacial; according to Cnossen and Zandstra (1965) mainly during the first half of the last glacial period. It is possible however that the boulder-sand was already partly formed during the last part of the penultimate glacial and the last interglacial (Maarleveld, 1960).

Ter Wee (1966) assigns the boulder-sand to the "Drente Formation".

On top of the boulder-sand there is usually cover-sand, wind-deposited sand dating from the Late Glacial period of the last glacial.

The little that is known about the geological conditions at the few Middle Palaeolithic findspots in the Northern Netherlands indicate that these finds are derived from the boulder-sand or from immediately on top of it. This is hardly surprising, considering the fact that there was scarcely any deposition of cover-sand in the Northern Netherlands during the first half of the last glacial. Outside the valleys there is therefore no other layer except for the boulder-sand that could possibly be considered from a geological point of view as that from which these finds originate.

In boulder-sand there are many stones which have come from boulder-clay, especially of weathering-resistant rocks such as flint and quartzite. During the last glacial period this outwash material, then lying on the surface, was subject to periglacial soil movements such as cryoturbation and gelifluction (solifluction). These soil movement involve the operation of sometimes very strong forces in near-surface layers, whereby stones can be pressed against one another, combined with sliding and/or rotating movements among the stones, which may be fairly systematically directed

The flints naturally occurring in the boulder-sand nearly always show traces of these soil movements. In addition, without exception these flints exhibit (on old faces) one or other form of patina and/or wind-gloss. The flints in the boulder-sand have moreover been conspicuously affected by frost-splitting. This has resulted in a gradual decrease in size of these stones, the majority of which therefore now have rather a small diameter; there seems to be a kind of "end-product" only a few centimetres in diameter. Larger pieces of flint show cracks due to frost action along which splitting has not yet taken place. Large, intact pieces of flint are absent from boulder-sand.

Figure 1 gives an example of how boulder-sand can appear in profile. Shown here are two profiles, drawn in the course of an excavation near Hijken (province of Drente) where Middle Palaeolithic material was sought – in vain (Stapert, 1975A) The excavation site lies on a valley slope, and the profiles are at right angles to the valley. The vertical scale is exaggerated x 2.

The stratigraphy here consists only of boulder-clay and boulder-sand (cover-sand is absent). The boulder-sand is not an undifferentiated sediment, for some structures are clearly visible. These consist of loamy, more compact layers in the boulder-sand, which is otherwise fairly coarse-grained.

On the drawing it has been attempted to show schematically the following features:

a. The stones in the boulder-sand are most abundant at the base of this layer, on the boulder-clay. This applies both to the coarser boulder-sand and to the loamy layers where these lie immediately on top of the boulder-clay. Here and there one can even speak of a compact pebble layer.
b. In general, larger stones occur in the loamy layers than in the coarser boulder-sand.
c. Deformation due to cryoturbation is especially clearly visible in the transition from boulder-clay to boulder-sand, though much distortion is also in evidence within the boulder-sand. In some places (e.g. in the NW part of profile II) bands of boulder-clay have been distorted together with boulder-sand in a very complex manner.

The loamy layers possibly represent gelifluction levels.

It is clear that the boulder-sand has been subjected to periglacial soil movements to an extreme degree. In fact pseudo-artefacts are to be found in great quantities in this deposit (Stapert, 1975B).

The few Middle-Palaeolithic finds from the Northern Netherlands exhibit the same surface alterations which are so typical of flints naturally occurring in boulder-sand (traces of soil movements, patination, wind-gloss, frost-splitting), which indicates that they are derived from this deposit.

An analogous situation exists in the province of Noord-Brabant. There no boulder-clay with boulder-sand is present, but close to the surface in many areas there are other Pleistocene deposits rich in stones (Sterksel and Veghel Formations). At the top of these deposits there is often a pebble floor which is also almost always folded here as a result of cryoturbation.

3. NATURAL SURFACE MODIFICATIONS

3.1. *GENERAL POINTS*

Flints which have lain for a long time in water-permeable soil or on the surface, and/or which have been subjected to soil movements, will bear all kinds of traces of various processes. These traces are many and varied depending on such factors as the topographical conditions, the nature of the surrounding sediment, the ground-water and

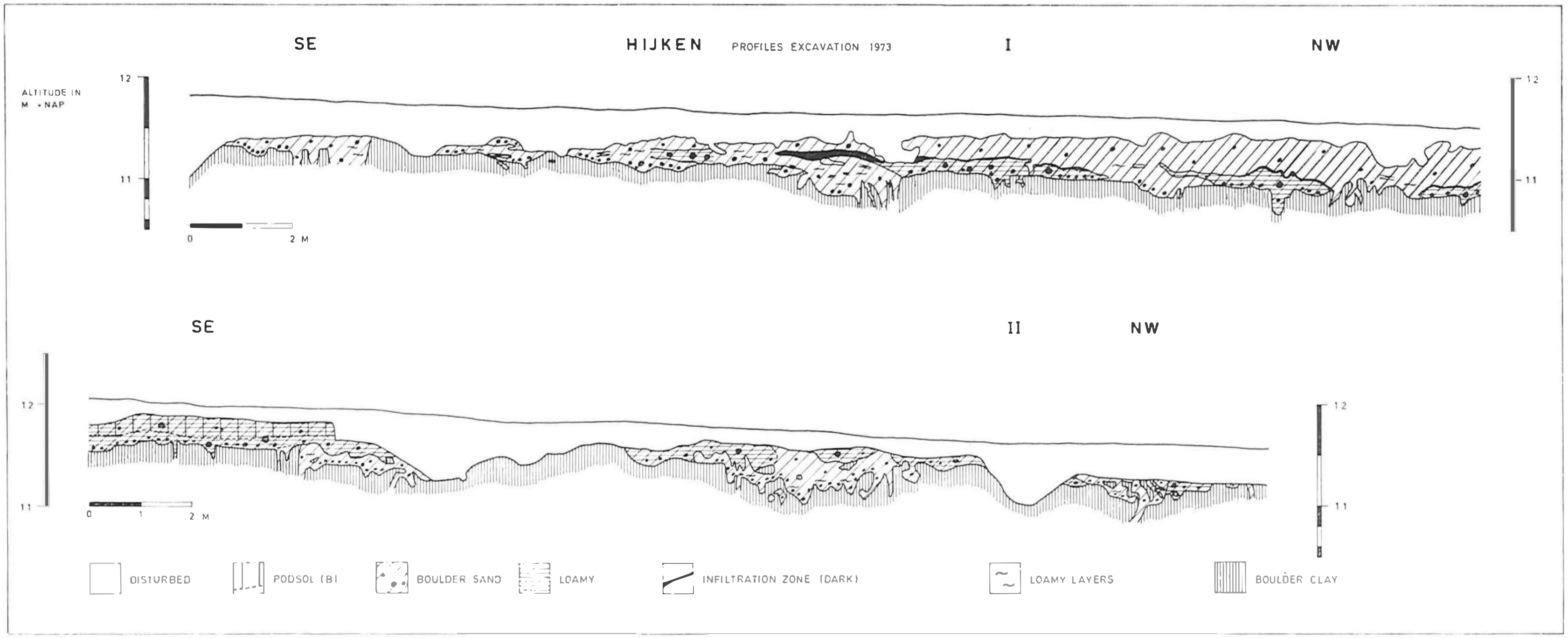


Fig. 1. Profiles of the excavation in Hijken (province of Drente), 1973. The profiles are at right angles to the valley (of the Vorrelveen), and are situated at the top of the valley slope. The vertical scale is exaggerated 2x. Drawing by D. Stapert, B.A.I., Groningen.

vegetation, as well as the age and type of flint concerned.

These surface modifications can be arbitrarily grouped together as follows:

a. *Chemical processes in the soil*
These can give rise to such phenomena as white patina[1]), gloss patina, coloured patinas and other solution phenomena such as rounding. These processes are still taking place today.

b. *Processes occurring on the surface*
Merely exposure to sunshine results in a certain surface modification of flint after a period of time. Here we are mainly concerned, however, with the so-called wind-gloss, a sheen of greasy appearance on the surface of flint. Flints with wind-gloss are also to be found in recent sand-drifts.

c. *Frost action*
A recurrent alternation of freezing and thawing results in the cracking and eventually splitting up of flint. This process still continues to the present day.

d. *Processes associated with soil movements*
Here we are concerned mainly with periglacial soil movements such as cryoturbation and gelifluction, which are clearly limited in time to glacial periods. Related soil movements, such as soil-creep still occur at the present time. These various soil movements can give rise to such phenomena as scratches, small "pressure cones" and "cryoturbation retouch".

e. *"Friction gloss"*
Small patches with a high sheen, the mode of genesis of which is still not understood.

In addition to these above-mentioned processes, there are various other surface modification processes mentioned in the literature, such as abrasion in sand as a result of soil movements, rounding due to river action, polishing through the action of sand-bearing water, desert varnish, secondary deposition of silica, etc. These other processes will not be discussed here however, because they are not represented in the Dutch material examined by the author.

3.2. CHEMICAL PROCESSES IN THE SOIL

3.2.1. WHITE PATINA

White patina is a commonly occurring phenomenon on which subject much has been published. It refers to a white coloration on the surface of flint, which in the initial stage of development appears as a bluish film. White patina occurs not only as a uniformly white coloration but also in the form of irregular striped patterns (possibly associated with plant roots) and patches (see Shepherd, 1972). It is frequently observed that the upwardfacing surfaces of flint in soil exhibit a thicker patina than those facing downwards (see e.g. Curwen, 1940; Zotz, 1965). An analogous phenomenon is the occurrence of white patina in a "shadow pattern" (Stapert, 1976, this volume). Flint surfaces where damaged for example by scratches and small cracks sometimes display a more intense white patination than the surrounding area, for which reason these signs of damage may be more conspicuous.[2]) The thickness of white patina varies from scarcely being measurable to over 2 mm; in extreme cases the flint may have a white patination through and through.

The explanation for the origin of the white coloration has long ago been expounded: the flint surface has become porous as a result of "weathering", giving rise to refractive effects which from an optical point of view result in a white "colour" (cf. for example foam where exactly the same effects are involved) (Judd, 1887; after Schmalz, 1960).[3]) The reason why this high porosity develops is another problem. At first the supposition that flint consists of a mixture of chalcedony and (colloidal) opal was taken as a starting-point. The opal would then be dissolved by the ground-water. After it transpired that flint contains no opal, for some time an explanation was sought in the expulsion of water from the pores between quartz crystals, of which flint appears to consist for the main part as is evident from electron-microscopic studies (see references in Shepherd, 1972). Experiments have shown however that dehydration alone cannot result in the formation of white patina (Schmalz, 1960). In fact the latest explanation is that the high porosity arises as a result of the dissolution of quartz by soil water. This process can also be simulated in the laboratory (Curwen, 1940; Schmalz, 1960; Rottländer, 1975A). Schmalz thus produced a white patina in alkaline solutions such as NaOH. The reaction took place faster in the presence of $CaCO_3$ because the latter acts as a buffer and thus maintains the high pH. It is known that the solubility of quartz increases with higher pH levels (Elgawhary and Lindsay, 1972). White patination would therefore be caused by etching in the soil, and stimulated by much movement of soil water and the presence of $CaCO_3$. According to Hurst and Kelly (1966), however, the patination process operates mainly on impurities in flint, and not on the quartz crystals.

White patina can also develop in acid soils such as podsols on cover-sand (pH usually between 3 and 5.5: Van Heuveln, 1965) or even in peat soils. Certain "humic acids" are in such cases presumed to be responsible, namely catechol and similar substances which can form complexes with Si ions (Rottländer, 1975A). Generally speaking however under such conditions gloss patina develops rather than white patina. According to Rottländer (1975 A), under relatively strongly dissolving conditions (or after a long period of time) white patination develops, while more weakly dissolving conditions give rise to gloss patina.

The surface of flint displaying a white patina is actually extremely pitted, as illustrated in figure 2 which is a scanning electronmicrograph (SEM-photo) of the point from Etten (Stapert, 1975C). Similar pictures have been published by Rottländer (1975A). It should be pointed out that flint surfaces without a white patina are also often pitted, but that in the case of white patina there are also extremely small pits: at higher magnifications more and more small pits become visible.

Not all kinds of flint acquire patination by means of etching in the soil equally readily. The structure and degree of homogeneity of the flint are apparently of decisive importance in this respect. Even when all the above-mentioned conditions are fulfilled, white patina can still fail to appear. In boulder-sand flints both with and without white patina are in fact found close together, so, as a general rule, white patination cannot be used as a valid measure of relative age without taking other factors into consideration. White patina can occur on flints from virtually all periods.

3.2.2. GLOSS PATINA

Gloss patina is a uniform sheen, usually not very high, over the entire surface of flint. This gloss is thought to be caused by a certain smoothness of the surface. SEM-photos of flint with gloss patina do indeed show rather smooth, "finished" surfaces (Rottländer, 1975A). Although it is sometimes suggested that a mechanical effect may be responsible (e.g. polishing in a sand matrix due to soil movements), most authors assume that this smoothness is a result of chemical processes in the soil. By means of such chemical processes silica could be dissolved from protruding edges and redeposited in cavities (e.g. Rottländer, 1975A). Cavities also may become filled up with silica from groundwater (e.g. Shepherd, 1972). An indication that cavities are filled up with silica is given by the fact that flints with gloss patina are less prone to white patination, presumably because any small cracks and cavities, along which white patination could take place, would no longer be available (Rottländer, 1975A). Since the gloss is produced by silica it cannot be removed.

Gloss patina is only seldom in evidence on Middle Palaeolithic finds from the Netherlands, though it is generally present on Upper Palaeolithic flints (which can also exhibit other surface modifications such as white patina, wind-gloss, etc.). This may be due to different soil conditions: Upper Palaeolithic flints are mostly found in acid cover-sand soils, while Middle Palaeolithic artefacts come from older layers of essentially different structure.

3.2.3. COLOURED PATINAS

According to the traditional explanation for the development of coloured patinas (usually shades varying from yellow-brown to red, though sometimes peculiar blue-black colorations occur), these patinas are due mainly to the deposition of various oxides and hydroxides of iron (chiefly ferric) out of soil water on the surface of flint. This process would occur more readily on porous surfaces. This explanation is however not always valid. Rottländer (1975A) found that in some cases the iron concentration in such a layer of patina was just as high as in the fresh core of the same piece of flint; in such cases it appears that iron already present in the flint becomes oxidized on the surface. It is noteworthy in this connection that in boulder-sand

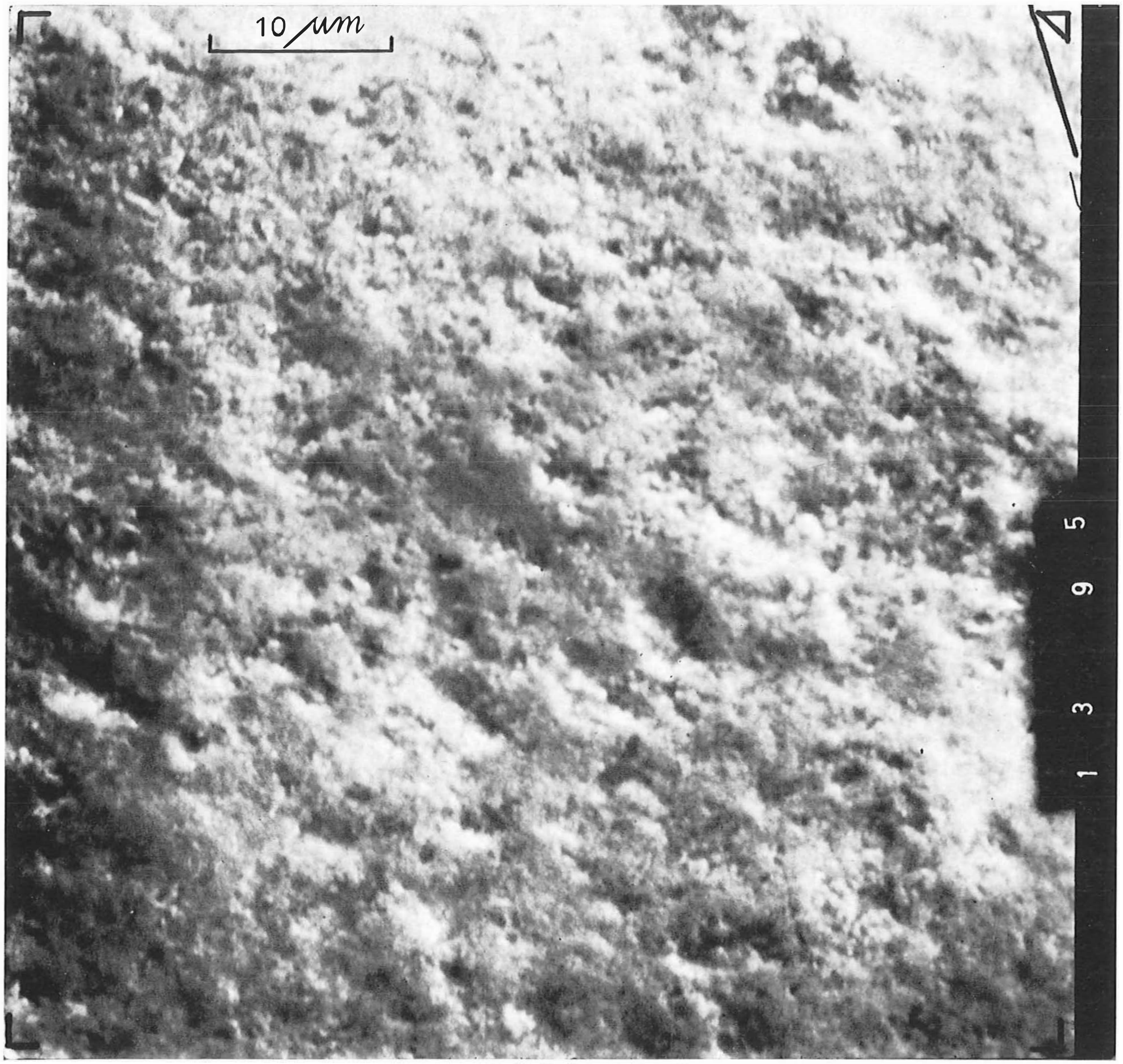


Fig. 2. S.E.M.-photograph of the point from Etten (province of Noord-Brabant). The implement has a thick white patina, and the surface is highly porous. Photograph by Dr. G. Boom, Laboratory of Physical Metallurgy, Groningen.

flints both with and without brown patination occur, as is the case with white patina, which fact could not be explained were the formation of brown patina completely independent of the structural composition of the flint itself. Superficial observation of the degree of patination can therefore give no indication of the relative age of flints displaying a brown patina. Similarly as with white patina, brown patina too is often more intensely developed on one of the faces than on the rest.

Brown patina is very common on natural flint in boulder-sand and on Middle Palaeolithic finds from the Netherlands. It is also present on flints in several Young Palaeolithic collections, especially on those flints that have later been covered by peat.

3.2.4. SOLUTION PHENOMENA, OTHER THAN WHITE PATINA AND GLOSS PATINA

Flints which for a long time have lain in soils, such as those occurring in the Northern Netherlands, are affected as a result of solution. The most commonly occurring effect is that ridges and edges become rounded off to a certain degree; this phenomenon can clearly be seen with the aid of a stereo microscope (figures 3 and 4). All of the older flints which were examined exhibit this phenomenon.

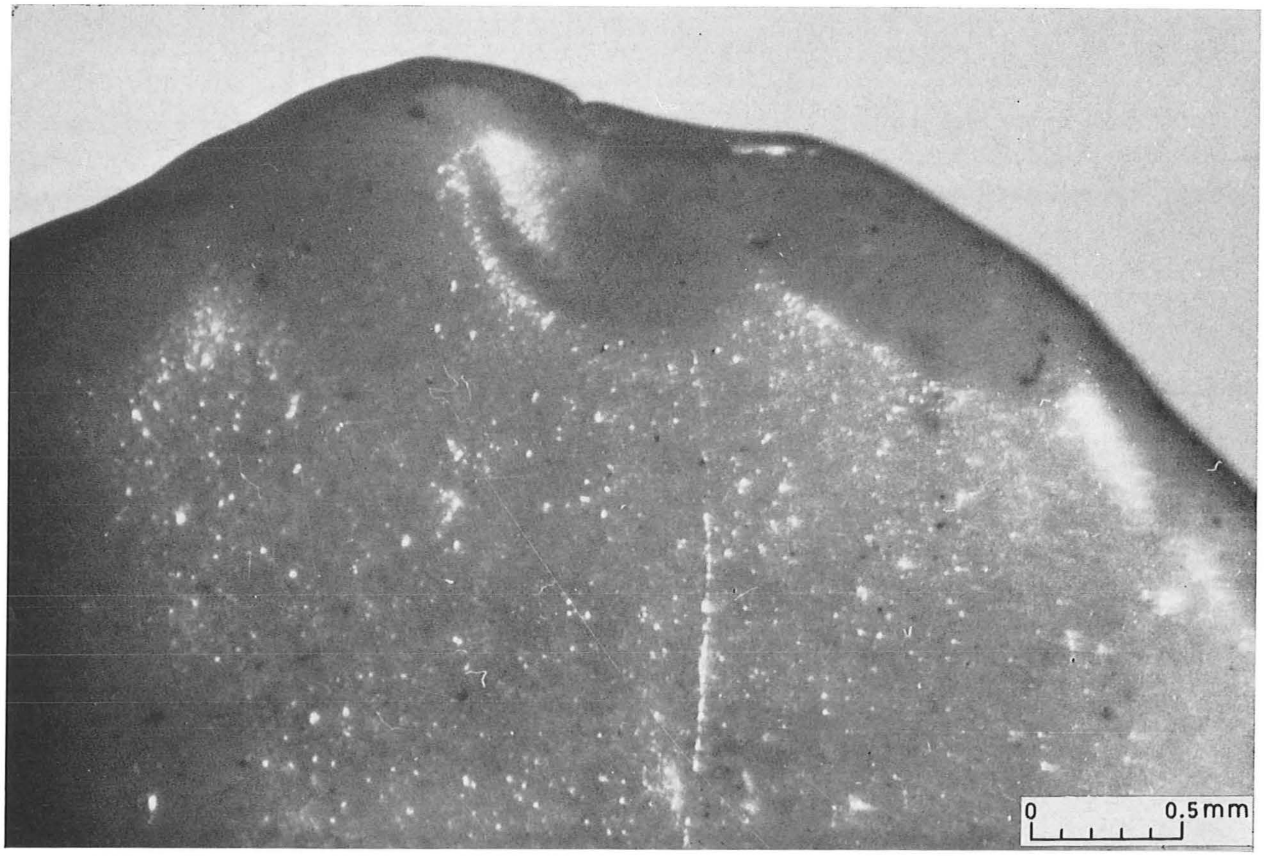
The development of this phenomenon to an extreme degree results in the disappearance of a significant part of the original surface of particularly the edges of flints (which had often been "working edges"). Rounding of ridges and edges is virtually always present on Palaeolithic flints, but hardly or not at all on mesolithic or younger flints.

Another phenomenon is the presence of small pits in the surface (probably the same features as the "pock marks" described by Reid Moir, 1914). These small pits are usually up to 1 mm in diameter, sometimes bigger though mostly smaller, round or oval in shape, and with in flat bottom (figures 5 and 6). These small pits can probably develop as a result of processes either mechanical or chemical (by means of solution), or a combination of both. It is remarkable in any case that these small pits are usually associated with wind-gloss (3.3.1.). These small pits are not often observed on flints from periods later than the Palaeolithic. Some flints are affected by chemical weathering to such an extent that their surfaces have become extremely pitted and porous, and in this way microscopic traces of use formerly present will be obliterated.

3.3. *PROCESSES ON THE SURFACE*

3.3.1. WIND-GLOSS

Wind-gloss is the term used to describe a sheen, not usually very high, on the surface of flints which has a somewhat "greasy" appearance. Wind-gloss can be distinguished from gloss patina fairly easily with some experience. A characteristic feature of wind-gloss is that the intensity of this sheen is usually rather variable on the same piece of flint; indeed, on some flints exhibiting wind-gloss there are often several places where this phenomenon is hardly if at all present. The current explanation for the development of wind-gloss is polishing by wind carrying sand and/or dust. The presence of the above-mentioned (3.2.4.) small pits in the surface of flint seems to be associated with wind-gloss. Davies (1967) observed that as a result of sand-blasting of basalt, phenocrysts and other weak spots in the surface became hollowed out into small pits. The present author has sandblasted a number of flints for a period of ± 10 minutes with tiny glass pearls measuring 90-150 microns in diameter. When the apparatus was used at maximum power, many small pits developed in the surface, which moreover acquired a low sheen (fig. 7). When less power was applied, a certain degree of sheen resulted but hardly any small pits. It therefore seems as though the small pits associated with wind-gloss on flint can be produced mechanically. There is however not always a strong correlation apparent between the intensity of the sheen and the quantity of small pits, so that a chemical component can certainly not be completely excluded as a contributory factor to the production of these small pits. Davies observed furthermore that concave faces (flake scars) became hollowed out while ridges became accentuated as a result of sandblasting. On flint with highly developed wind-gloss ridges do indeed appear to be accentuated in the sense that the surrounding



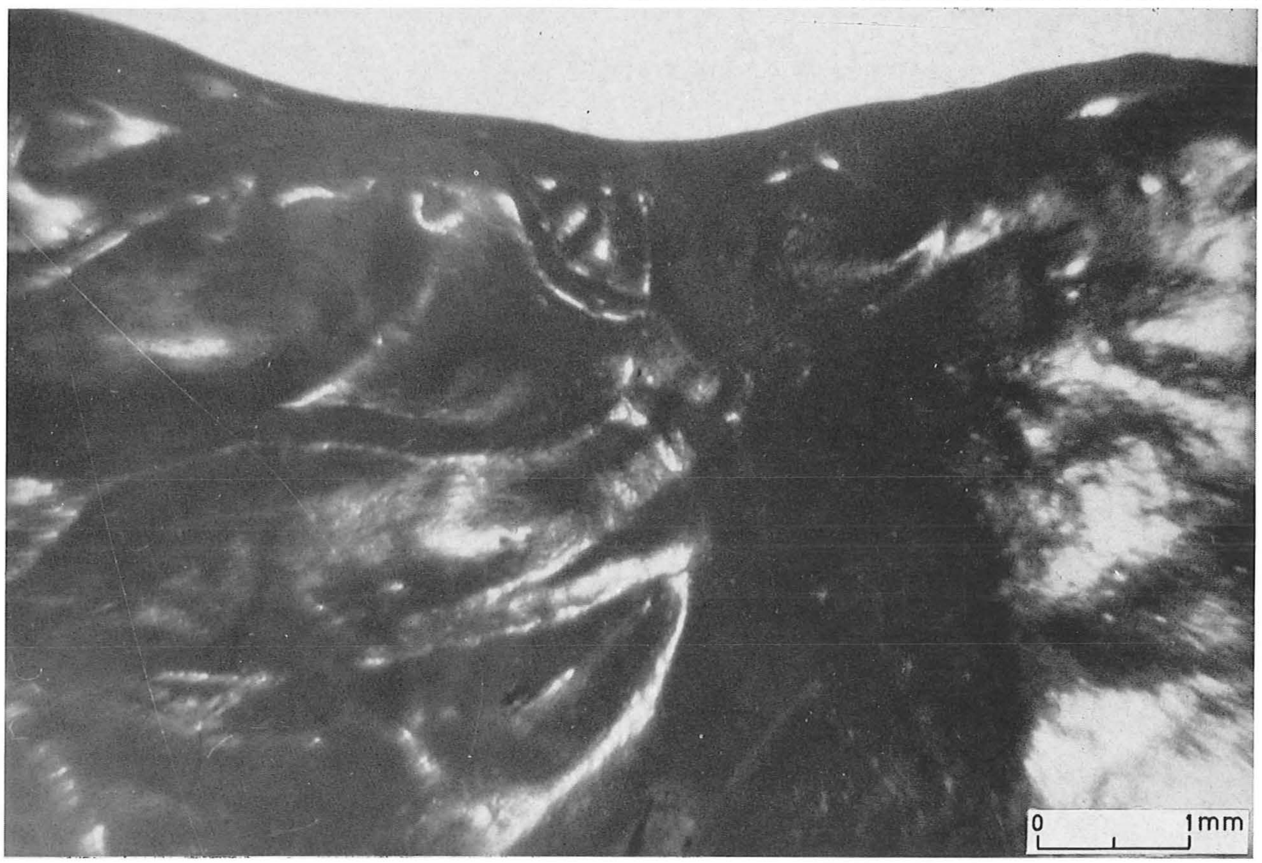
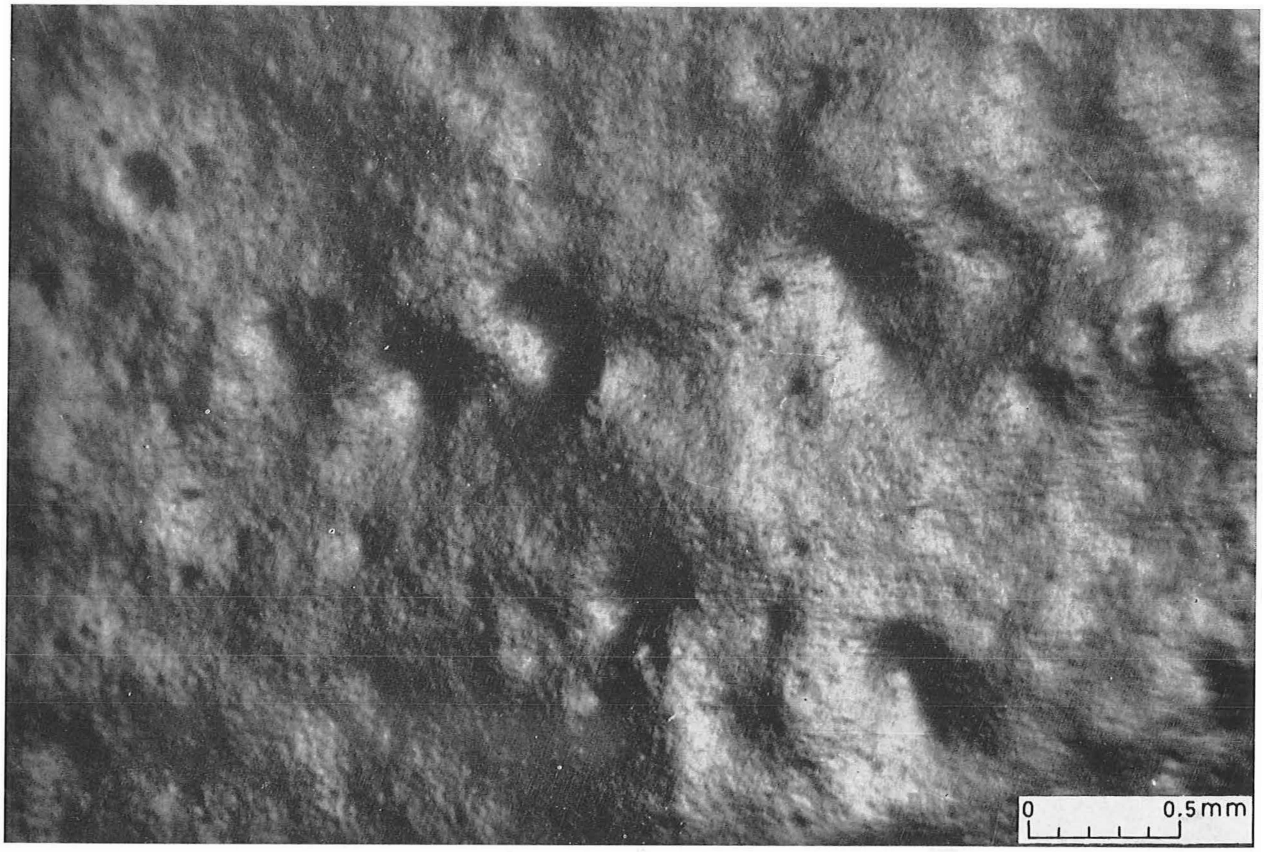


Fig. 3. Photograph of the top of the point from Deldenerbroek (province of Overijssel), taken through a stereo microscope. Clearly visible features include rounding and a scratch, which is probably the result of cryoturbation and/or gelifluction. Photograph by Dr. W. A. Casparie, B.A.I., Groningen. Stereo microscope used: Wild, type M5.

Fig. 4. Photograph of one of the side-edges of the hand-axe from Wijnjeterp (province of Friesland), taken through a stereo microscope. Rounding of ridges and side-edge is clearly visible. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.



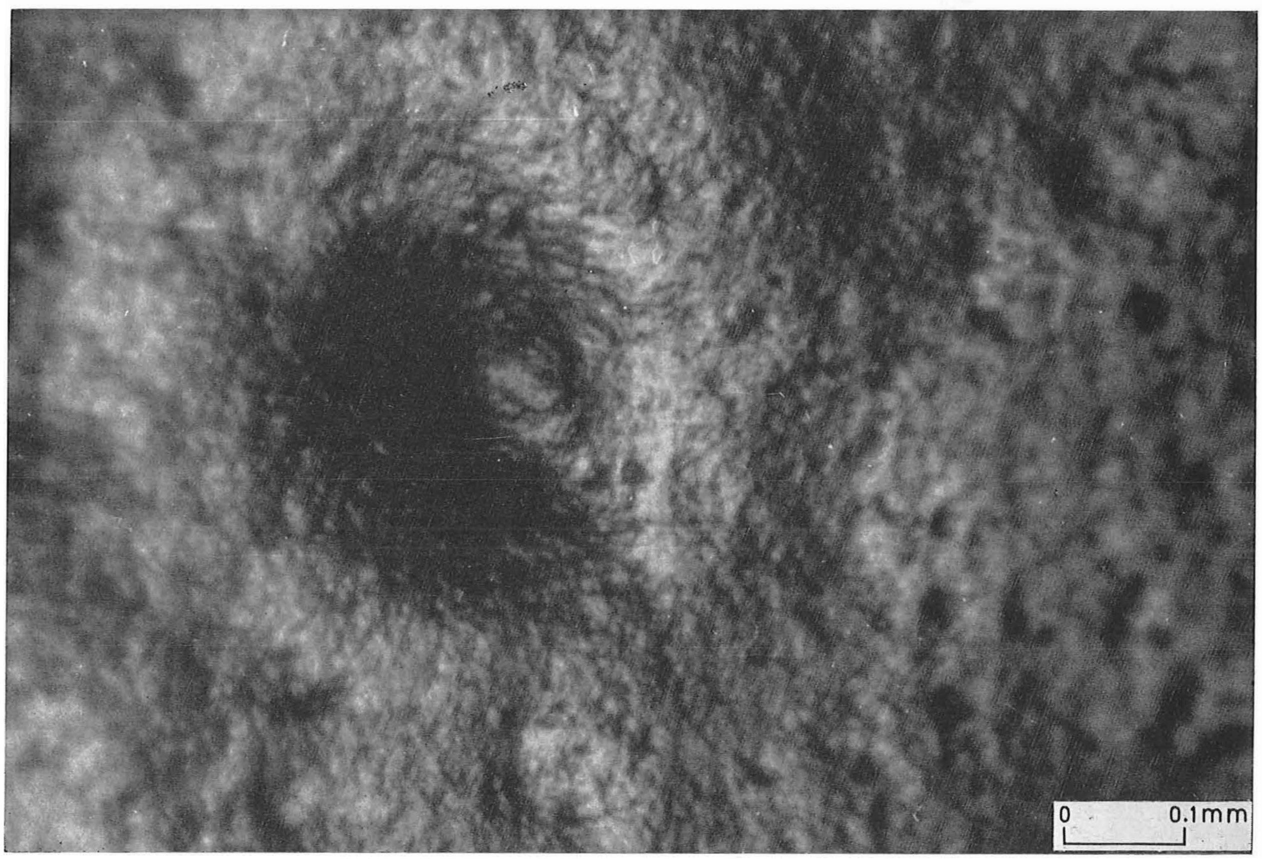


Fig. 5. Small pits in the surface of the point from Deldenerbroek (province of Overijssel) viewed through a stereo microscope. Photograph by Dr. W. A. Gasparie, B.A.I., Groningen.

Fig. 6. Detailed photograph of one of the small pits in the surface of the point from Deldenerbroek (province of Overijssel). The pit has a flat bottom. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.

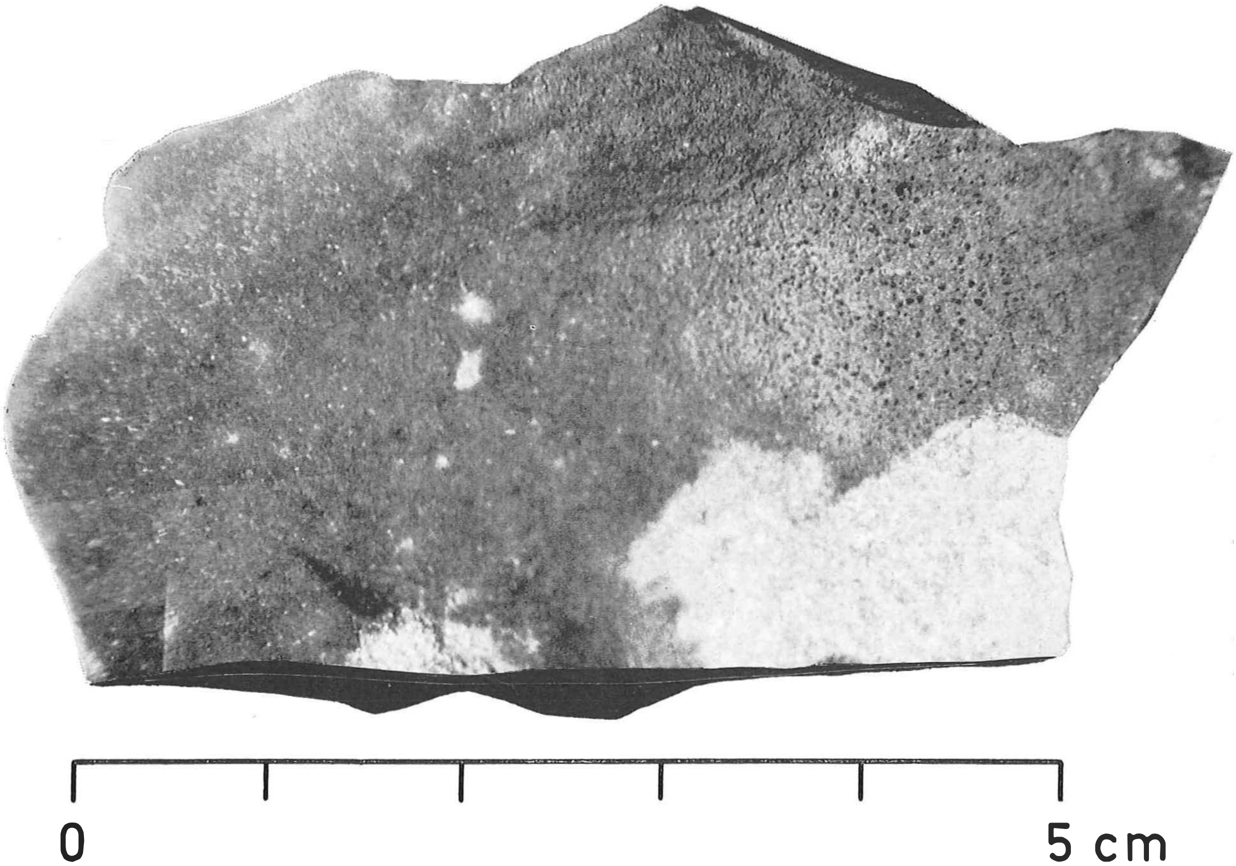


Fig. 7. A fragment of Grand-Pressigny flint, sand-blasted by the author with small glass beads for a period of 10 minutes from a distance of ca. 10 cm. This resulted in a low sheen and many small pits. A thin surface-layer disappeared, as is evident from the fact that the percussion waves on the piece of flint are not longer visible in the area which became pitted. Photograph by F. W. E. Colly, B.A.I., Groningen.

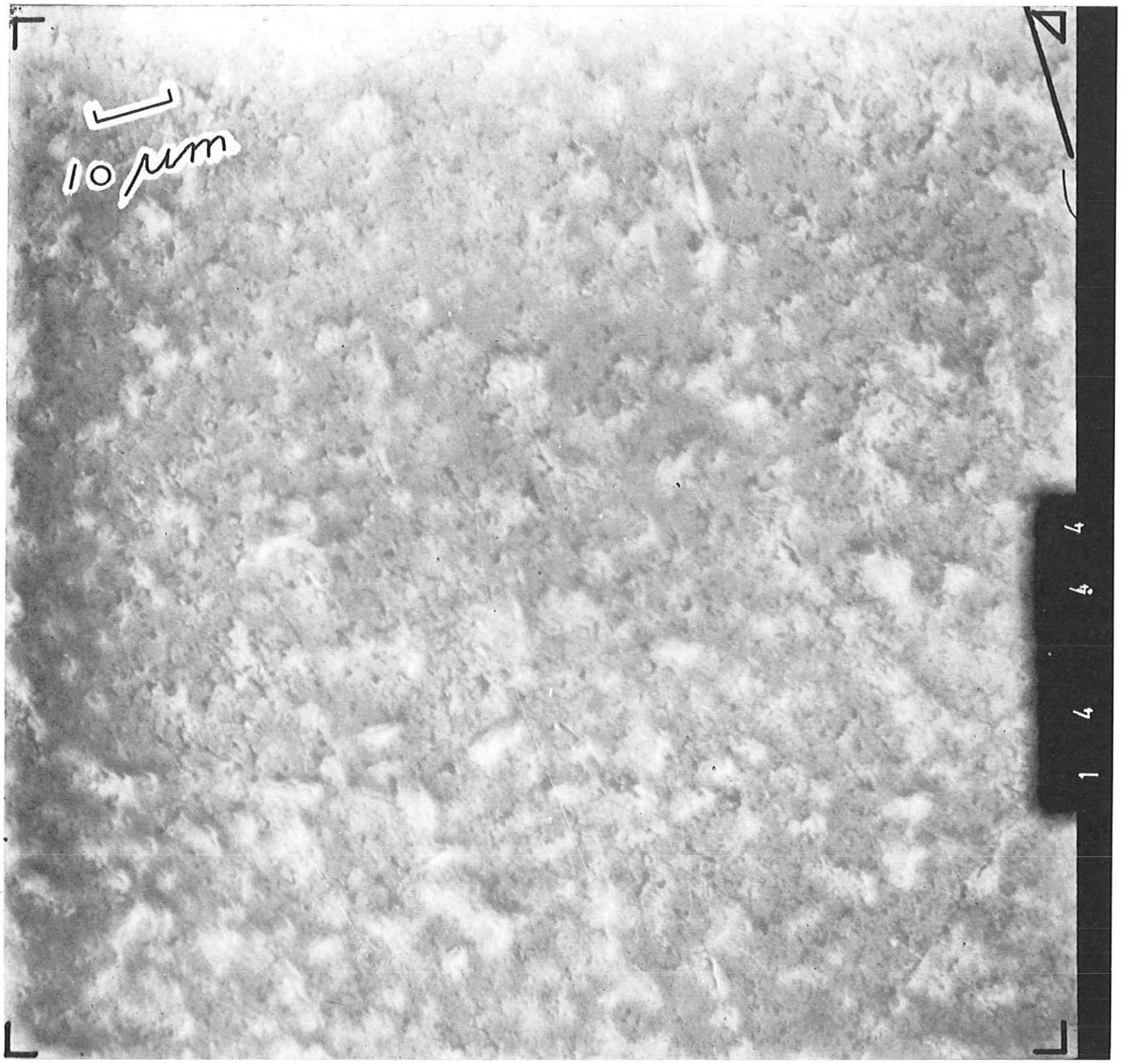


Fig. 8. S.E.M.-photograph of the surface of a (natural) flint from the boulder-sand of Drente, with wind-gloss. The flattening of higher parts of the surface is clearly visible. Photograph by Dr. G. Boom, Laboratory of Physical Metallurgy, Groningen.

faces on both sides are somewhat more hollowed out in the immediate vicinity of the ridges.

It is an interesting fact that a surface with wind-gloss does not become less lustrous to any great extent as a result of the subsequent development of a white patina, provided the latter is not very intense.

Wind-gloss is not comparable with desert varnish (Engel and Sharp, 1958). Desert varnish is dark in colour and is essentially a deposition of material locally present, especially Mn and Fe compounds. Wind-gloss is colourless and is formed mainly mechanically as a result of polishing, though a chemical component may contribute to its formation. The surface of flint with wind-gloss can be seen on SEM-photos to be clearly levelled off

Fig. 9. S.E.M.-photograph of the same surface as in Figure 8, but a higher magnification. The flattened higher parts are clearly visible. The intervening lower areas appear to be unchanged (the normal "plate structure" of flint is visible). Scratches are not present. Photograph by Dr. G. Boom, Laboratory of Physical Metallurgy, Groningen.

(figures 8 and 9) with deeper parts apparently unaffected. Scratches are not visible. It is not impossible that, in places where wind-gloss is highly developed, microscopic traces of use formerly present are completely or partly obliterated.

Wind-gloss is very common on flints occurring naturally in boulder-sand, and on Middle Palaeolithic finds from the Netherlands.

3.4. *FROST ACTION*

3.4.1. FROST-SPLITTING

A frequently recurring alternation of freezing and thawing leads in the course of time to the development of fine cracks in flint, along which splitting can occur. These frost-split surfaces are fairly characteristic. It is significant that the splitting force is exerted from the inside and not from the outside as in the case of flint worked by man. Frost-split faces are sometimes interpreted as flake scars, due to the appearance of more or less concentric rings. On complete frost-split faces it is however immediately clear that these are natural in origin since the centre of these rings is not situated along an edge (as in the case of an artificial flake: the "point of percussion"), but somewhere in the middle, often near a fossil or other inclusion in the flint. Percussion bulbs are not caused by frost-splitting. The rings are furthermore not regularly parallel, as in the case of flakes, but fan out here and there.

A significant characteristic is that the rings on frost-split faces do not exhibit a smooth, asymmetric sinus curve in cross-section, as is the case with percussion waves on flakes, but that on the contrary they are mostly sharply profiled and therefore clearly isolated from one another. Moreover these rings can be developed positively as well as negatively, sometimes both together on the same face (figure 10).

These rings may be absent, however, just as with percussion waves. Even in that case there is a difference discernible between these two kinds of

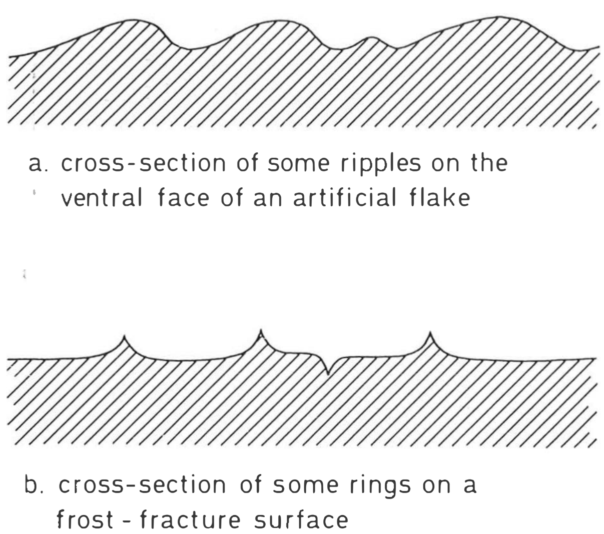


Fig. 10. Schematic drawing to illustrate difference in cross-section between percussion waves on flakes and rings on frost-split faces. Drawing by H. R. Roelink, B.A.I., Groningen.

surfaces when they can both be observed on one piece of flint: frost-splitting results in somewhat more granular faces than percussion. This is probably due to the fact that frost-splitting is a slower process which therefore possibly takes place around the "grains".

In flint that has been subject to frost-splitting, cracks can frequently be seen (also on a micro-scale) along which splitting has not yet taken place.

An important point is that frost-splitting is a process which still occurs at the present time, so Middle Palaeolithic artefacts may have been affected by frost-splitting since the time of their manufacture. This is the case with various Middle Palaeolithic finds from the Netherlands, including the hand-axe from Bakel (Stapert, 1975C) and the hand-axe from Anderen (Stapert, 1976, this volume).

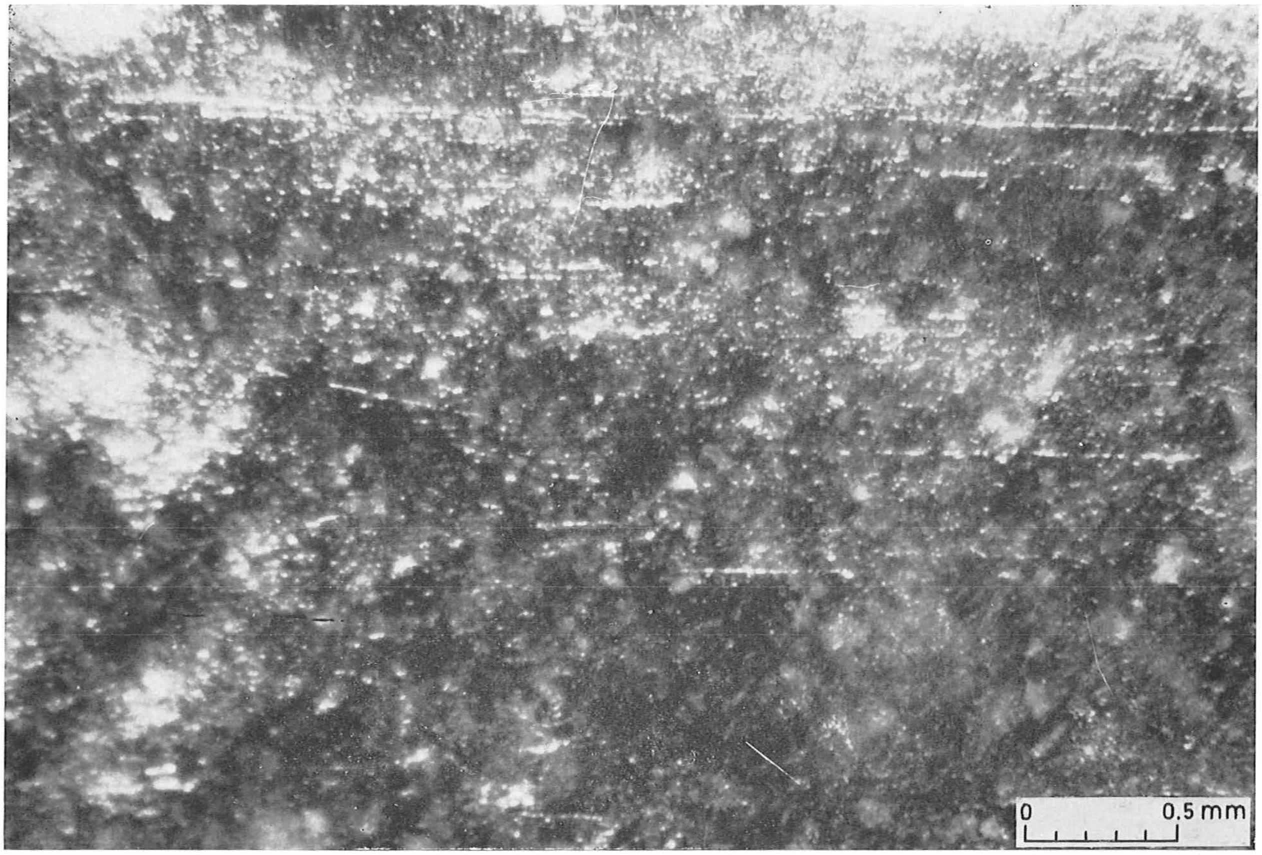
3.5. *PROCESSES ASSOCIATED WITH SOIL MOVEMENTS*

3.5.1. SCRATCHES

Scratches are seldom abundant on any one piece of flint. This is understandable, since flint is a hard and tough material. Scratches can only be produced on flint by stones which are just as hard as or harder than flint, in the former case only at fairly high pressures. Nevertheless in some cases many scratches can be observed on flint, e.g. flints which have been exposed to the action of land-ice during the penultimate glacial. On such stones the scratches always go together with very distinct pressure phenomena (see 3.5.2.). Scratches also occur on most flints from boulder-sand and on Middle Palaeolithic finds from the Netherlands, but only in small numbers which are moreover in most cases only visible with the aid of a stereo microscope. These scratches are randomly distributed

▶ Fig. 11. A set of subparallel scratches on the side-scraper from Bladel (province of Noord-Brabant), viewed through a stereo microscope. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.

▶ Fig. 12. A small set of subparallel scratches on the *Faustkeilblatt* from Eersel (province of Noord-Brabant), viewed through a stereo microscope. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.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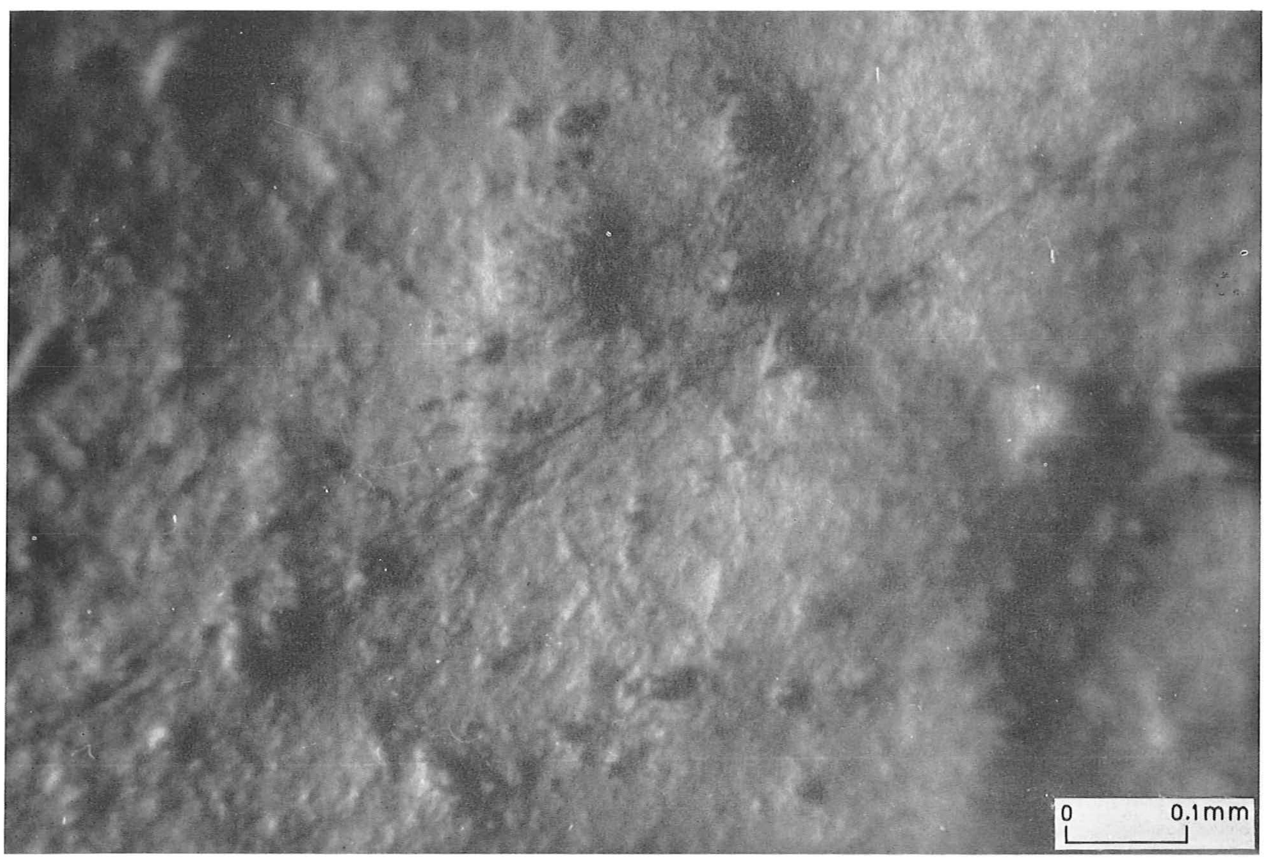
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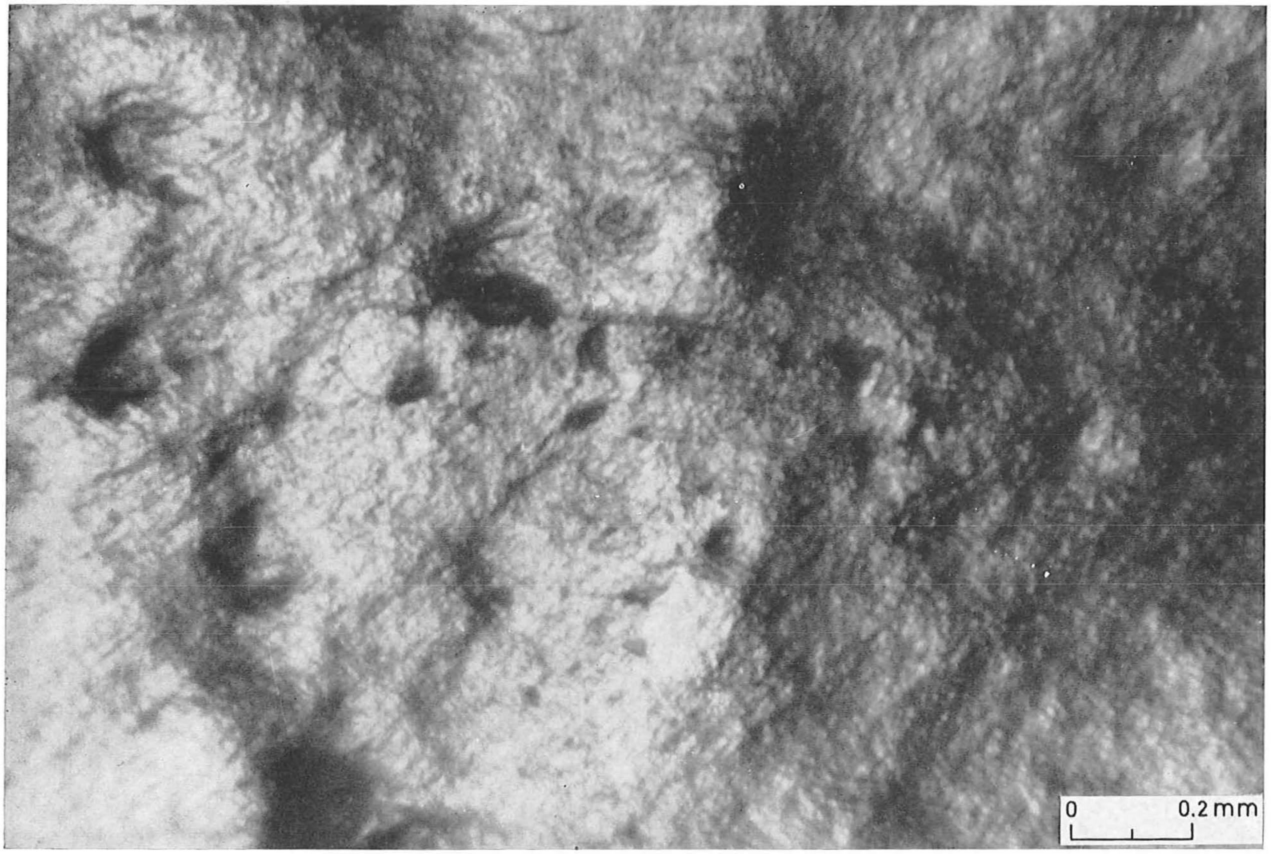
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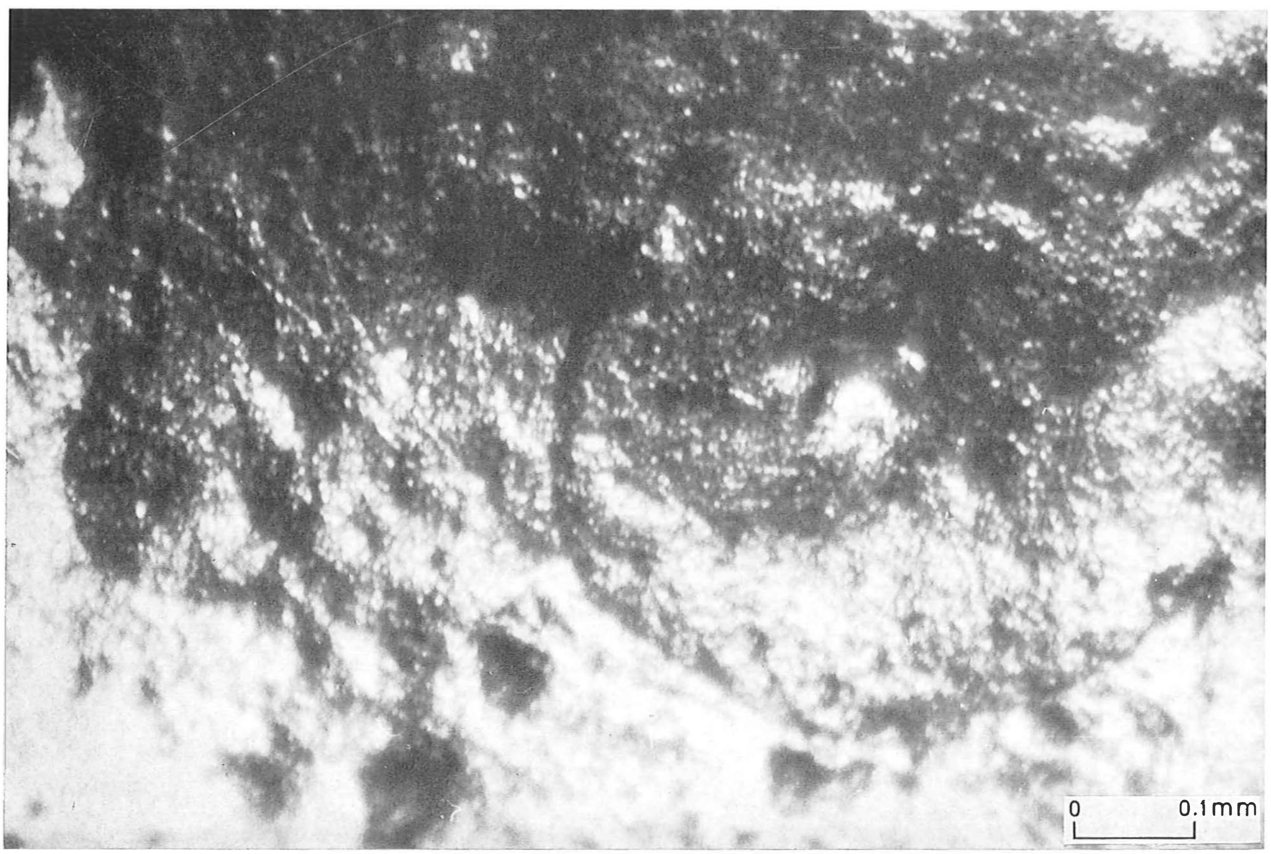
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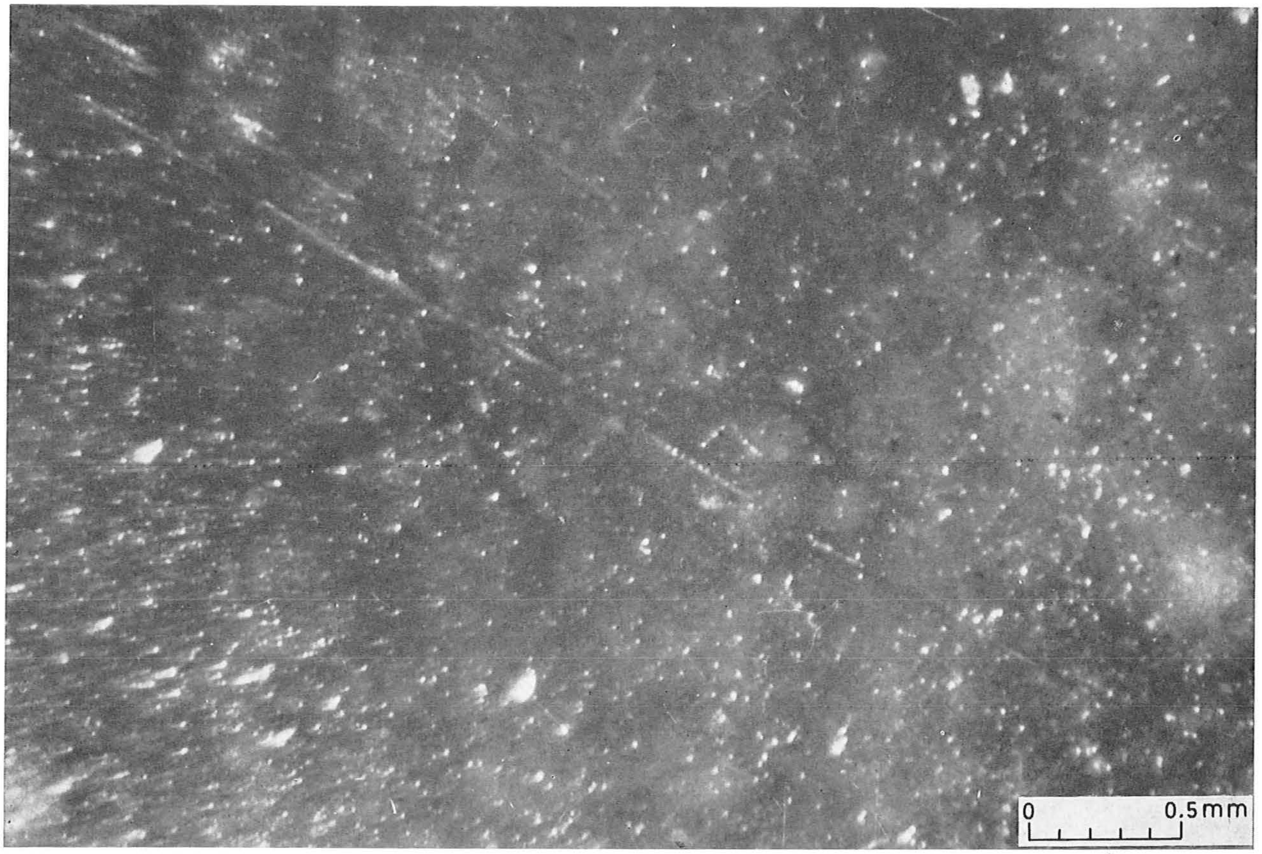
Fig. 15. A set of subparallel scratches, associated with a damaged patch on the surface of the *Faustkeilblatt* from Eersel (province of Noord-Brabant), viewed through a stereo microscope. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.

◀ Fig. 13. A scratch, associated with a damaged patch on the surface, and a pressure-cone on the hand-axe from Wijnjeterp (province of Friesland), viewed through a stereo microscope. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.
◀ Fig. 14. Scratches, associated with two pressure-cones, on the side-scraper from Bladel (province of Noord-Brabant), viewed through a stereo microscope. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.



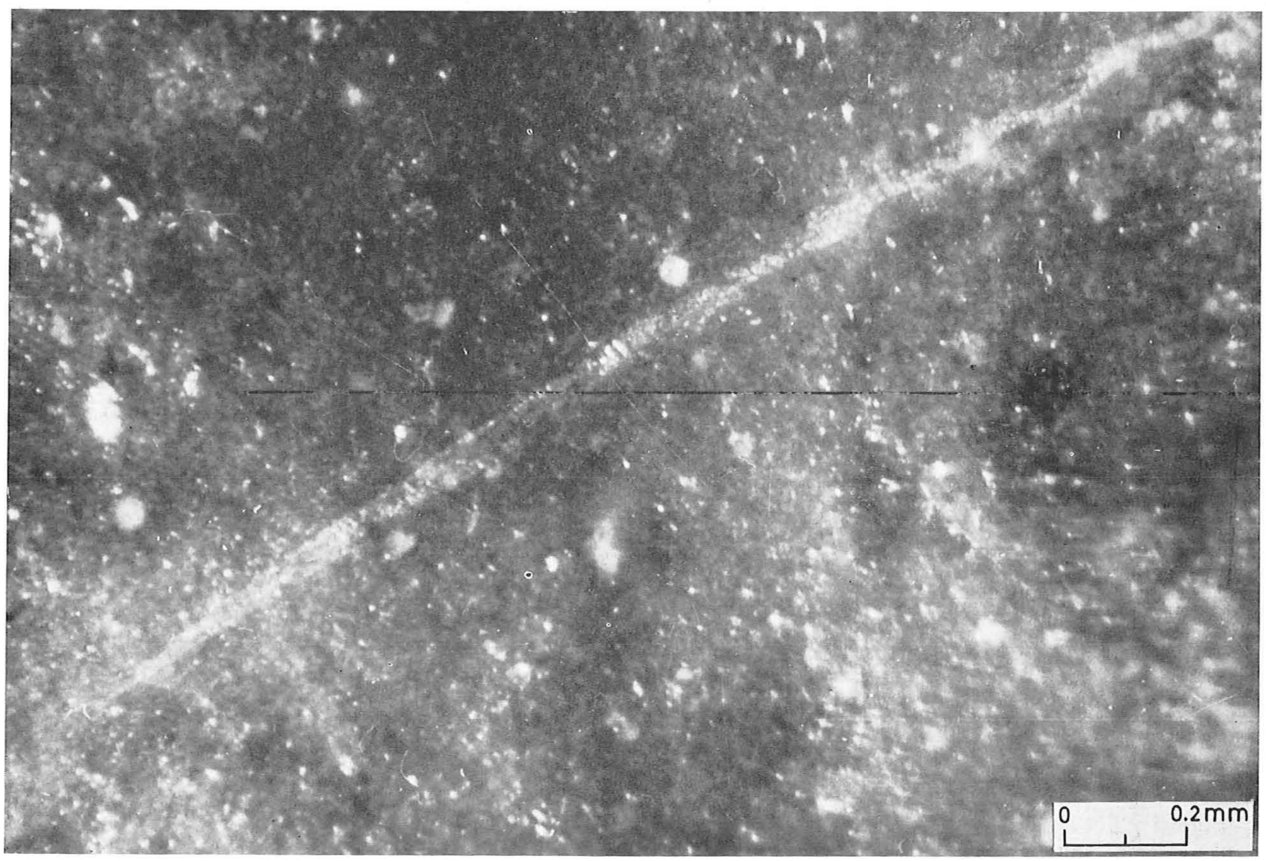
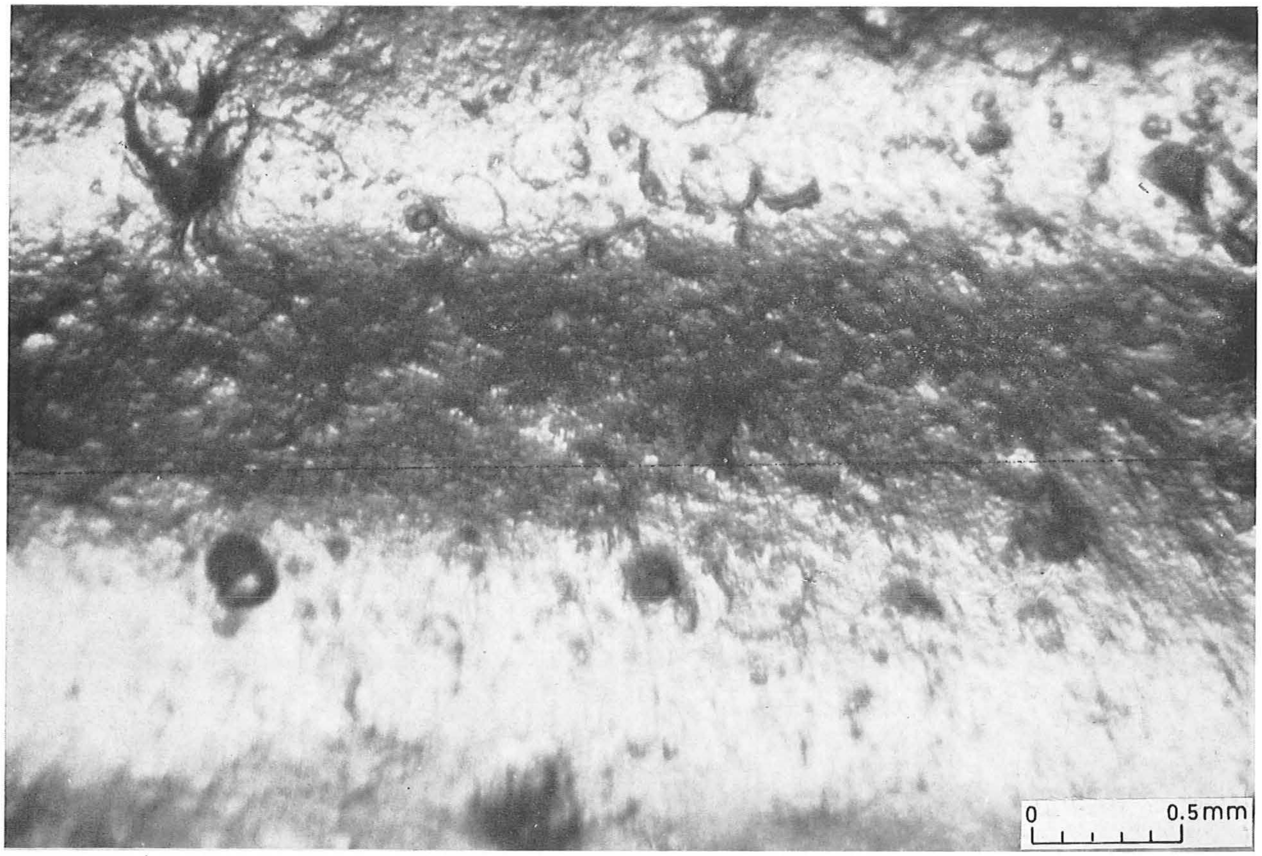


Fig. 16. A set of subparallel scratches on the *Faustkeilblatt* from Eersel (province of Noord-Brabant), viewed through a stereo microscope. Some scratches are "segmented", a phenomenon which appears to be characteristic of naturally caused scratches. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.

Fig. 17. A scratch on the scraper from Emmen (province of Drente), viewed through a stereo microscope. The scratch is "segmented", but in a different way to those shown in fig. 16. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.



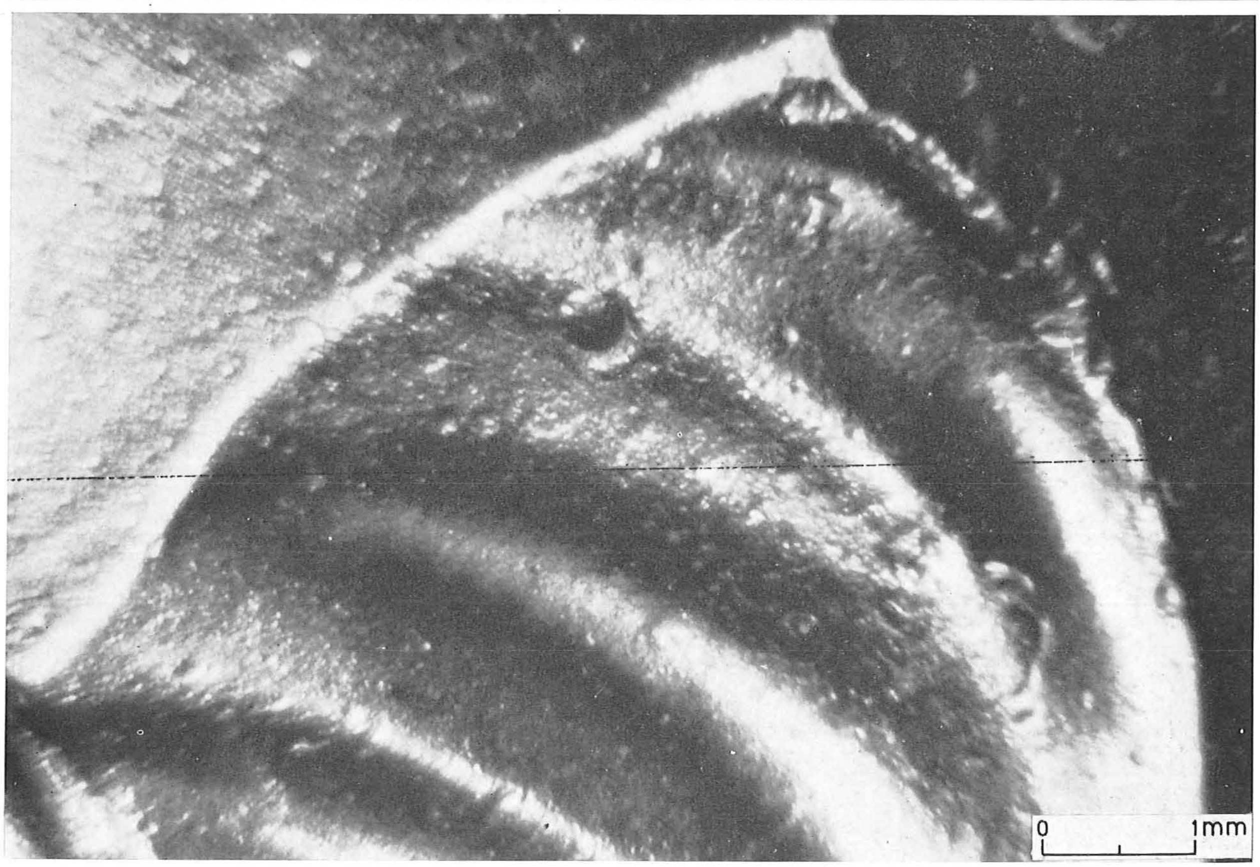
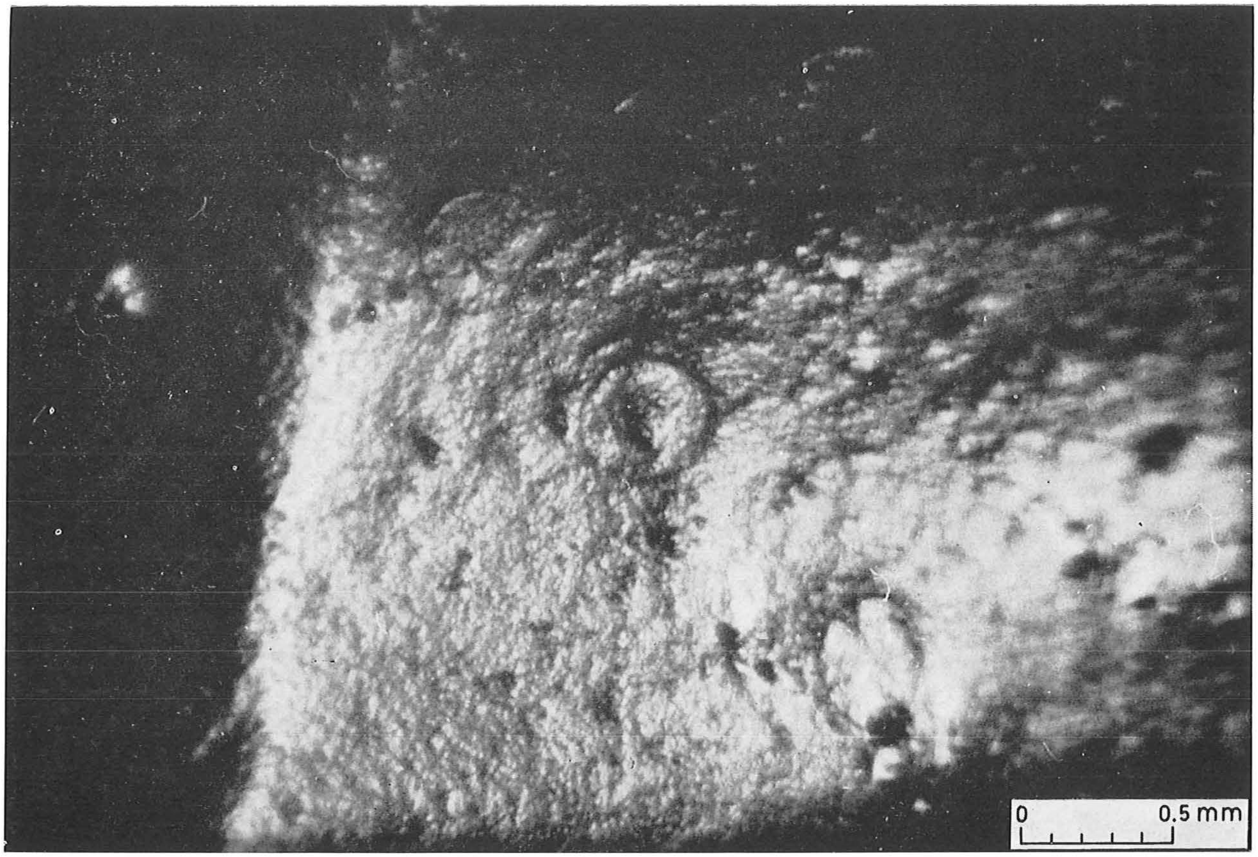


Fig. 18. A ridge on the *Faustkeilblatt* from Eersel (province of Noord-Brabant), with many pressure cones, viewed through a stereo microscope. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.

Fig. 19. A ridge on the *Faustkeilblatt* from Eersel (province of Noord-Brabant) with many pressure cones, viewed through a stereo microscope. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.



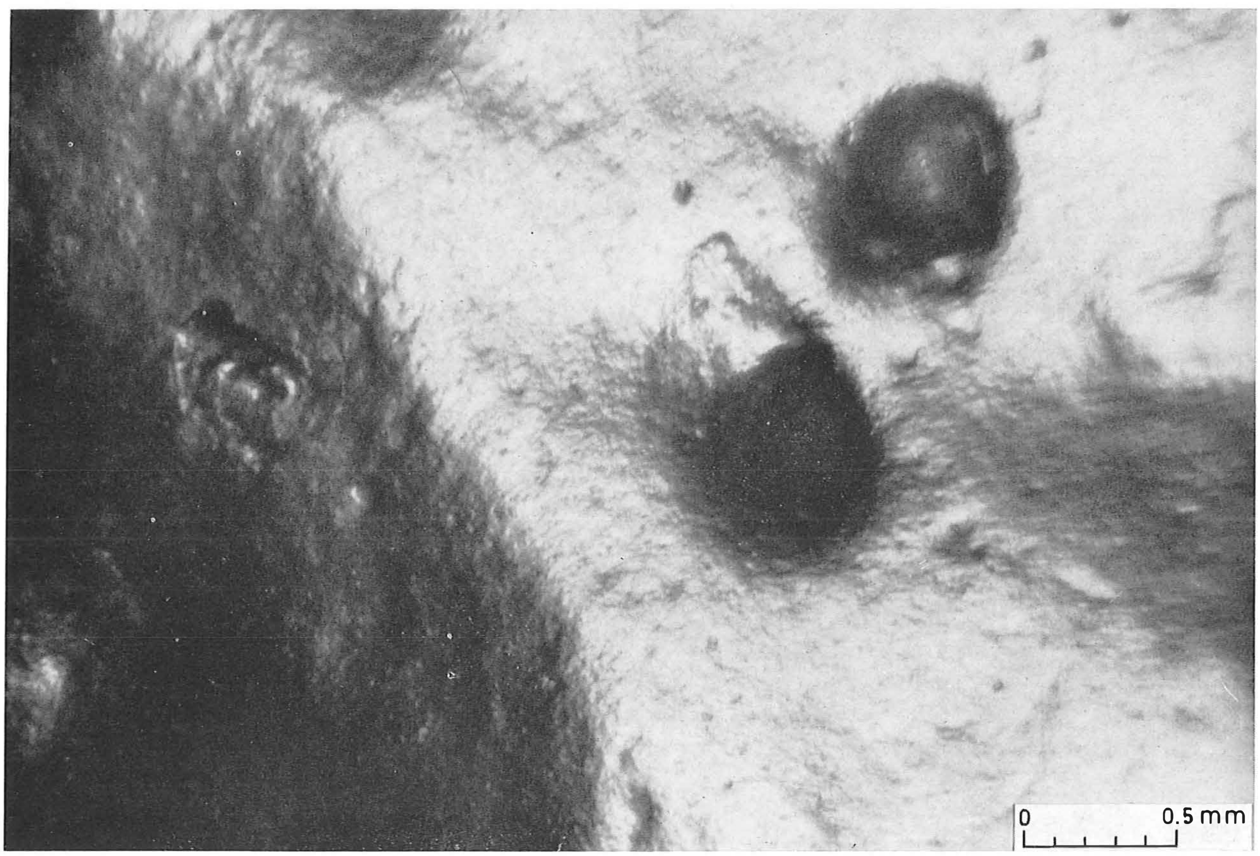
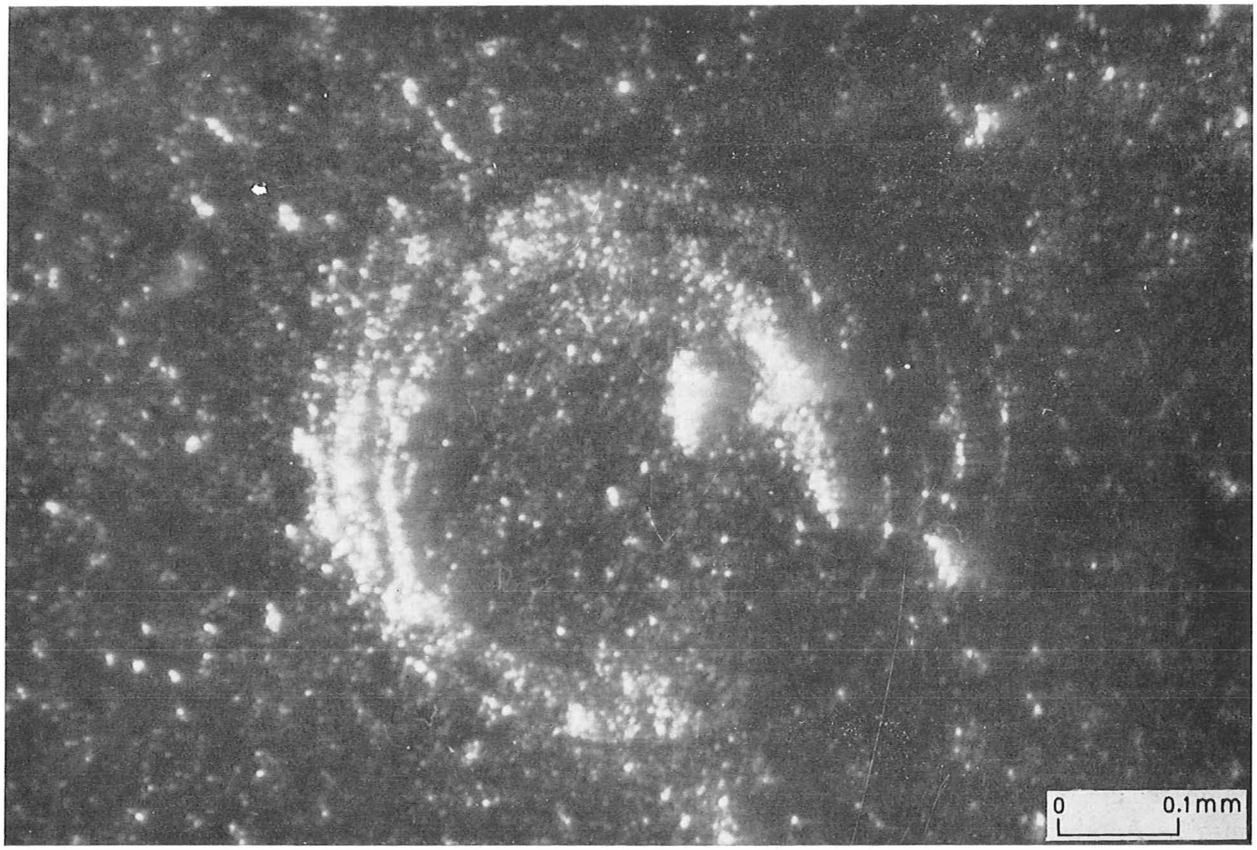


Fig. 20. Pressure cones near a ridge on the point from Deldenerbroek (province of Overijssel), viewed through a stereo microscope. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.

Fig. 21. A ridge on the hand-axe from Wijnjeterp (province of Friesland), with (right) small pits, and (left) a damaged pressure cone, viewed through a stereo microscope. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.



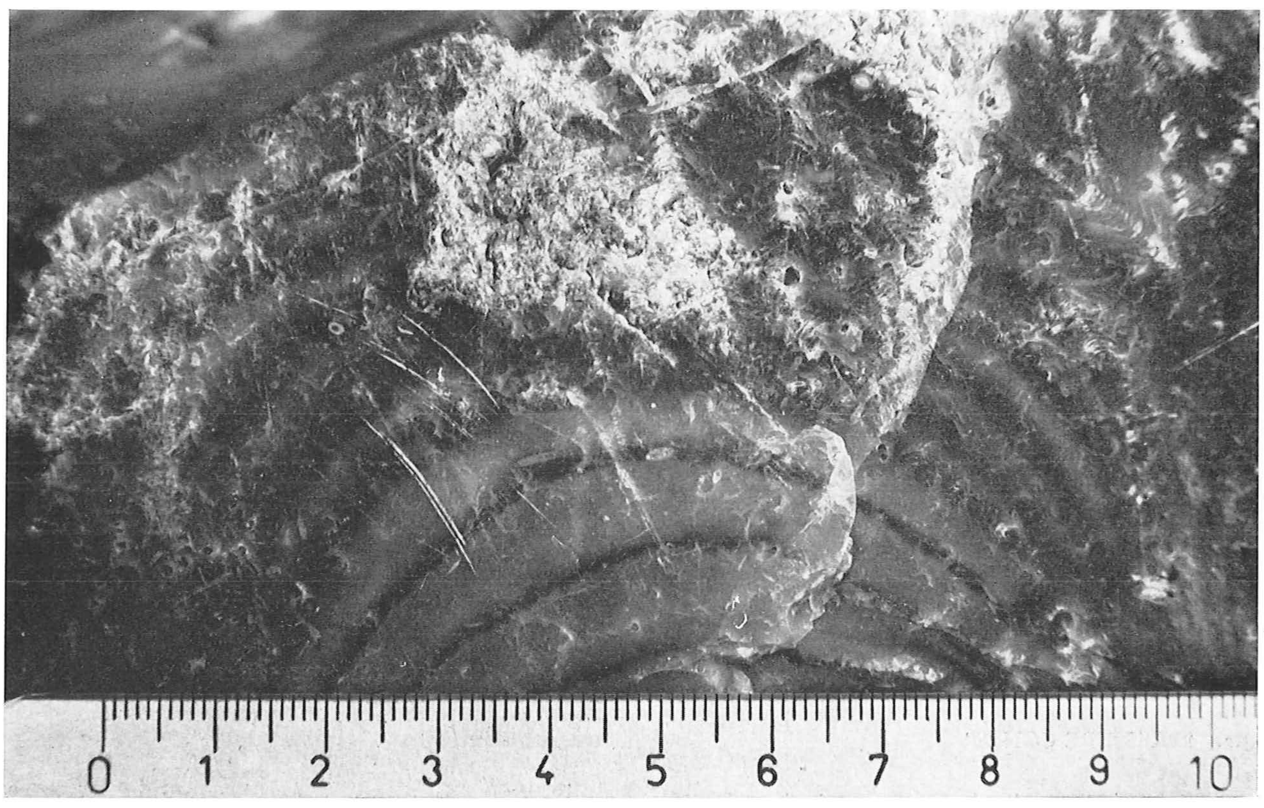


Fig. 22. A multiple pressure cone on the point from Deldenerbroek (province of Overijssel) viewed through a stereo microscope. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.

Fig. 23. A (natural) flint from the bouder-clay reserve near Urk, heavily scratched due to moving land-ice. Visible features include pressure cones (circles), series of oblique pressure cones, and scratches. Edges and ridges are blunted. Photograph by F. W. E. Colly, B.A.I., Groningen (scale in cm).

over the surface of such flints, occur mainly on the flatter parts and usually run in all directions.

Sometimes sets of subparallel scratches occur (figures 11 and 12).

It is important to note that there will be no direct relation between these scratches and the working edges of the flint implements. A very important point is that natural scratches are always accompanied by pressure cones (3.5.2.) and "cryoturbation retouch" (3.5.3.). Natural scratches are sometimes even directly associated with pressure cones (figures 13 and 14). These scratches regularly occur together with signs of damage apparently caused by the same stone which made the scratches (figures 13 and 15). Another interesting phenomenon is that some of these natural scratches are "segmented", as if they developed slowly, by "fits and starts" (figures 16 and 17). This phenomenon does not occur in the case of scratches caused by use, as illustrated by Semenov (1973 (1957)). Another observation is that natural scratches are almost never approximately parallel to one another over a large part of a flint implement, as is indeed mostly the case with scratches caused by use according to Semenov (1973 (1957)).

One can expect scratches resulting from use to be related in the first place to a working edge; furthermore, such scratches never go together with pressure cones, if one assumes that scratches resulting from use are caused in most cases by friction with sand grains or other fine particles. It can be concluded that when one wishes to study scratches resulting from use on Palaeolithic implements, one should firstly ascertain whether natural scratches are present. This will most probably be the case if pressure cones and "cryoturbation retouch" are also present. If such features are indeed present, then only in exceptional cases will it be possible to determine which of the two types of scratches one is dealing with: in most cases however it will then be impossible to make a meaningful study of scratches resulting from use. The same argument applies with respect to edge damage and abrasion.

3.5.2. "PRESSURE CONES"

As previously stated, the nature of the abovementioned soil movements is such that any scratches which may be present always go together with pressure cones when the pressure is exerted on a face, and in the form of edge damage ("retouch") when pressure is exerted on the edges (see 3.5.3.). Pressure on a face can lead to the development of a small break, circular in section, in the surface of the flint which widens out inwards in the form of a cone. This phenomenon is related to incipient cones of percussion and collision cones, but in this case brought about by pressure. When very high pressures are exerted (as under conditions of glaciation) then there will be pressure cones present in great numbers and of large size, but when less powerful forces are operative (cryoturbation, gelifluction) then the pressure cones will often be very small and usually only visible with the aid of a stereo microscope. Such pressure cones occur much more frequently than scratches, since pressure cones, in contrast to scratches, can also be produced by the action of stones which are softer or less tough than flint. It follows from this that whenever (natural) scratches are present, pressure cones cannot possibly be lacking. On the other hand, the presence of pressure cones is not a *sine qua non* for the presence of scratches.

Dense clusters of pressure cones are frequently observed near ridges between flake scars or other protruding parts of the surface (figures 18, 19 and 20). As previously stated, pressure cones are sometimes directly associated with scratches. Sometimes pressure cones are damaged by the stone responsible for their formation (figure 21). Multiple pressure cones also occur (figure 22).

Flints which have been subjected to the more powerful forces exerted e.g. by land-ice exhibit exceedingly large number of scratches and pressure cones (figure 23). Series of inclined pressure cones often occur (which may or may not be combined with scratches), as shown in figure 24. This is a drawing of part of an "eolith" (figure 25) from Wezep (Bursch 1939; Bohmers 1950; Stapert 1975B). One such series of inclined pressure cones on the drawing shows a distinct curve, indicating that the stone which caused the formation of the pressure cones changed direction during its passage over this surface.

3.5.3. "CRYOTURBATION RETOUCH"

The same soil movements also result in damage to

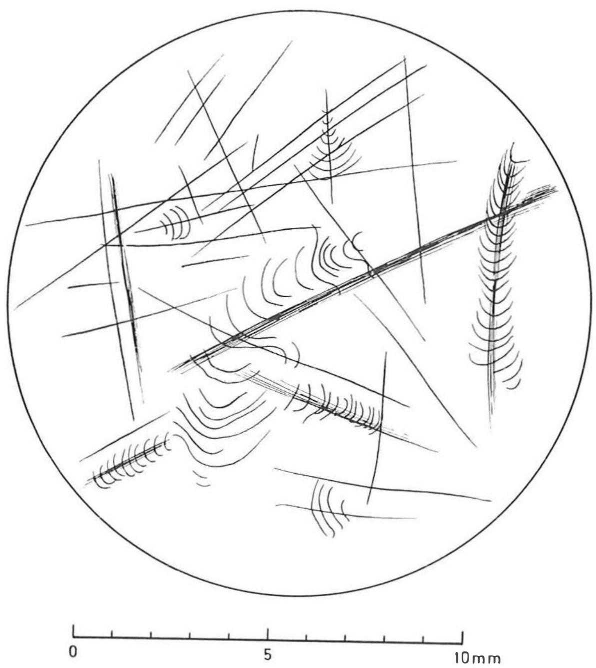
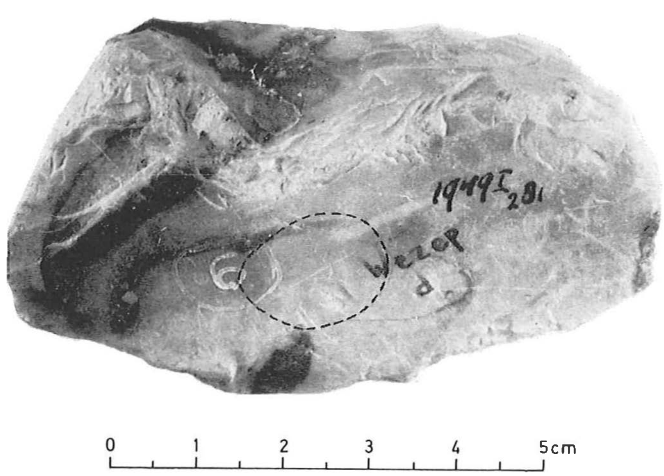


Fig. 24. Drawing of scratches and series of oblique pressure cones (in most but not all cases accompanied by scratches) on an "eolith" from Wezep, as viewed through a stereo microscope. The area shown in this drawing is indicated on Figure 25. Drawing by H. R. Roelink, B.A.I., Groningen.

Fig. 25. The "eolith" from Wezep, showing the location of the area depicted in Figure 24. Photograph by F. W. E. Colly, B.A.I., Groningen.



the edges of flints. This form of damage, "cryoturbation retouch", can strongly resemble artificial retouch, and in some cases it is not easy to identify this type of "pseudo-artefact" as such. In most cases however a number of distinctive characteristics are discernible (see Adrian, 1948). These include the following: in the case of natural "retouch" small "teeth" often develop along the "retouched" sides. Alternating retouch is also often present. Furthermore, obtuse (overhanging) "retouch angles" occur regularly. Natural retouch can vary widely in terms of size and direction, while the degree of patination often is also variable.

It should be mentioned here that "cryoturbation retouch" is very common and that Palaeolithic flint implements can be affected by it after their manufacture. This is indeed the case with most of the Middle Palaeolithic finds from the Netherlands (see Stapert, 1976, this volume). The same argument applies for example to certain "Tayacian" collections.[4]) It is clear that in the study of edge damage as a result of use, a very promising field of research (Tringham *et al.*, 1974; Odell, 1975), insurmountable problems will be encountered in dealing with implements thus affected by postmanufactural "cryoturbation retouch". In extreme cases protruding parts have become blunted or abraded.

3.6. "*FRICTION GLOSS*"

This is a very remarkable phenomenon which still poses problems. The name (which wrongly suggests some kind of genesis) is derived from Shepherd (1972). The term applies here to usually very small patches on the surface of flint with a very high gloss. Such patches have been mentioned by various researchers. Semenov (1973 (1957)) describes them as "single or groups of scintillations, sharply defined stars or luminous veins. Their origin still remains unexplained". Here Semenov apparently means a phenomenon other than polishing as a result of use, as is present for example on his "whittling knives". In the criticism of his book by Bordes (1967), natural "friction gloss" is spoken of, but it remains questionable whether anything is said about the "use polishing" of Semenov. Bordes distinguishes between 3 sorts of "*poli en miroir*", namely (1) as a result of a secondary deposit of silica on the flint, (2) as a result of use, (3) as a result of natural polishing. According to Bordes the small natural glossy patches are the result of "*éolisation*" by fine particles, comparable therefore with wind-gloss. He mentions further an analogous phenomenon on a flint from Denmark, on which depressions are visible within these glossy patches running approximately parallel to one another. The "*éolisation*" hypothesis had already been brought to the fore by Bordes (1950) at an earlier date. There it was mentioned among other things that such patches cannot be traces of use because there is no relation between them and the working edges of the implements. According to Bordes these patches may sometimes have been produced by friction with sand in the soil, but certainly in the case of flints from loess, Bordes regards "*éolisation*" as the main operative process.

Reisch (1974) reports similar small patches of gloss occurring on hornstone implements from Lengfeld: '*In einzelnen Fällen wirkt die Oberfläche wie angeschmolzen*". He too concludes that these small patches cannot be traces of use. Reisch thinks it probable that these small patches of gloss are due to a secondary deposition of silica on the surface.

Löhr (1972) also mentions these patches of high gloss on material from loess near Langweiler. He was unable to observe any structure within these patches with the aid of a stereo microscope.

Shepherd (1972) describes these small patches as "friction gloss". In his opinion they are the result of friction between stones in the soil. He maintains that these small patches can also be produced experimentally. Extremely glossy patches within hollow parts of flints are however attributed by Shepherd to solution.

Of course there are, besides, other mechanisms also known to produce gloss on flint, as for example in the case of "fracture-gloss" (Shepherd, 1972) and patches of gloss on flints which have come into contact with fire. Some kinds of flint contain brightly glittering inclusions, which on the surface sometimes strongly resemble small patches of "friction gloss".

With regard to the Dutch material, it is noteworthy that "friction gloss" is far commoner on Upper Palaeolithic flints than on Middle Palaeolithic, or natural flints from boulder-sand. It is also

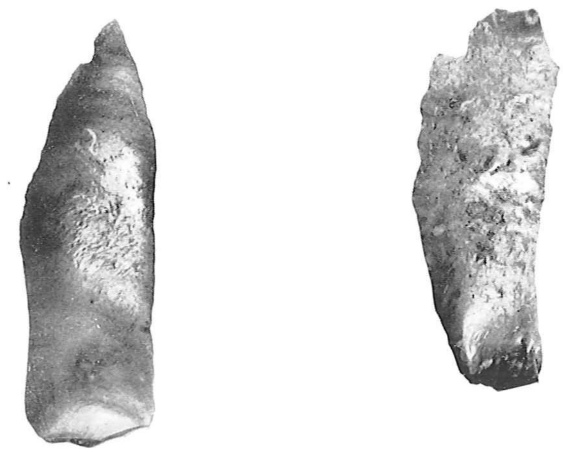
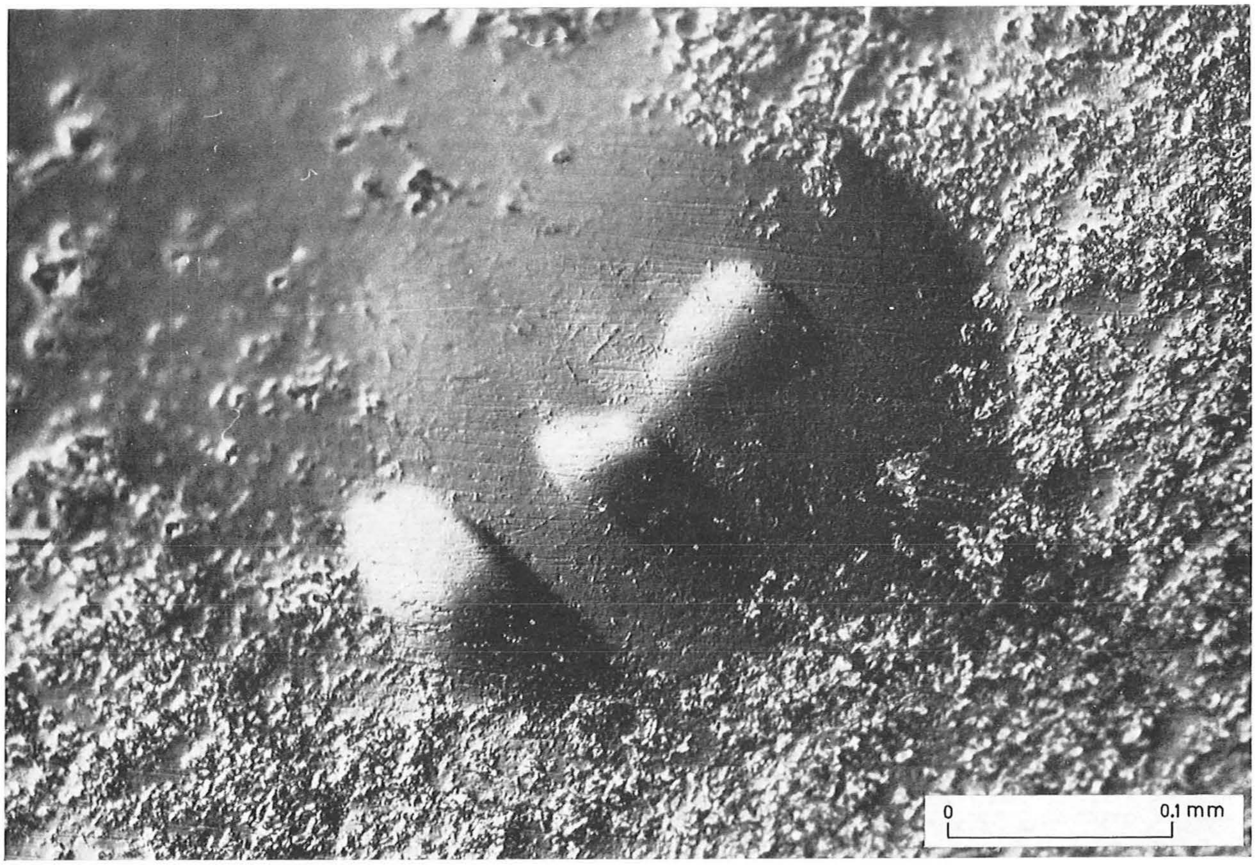


Fig. 26. (a and b). "Friction gloss" on two blades from the Upper Palaeolithic findspot of Zeyen (province of Drente). a: 1952-I-4881 Ze; b: 1952-I-4425 Ze. Within the patch of friction gloss on *a*, a conspicuous group of depressions is visible, arranged radially with respect to the spot where the gloss is highest. This phenomenon is suggestive of contact with organic material. Scale 1:1. Photograph by C.F.D., Groningen.

▶ Fig. 27. Patch of friction gloss on a blade from the Upper Palaeolitic findspot of Zeyen province of Drente; (no. 1952-I-4827 Ze), taken through an interference microscope (Nomarski-interference). Visible features include several depressions (light coming from the right), and a pattern of fine subparallel stripes. This striping continues uninterrupted across the bottom of the depressions. Photograph by H. L. Leertouwer, General Physics Laboratory, Groningen.

▶ Fig. 28. Another patch of friction gloss on the same blade from Zeyen as that shown in Figure 27. On this photograph a set of longitudinal subparallel depressions can be seen. The fine striping continues uninterrupted across the bottom of these depressions. Taken with an interference microscope (Nomarski-interference). Photograph by H. L. Leertouwer, General Physics Laboratory, Groningen.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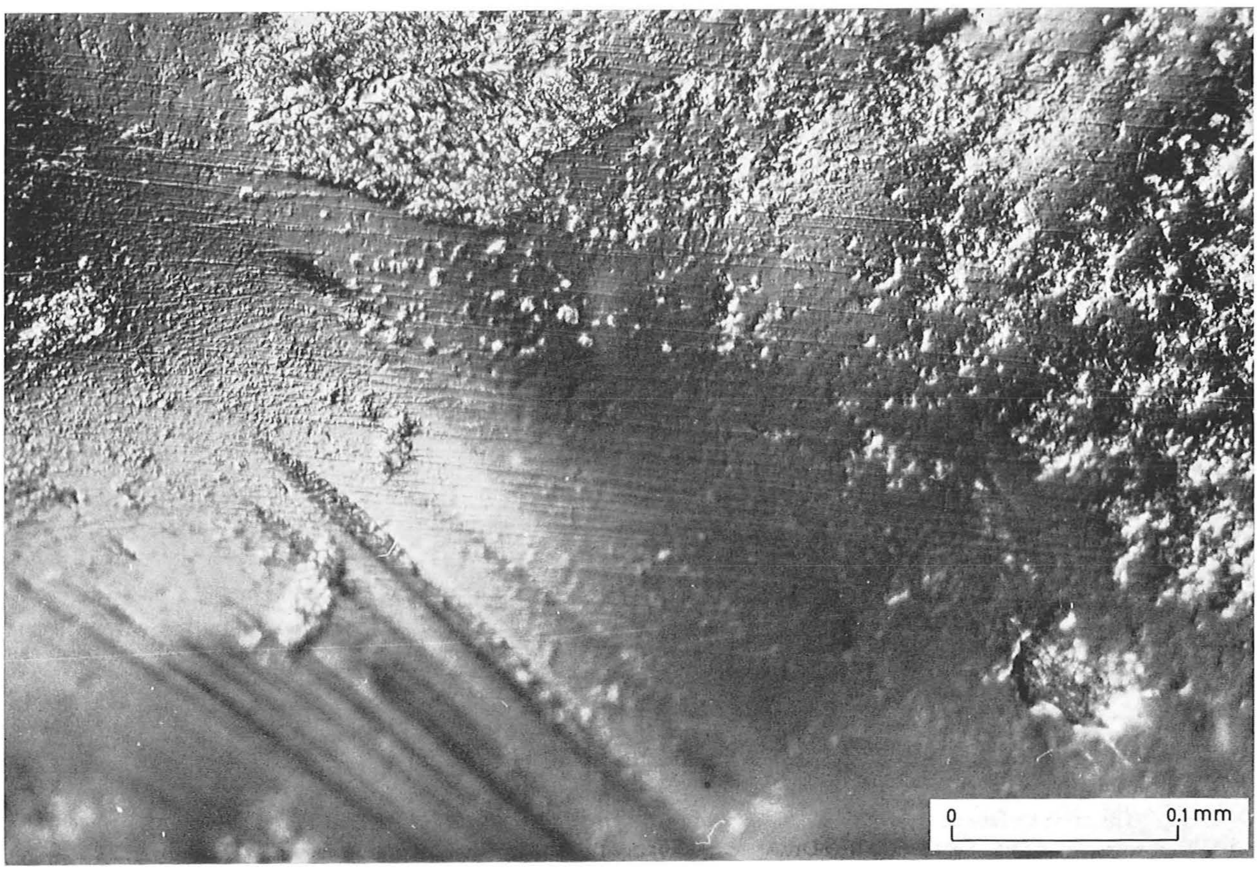
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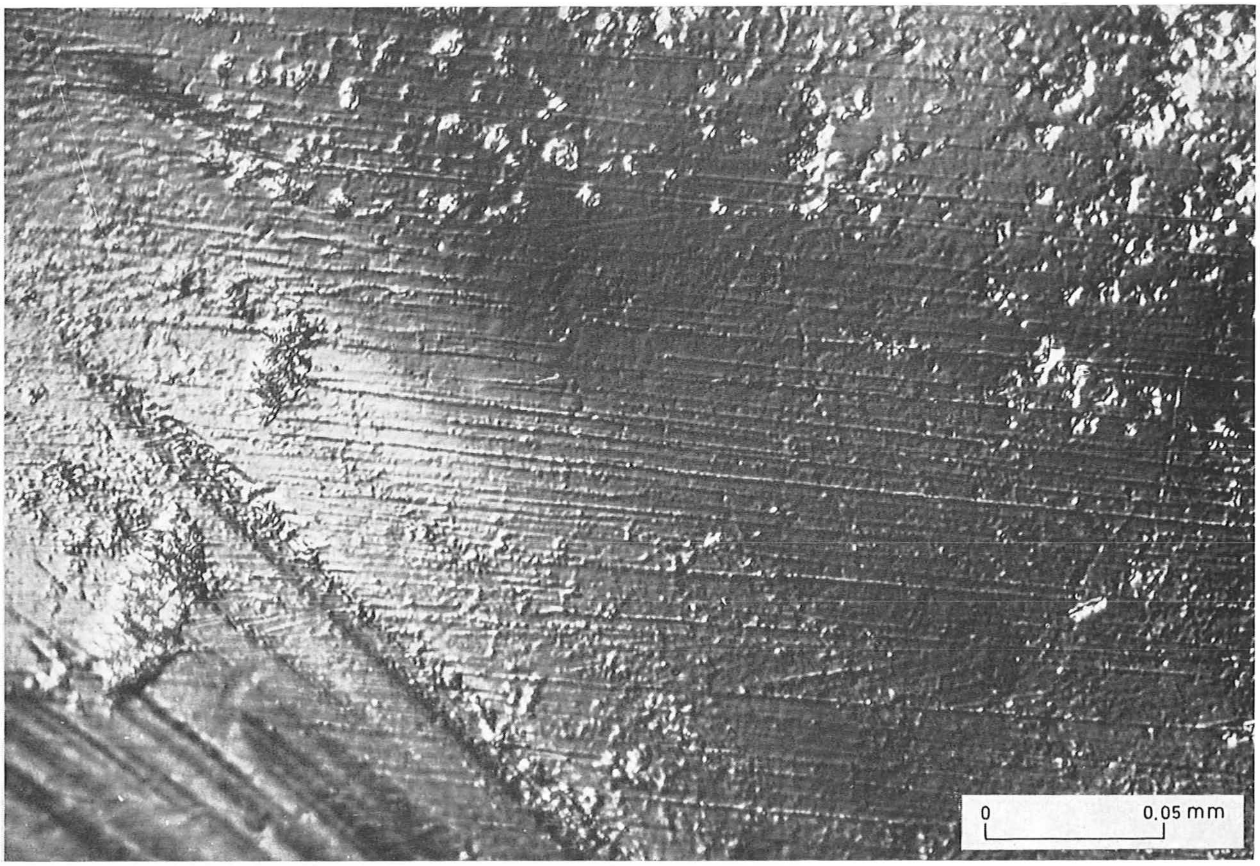
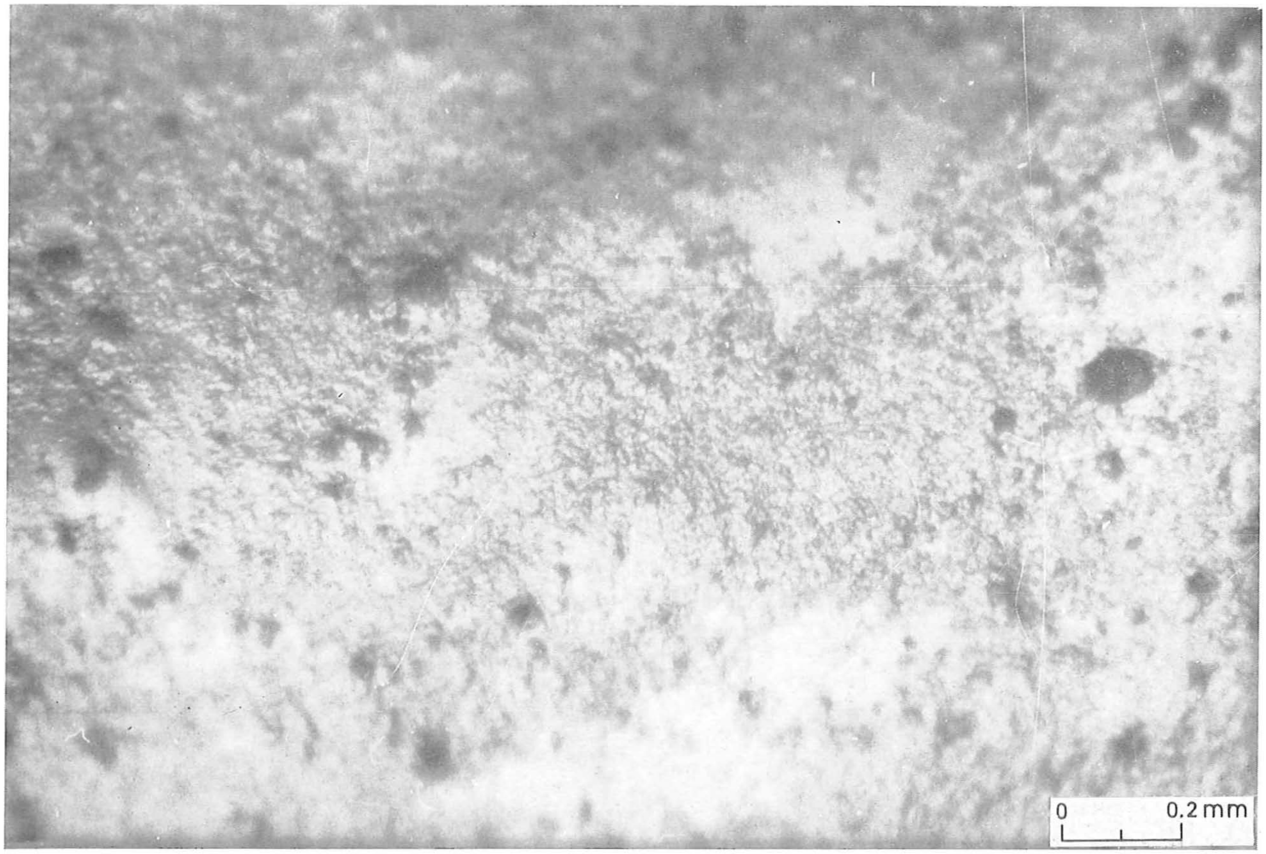


Fig. 29. Detail of Figure 28. Note the presence of strips with truncated striping running in a deviating direction. Photograph by H. L. Leertouwer, General Physics Laboratory, Groningen.

▷ Fig. 30. Several patches of friction gloss on the scraper from Emmen (province of Drente), viewed through a stereo microscope. Photograph by W. A. Casparie, B.A.I., Groningen.
▶ Fig. 31. The same surface as shown in Figure 30, at a higher magnification. Within the patches of friction gloss a fine subparallel striping is visible. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.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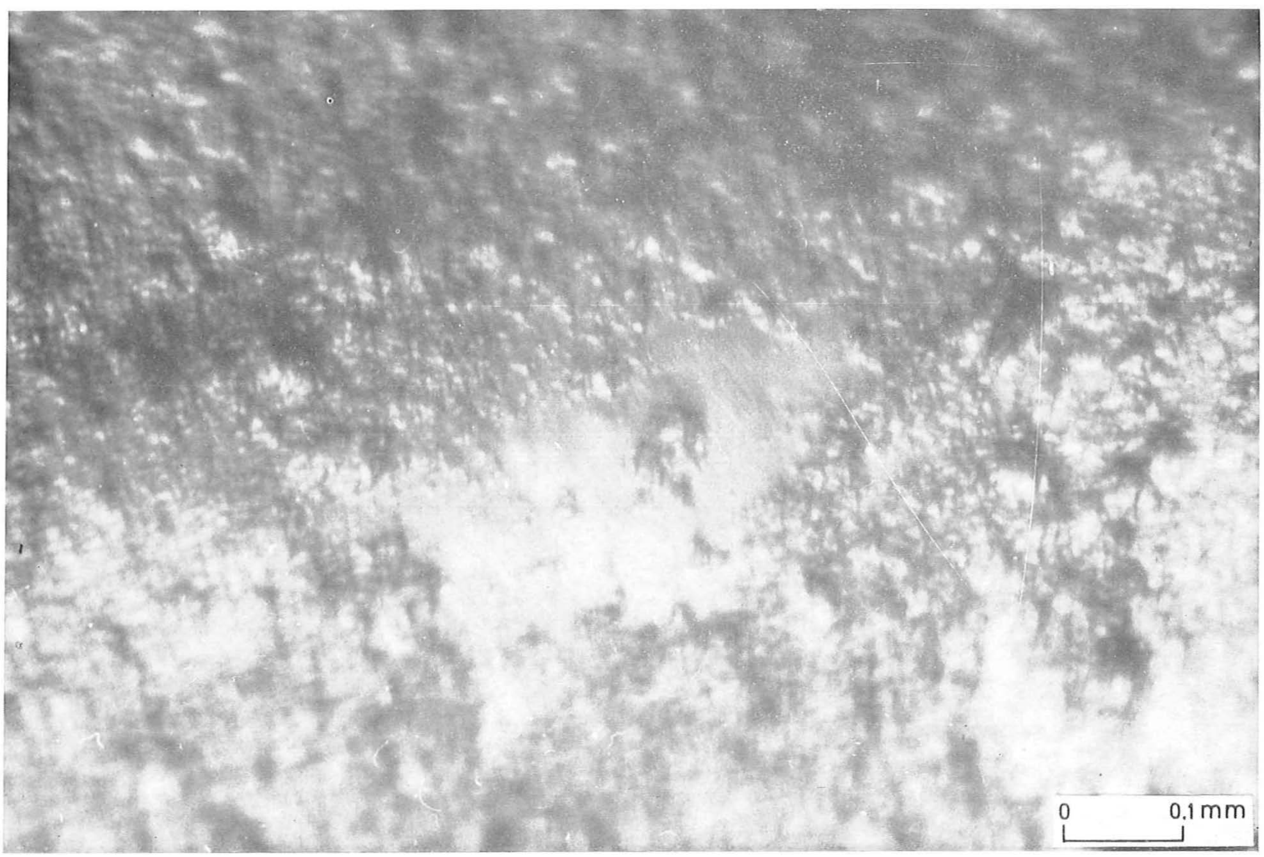
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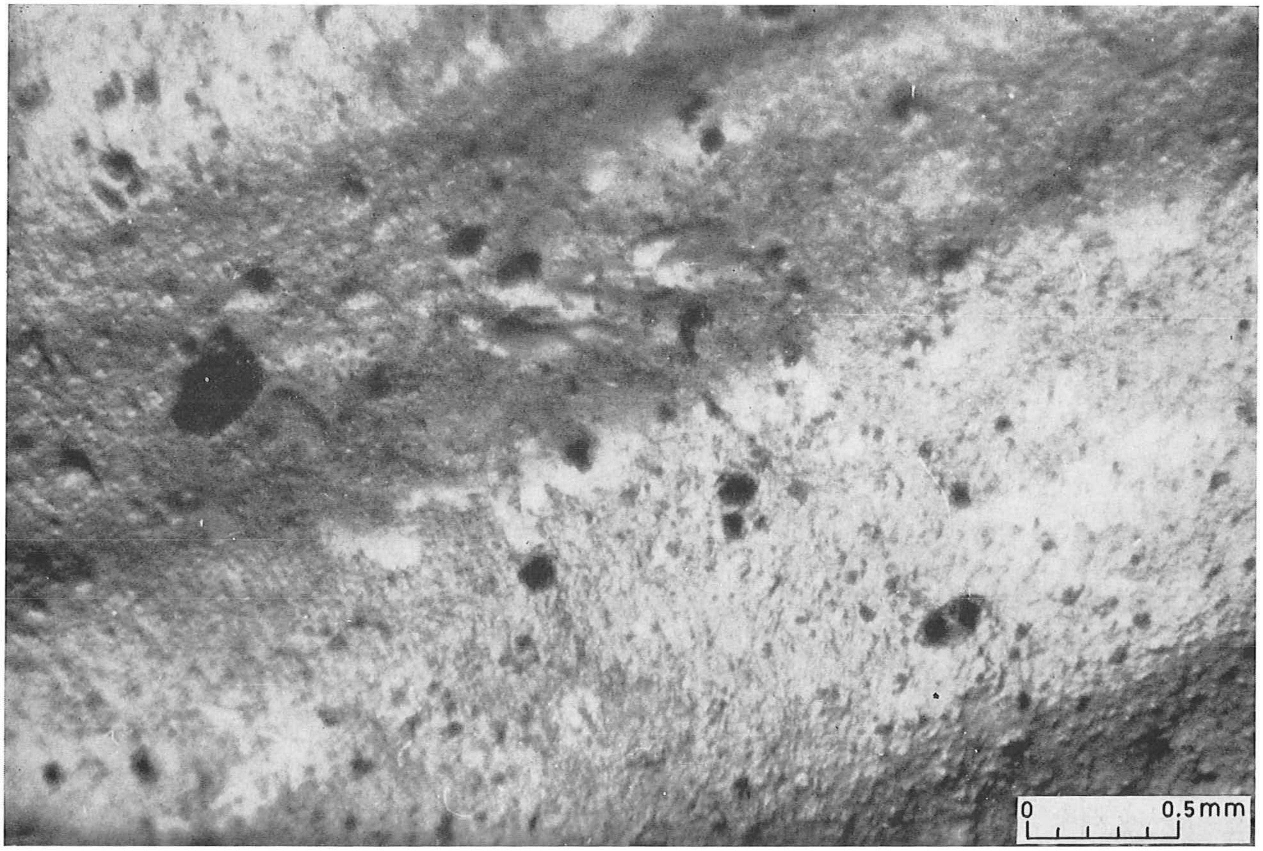
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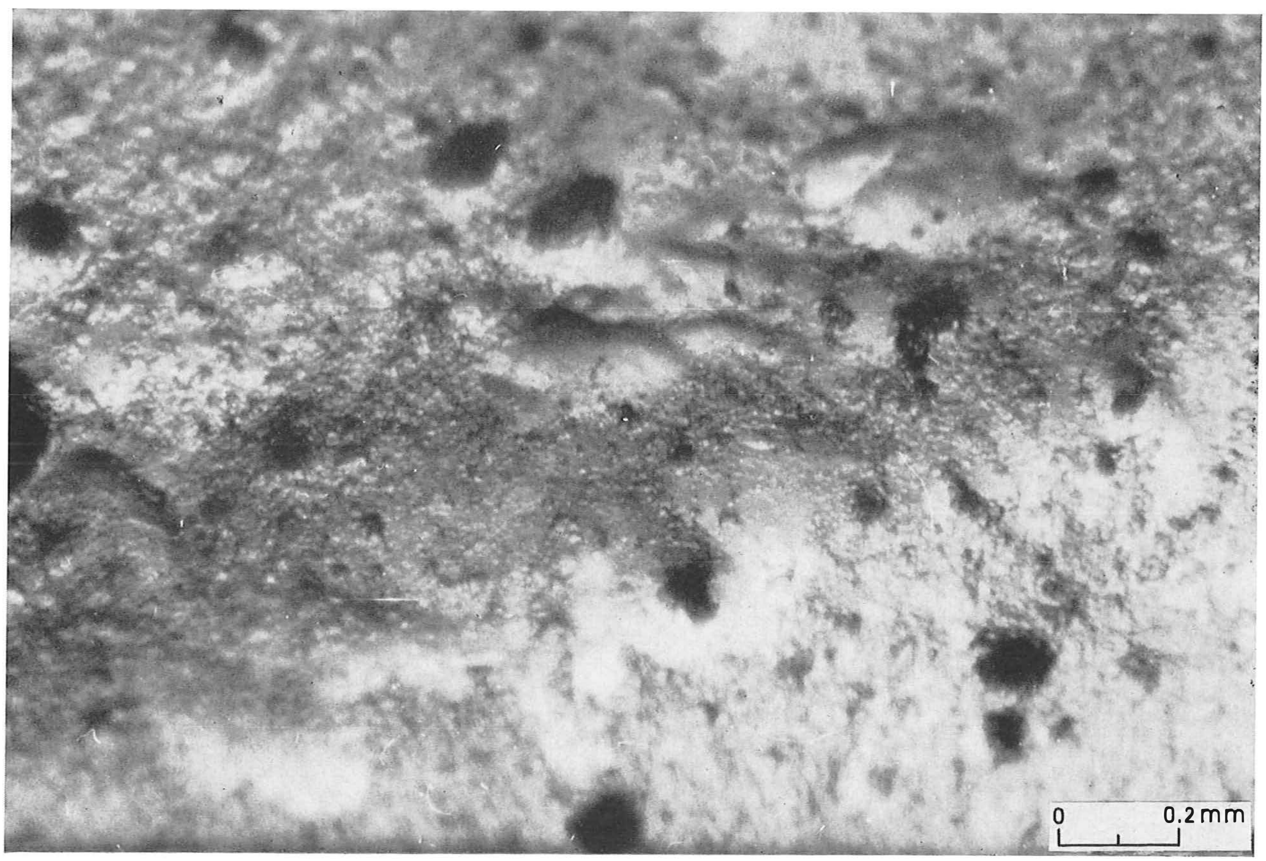
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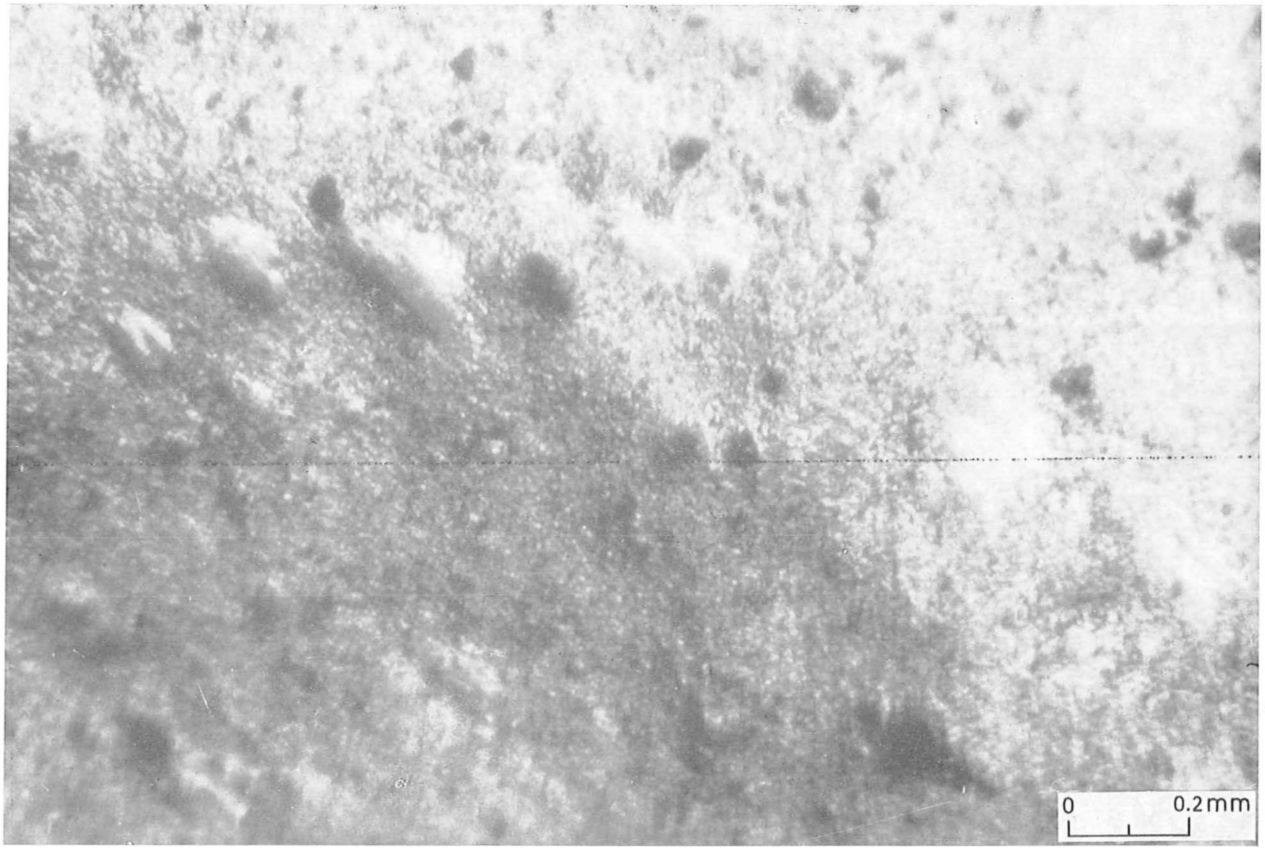
Fig. 34. The same surface as in Figure 33, at an even higher magnification. Within the patches of friction gloss a fine sub-parallel striping is visible. Photograph by Dr. W. A. Casparie, B.A.I., Groningen

◀ Fig. 32. A group of patches with friction gloss on the scraper from Emmen (province of Drente) viewed through a stereo microscope. It can clearly be seen that these patches are depressed with respect to the surrounding surface. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.

◀ Fig. 33. The same surface as on Figure 32, but at a higher magnification. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.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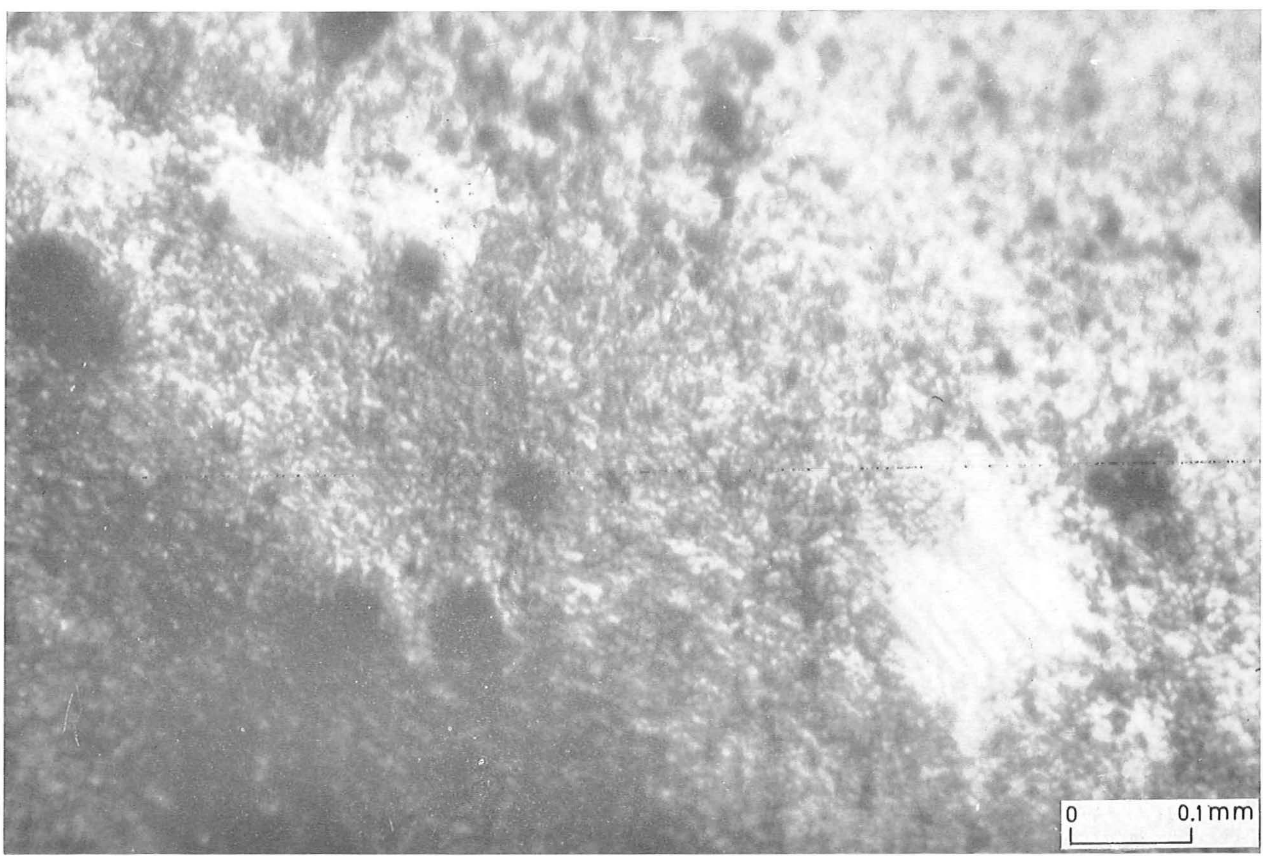
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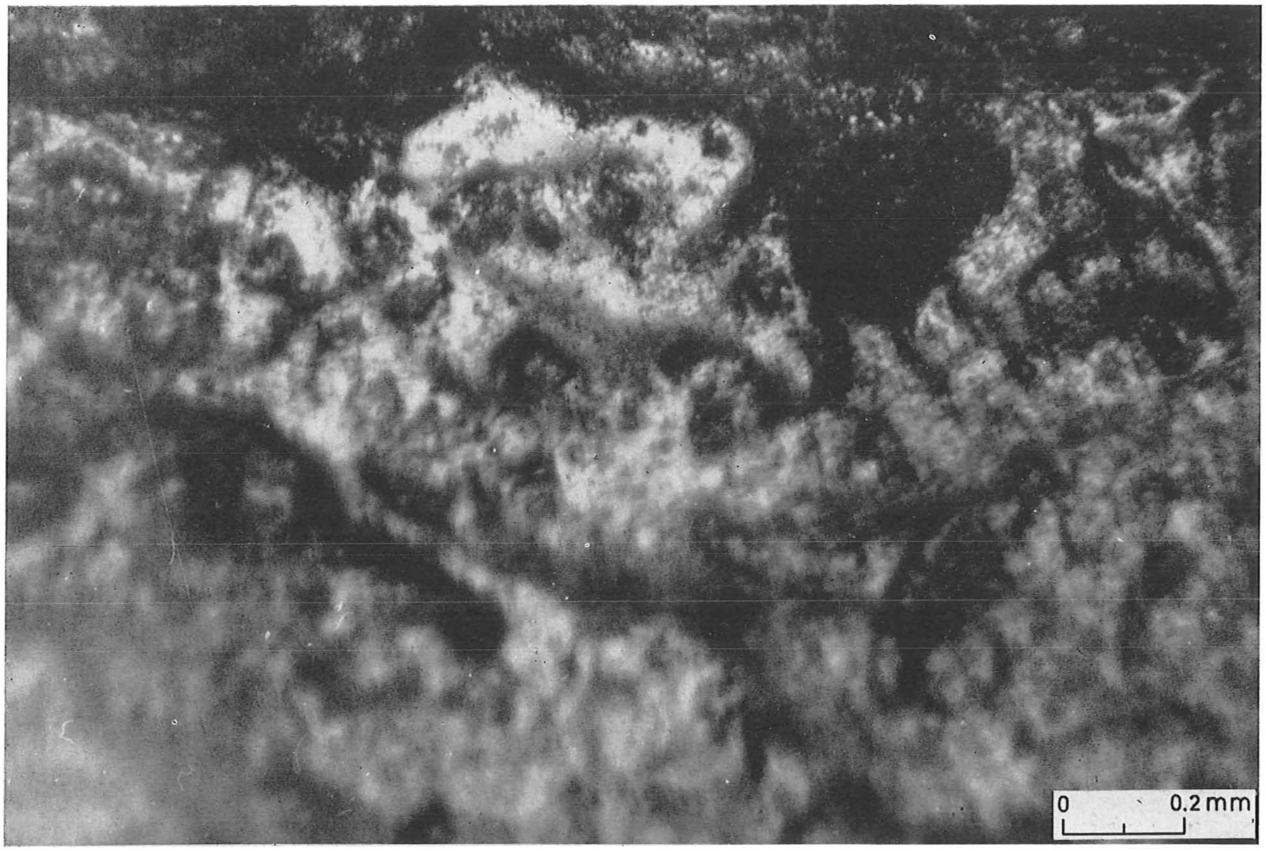
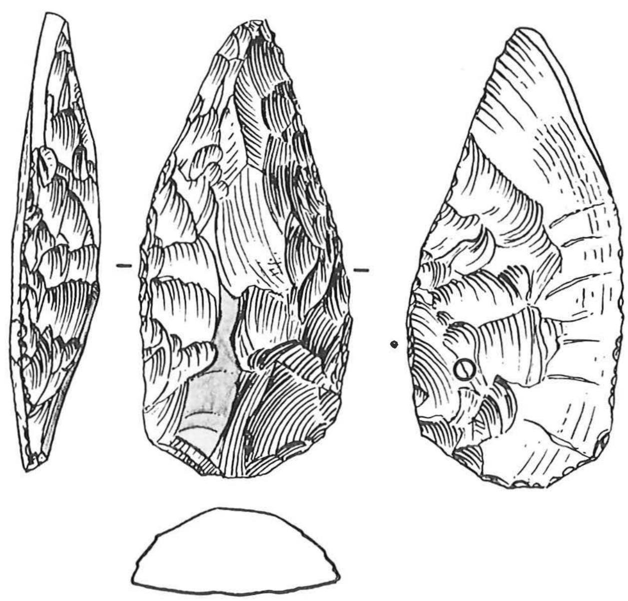


Fig. 37. a: Patch of gloss on the point from Bladel (province of Noord-Brabant), viewed through a stereo microscope. This patch of gloss is situated on a ridge between flake scars on the ventral surface of the point, which were intended to remove the bulb of percussion. This patch of gloss is not comparable with the small patches of friction gloss shown in the preceding illustrations: 1. the patch is not depressed with respect to the surrounding surface; 2. the patch has no distinctive microtopography of its own; 3. nor is any fine striping visible. On the Middle Palaeolithic implements discussed in this article, this patch of gloss is the only example of a possible "use trace", which in this case could be the result of hafting.

b: Drawing of the point from Bladel. The circle indicates the location of the glossy patch shown in Figure 37a. A recently damaged area (near top) is left white; the area shaded grey indicates an old frost-split face. Scale 1:1. Drawing by H. R. Roelink, B.A.I., Groningen.



◀ Fig. 35. A group of patches with friction gloss on the *Faustkeilblatt* from Eersel (province of Noord-Brabant), viewed through a stereo microscope. The patches are depressed with respect to the surrounding surface, and have a distinctive microtopography of their own. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.

◀ Fig. 36. The same surface as shown in Figure 35, at a higher magnification. Fine subparallel striping is now visible. Photograph by Dr. W. A. Casparie, B.A.I., Groningen.

present on Mesolithic, Neolithic, and probably even younger material. Moreover, on Upper Palaeolithic or later material the patches with friction gloss are as a general rule much bigger (figure 26). On Middle Palaeolithic flints these patches are usually only visible with the aid of a stereo microscope, while on Upper Palaeolithic flints they are frequently bigger than 1 cm. This state of affairs contradicts the hypothesis that these patches of gloss have been produced as a result of friction between stones in the soil, since the latter process has been in operation for more often on Middle Palaeolithic than on Upper Palaeolithic or later implements. In addition, certain details regarding these small patches do not tally with the above-mentioned hypothesis. Thus, on Upper Palaeolithic flints ridges sometimes run through these patches, so that the impression is given rather of contact with something soft or a fine-grained substance. Finally, friction-gloss is encountered on flints from a wide variety of sediments, e.g. boulder-sand, sand, löss etc., which also seems to contradict the hypothesis of friction between stones.

The patches of gloss are randomly distributed over the flints, and also occur on what is clearly waste material, without there being any systematic relation to any working edges of the flints. These patches occur both individually and in small groups. It is not always true that these patches are sharply delimited: under the stereo microscope it appears that there is usually a transition zone between the patches of gloss and the unaltered flint surface around them. Within this zone both altered and unaltered areas occur in a patchy distribution.

Nor is it true that no structures are visible within these patches. In addition to the depressions previously described by Bordes (which are usually though not always parallel to one another), there is often a pattern of subparallel fine stripes present, which also continues uninterruptedly over the bottom of the depressions (figures 27, 28 and 29). The surface within the patches of gloss is otherwise exceedingly smooth, thus accounting for the high gloss.

The patches in their entirety are usually depressed with respect to the surrounding surface (figures 30-36), so there is no possibility of their being due to a secondary deposition of silica. In further contradiction to this latter theory is the pattern of fine, subparallel stripes. The presence of these stripes also rules out the possibility of solution as the sole operative agent in the formation of these patches of gloss.

Polishing by wind carrying sand and/or dust is likewise ruled out, because no such pattern of stripes develops as a result of this process; moreover, it is inconceivable that only a few small patches less than 1 mm in diameter could become so drastically altered by such a process.

Friction between stones cannot be excluded in some cases, for example in the case of some of the small patches of gloss on exposed parts of some Middle Palaeolithic finds from boulder-sand (which are also sometimes associated with scratches), but in the case of the Upper Palaeolithic or later material, and most of the Middle Palaeolithic finds, this explanation is not vindicable.

Still it seems obvious that some kind of friction has taken place, in view of the extreme smoothness of the surface and the pattern of stripes. One gains the impression that flint could have become plastic in some degree in this process (due to friction-heat?).

Certain details regarding the striping are difficult to account for (figure 29). Thus one finds strips with "truncated" stripes which deviate in direction; the larger, oriented depressions also deviate sometimes from the direction of the striping.

Patches of friction gloss often occur in conspicuous groups, sometimes accompanied by small areas which many pits or longitudinal depressions. Sometimes the patches of friction gloss, or the depressions within these patches, are arranged more or less radially, which is apparently indicative of contact with some kind of organic substance.

Perhaps further consideration should be given to the possibility of root activity, or even the effects of certain lower organisms.[5]) Meanwhile these shiny little patches remain an *enigma*.

It is however possible to point out several differences with respect to polishing as a result of use. In the case of the latter phenomenon, depressions and such fine striping will probably be absent in most cases. In addition, patches displaying polishing as a result of use will not be depressed with respect to the surrounding surface nor will they have a distinct microtopography of their own. Finally they will show some relation to one working edge or another, unless they are the result of the implement being hafted.

Figure 37a shows a patch of gloss that does not resemble all the observed patches of "friction gloss". It occurs on a ridge between two flake scars on the ventral surface of a Mousterian point (Bladel; Stapert, 1975C) (figure 37b). These flakes have removed the bulb of percussion, presumably to facilitate hafting. It is not impossible that this glossy patch arose as a result of friction, caused by hafting. On the Middle Palaeolithic material investigated it is the only example of a patch of gloss that probably did not originate naturally, in view of the presence of features distinguishing it from patches of "friction gloss" clearly formed in a natural way.

4. THE INCIDENCE OF SURFACE MODIFICATIONS ON SEVERAL MIDDLE PALAEOLITHIC FINDS FROM THE NETHERLANDS

Table 1 gives a summary of the natural surface modifications observed on 11 Middle Palaeolithic finds from the Netherlands. Of these 11, 6 are from the Northern Netherlands and 5 from the

Table 1

Summary of natural surface modifications brought about in or on the soil since the implements were left behind, on 11 Middle Palaeolithic finds

	white patina	brown patina, rust	gloss patina	wind-gloss	small pits	cryoturbation retouch	scratches	pressure cones	friction gloss	rounding	secondary frost-splitting	strongly developed partial rounding
Wijnjeterp hand-axe[1]	+	+	—	+	+	+	+	+	—	+	—	—
Anderen hand-axe[1]	—	+	—	+	+	+	+	+	+	+	+	+
Exloo hand-axe[1]	+	—	—	+	+	+	o	o	—	+	—	—
Havelterberg point[1]	+	+	—	+	+	+					—	—
Emmen side-scraper[1]	+	+	—	+	+	+	+	+	+	+	—	—
Ambt-Delden point[1]	—	+	—	+	+	+	+	+	—	+	—	—
Bladel point[2]	—	+	—	+	+	+	+	+	+	+	—	—
Bladel side-scraper[2]	—	+	—	+	+	+	+	+	+	+	—	—
Bakel hand-axe[2]	+	+	+	—	—	—	o	o	—	+	+	—
Eersel hand-axe[3]	+	+	—	+	+	+	+	+	+	+	—	—
Etten point[2]	+	—	—	+	+	?	—	—	—	+	—	—

+ present
? possibly present
— not present
o flint unsuitable for observation of feature concerned
(left blank) flint not examined for feature concerned
1 Stapert, 1976, this volume
2 Stapert, 1975C
3 Stapert, 1976

province of Noord-Brabant. The most striking fact to emerge is that a high proportion of the surface modifications occur together concomitantly. Of the 11 distinguished surface modifications there is an average of 7 clearly represented on each flint. Rounding (due to solution) of ridges and side-edges is always present. Wind-gloss and small pits are also very common; wind-gloss is lacking only on the handaxe from Bakel, presumably because this flint has lain enclosed in "Brabantian loam" for so long (Stapert, 1975C). If white patina and brown patina are not present together, then in each case either one or the other of these surface modifications is represented on these flints. Phenomena related to soil movements are very common. Pressure cones are especially abundant, and can moreover be relatively easily observed. Cryoturbation retouch is also very common. Secondary frost-splitting is present on 2 out of 11 flints examined.

5. CONCLUSIONS

Surface finds dating from the Middle Palaeolithic in the Netherlands have been considerably affected by various surface-modifying processes. A number of these phenomena, such as scratches, rounding, "cryoturbation retouch" and "friction gloss", can sometimes resemble traces of use to some extent. A more serious situation is that traces of use which may have once been present are obliterated by or mixed with these alterations, so that it is virtually impossible to attempt a worthwhile study of traces of use with reference to these flints.

It will probably be possible to formulate criteria for several of these phenomena to distinguish them from features resulting from use. Thus natural "friction gloss" often displays peculiar depressions and a pattern of fine stripes. Natural scratches and "cryoturbation retouch" always go together with "pressure cones".

To make detailed descriptions of surface modifications present on Palaeolithic material is important for other reasons as well. Information could thus be gained concerning the stratum from which these flints are derived, and about the conditions under which they have lain over a long period on the surface or in the soil. Natural surface modifications have often drastically altered the original form and appearance of Palaeolithic flints.

6. SUMMARY

In this paper a brief description is given of a number of natural surface modifications on flint, with reference to their occurrence on Palaeolithic material and on flints naturally present in boulder-sand. Boulder-sand is a residual sediment of boulder-clay (ground moraine from the penultimate glacial period). Middle-Palaeolithic finds from the Northern Netherlands probably originate from boulder-sand, considering, among other things, their natural surface modifications.

These surface modifications are described with the following aim mainly in view, namely to ascertain the extent to which these alterations prevent or complicate the study of traces of use. In the first place, some of these surface modifications can resemble traces of use to some extent; in such cases an attempt is made to formulate criteria to distinguish between them. In the second place, any traces of use which may have been present can be wholly or partly obliterated as a result of these surface modification processes.

It is concluded that most of the Middle Palaeolithic flints found in the Netherlands have been considerably affected by various surface modification processes, and are therefore unsuitable for a valid study of traces of use. It is important that whenever a study is being made of traces of use, the possibility of the presence of natural features should be thoroughly investigated.

NOTES

1 The term patina has been applied to various phenomena throughout the course of time, and has consequently become a vaguely defined dustbin concept (see e.g. Shepherd, 1972). At the present time the term is used mainly with reference to a white coloration of the surface of flint, but originally a distinct sheen was implied in its meaning. It is therefore expedient to qualify the term accordingly at all times by means of a descriptive prefix, and thus to speak, for example, of white patina, coloured patina and gloss patina.

2 I do agree with Keeley (1975) that the presence of white scratches is in general a reliable indicator of soil movements. But that does not mean that a flint has not been affected by soil movements when no white scratches are visible.

3 An analogous white "colour" as a result of high porosity can be produced very quickly by means of hydrofluoric acid.

4 See e.g. Bourgon (1957) on the *"indice tayacien"*: *"Il est possible que cet indice indique surtout la cryoturbation: en effet la majorité des "retouches abruptes et alternes" semblent due à des phénomènes naturels"*.

5 Ackerman (1964) and Brochier (1976) describe the action of lichens on chert and other rocks. It appears that surfaces which were once covered by lichens became dotted with small pits. They do not mention gloss, however.

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