VII. Finds

1. Mining implements

1.1. Rope marks

In various shafts rope marks were encountered (Fig. 21). We assumed that these ropes had been used to lift material from the mine. At the surface there were no signs at all of any kind of crane. However, we think it likely that large excavated flint nodules were too heavy to lift from the mine without the use of a crane. The rope marks show that great power was exercised during lifting.

1.2. Wooden implements (voids)

Tools made of wood have not been preserved as such, having entirely decayed. Occasionally a void remained in the fill of shafts and galleries (Fig. 22). On the bottom of such voids we often found calcified remains of wood, allowing us to conclude that the void represented the original wood.

A total of 43 voids were found, which can be grouped as follows:
- 3 straight, semicircular voids 50, 130 and 140 cm long and 8, 8 and 12 cm in diameter, from the fill of a shaft. Therefore we assume this to have originally been split timber used for lining the shaft.
- 2 straight, circular voids 90 and 98 cm long with a diameter of 5 cm, which possibly were used forlining the shaft or as supporting props.
- 6 straight, circular voids (one slightly curved) 40-65 cm long (mean length 54 cm) and 8-10 cm in diameter (mean 9 cm), possibly representing timber supporting props.
- 9 straight, circular voids 42-55 cm long (mean length 52 cm) and diameters of 3-6 cm. Possibly used as handle. Indeed, one of the voids was found to contain a stone pick there where this would originally have been fixed to the handle.
- 1 trapezoid, flat void with a 15 cm base and a 5 cm top and a height of 20 cm. The diameter varies between 1½ and 2 cm. The assumption is that this was a wooden scraper or part of a shovel.
- 2 club-shaped voids, one 55 cm long and with diameter ranging between 7.5-13 cm and the other 60 cm long and with diameter up to 4-7 cm. It is thought that these voids are the remains of hammers or of special handles for picks.
- 20 circular voids 20-39 cm long and 3-5 cm in diameter, which possibly represent waste products or broken handles of hafted flint picks.

1.3. Bone tools

During the excavation few bone fragments were collected. Naturally the small number of finds allow only assumptions to be made as to their original use. It is possible that a few bone fragments were derived from activities at the surface and thus do not represent tool fragments used underground. A deer antler found was used as a pick (Fig. 23), while another specimen possibly served as a scraper (part of a hoe-shaped elk antler). Other remains of deer antlers are of such small size that it may be assumed that the fragments were discarded. A single ulna fragment, possibly *Bos*, appears to have been used as a pick, may be as a robust point on a softer handle (wood or deer antler).

As far as could be determined, a scapula (14 cm long) was not used as an implement. It may be that this bone, like other small bones (sheep ?), represent discarded remnants of meals.

1.4. Stone tools

Hammerstones

In total, 216 hammerstones were found (Fig. 24), which were described in detail by WILLEMS (1975), who distinguished two weight classes, namely specimens of 100-500 gr. and those of more than 1,000 gr.

He assumed that the small hammerstones were held in one hand to prepare stone picks and resharpen blunt instruments. We consider it likely that the picks were produced at the surface. In our opinion, no picks were made in the mines, as the amount of flint waste found there was very limited. We think that the

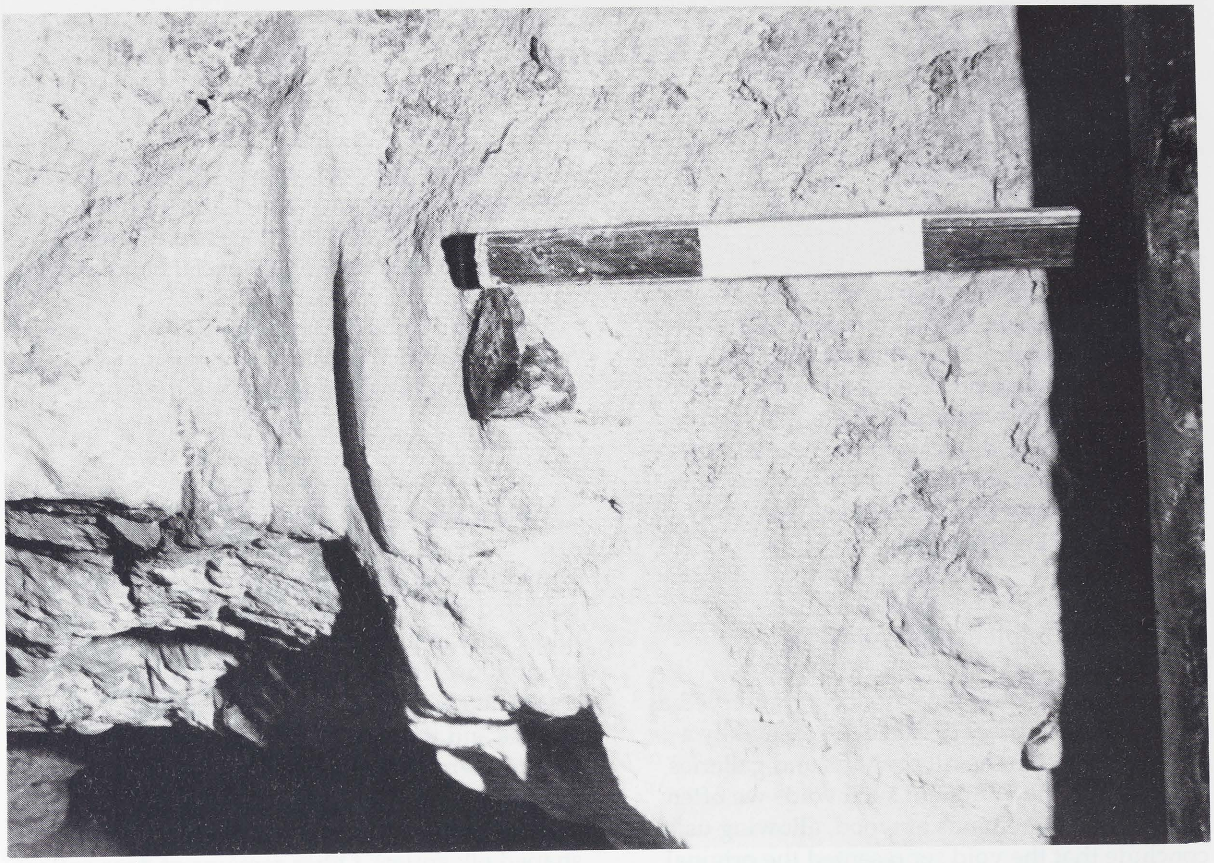


Fig. 21 Rope marks at the foot of a prehistoric mine shaft.

Fig. 22 A void in the fill of an gallery as an indication of a wooden object now decayed.

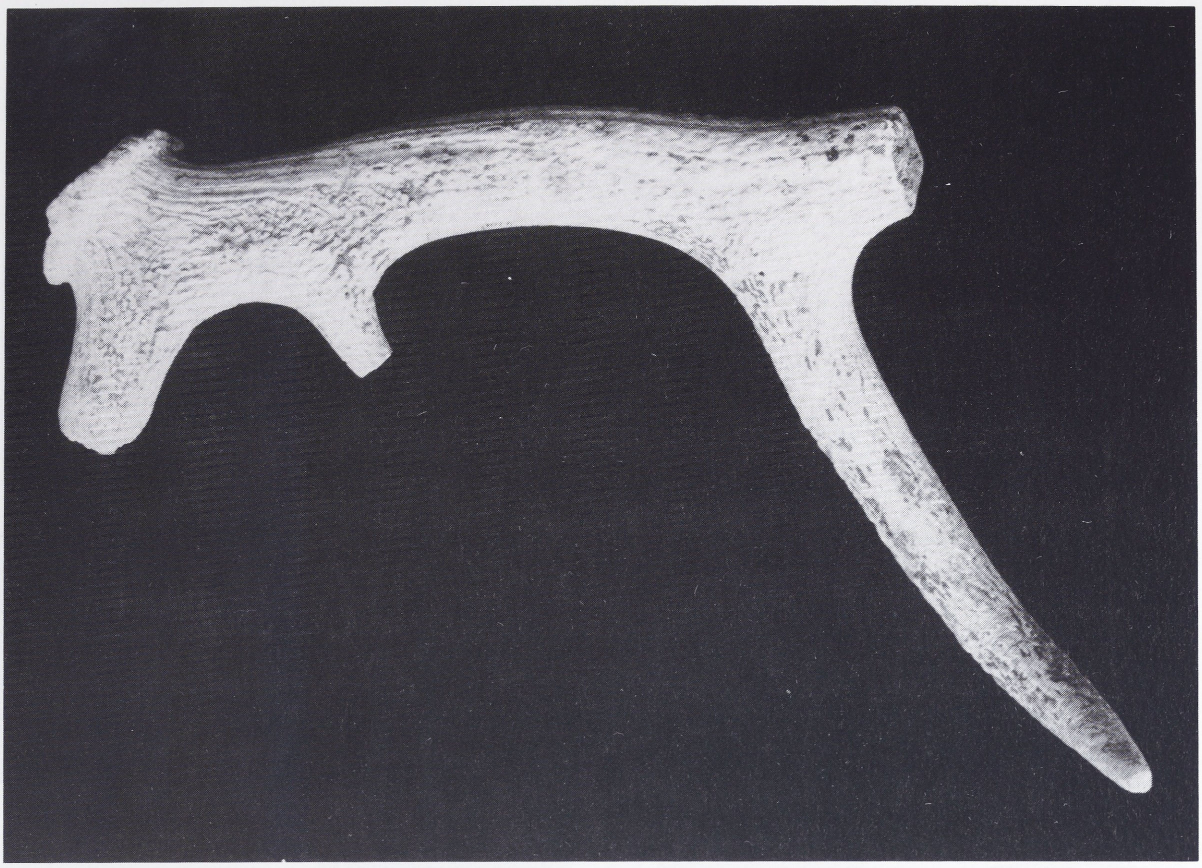


Fig. 23 Portion of a deer antler used as a mining tool.

	weight (gr)	%
primary & secondary decortication flakes	30,050	51.5
flakes without cortex	13,350	22.9
cores	5,150	8.8
artificial blocks	4,550	7.8
crested blades & rejuvenation pieces	3,650	6.2
burnt pieces	1,000	1.7
blade fragments	300	0.5
1 failed preform of bifacial implement	300	0.5
	58,350	99.9

Table 2 Contents of Shaft 19.

smaller hammerstones were exclusively used to resharpen blunt picks in the underground workings.

Remarkable also is that the majority of the small hammerstones (68%) consist of indurated chalk originating from within thicker flint nodules (paramoudras). These indurated chalk hammerstones are in fact 'soft' hammerstones, which enabled precision shaping of flint, such as sharpening stone picks. WILLEMS (1975) assumed the heavier hammerstones to have been held in both hands for cleaving thick and

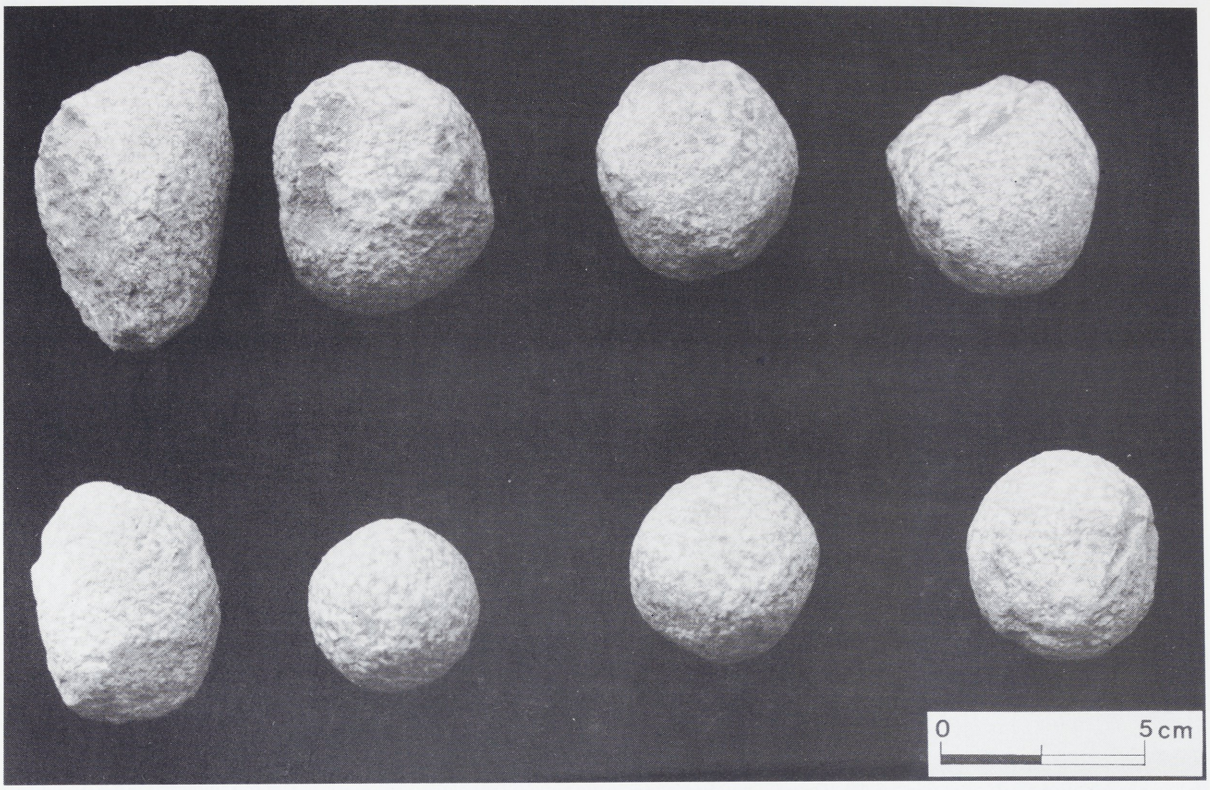
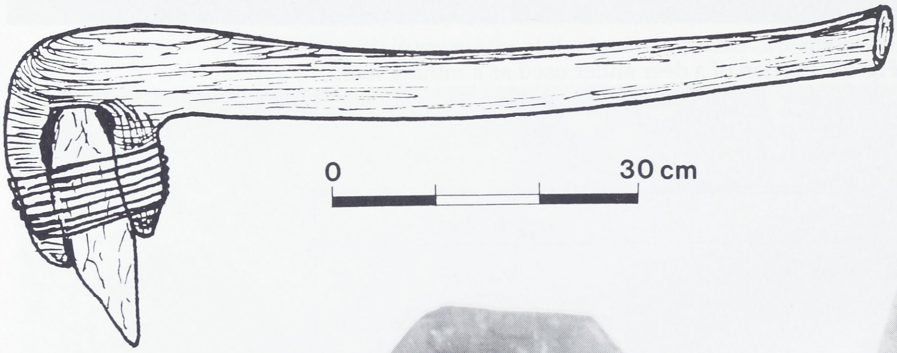


Fig. 24 Hammerstones.



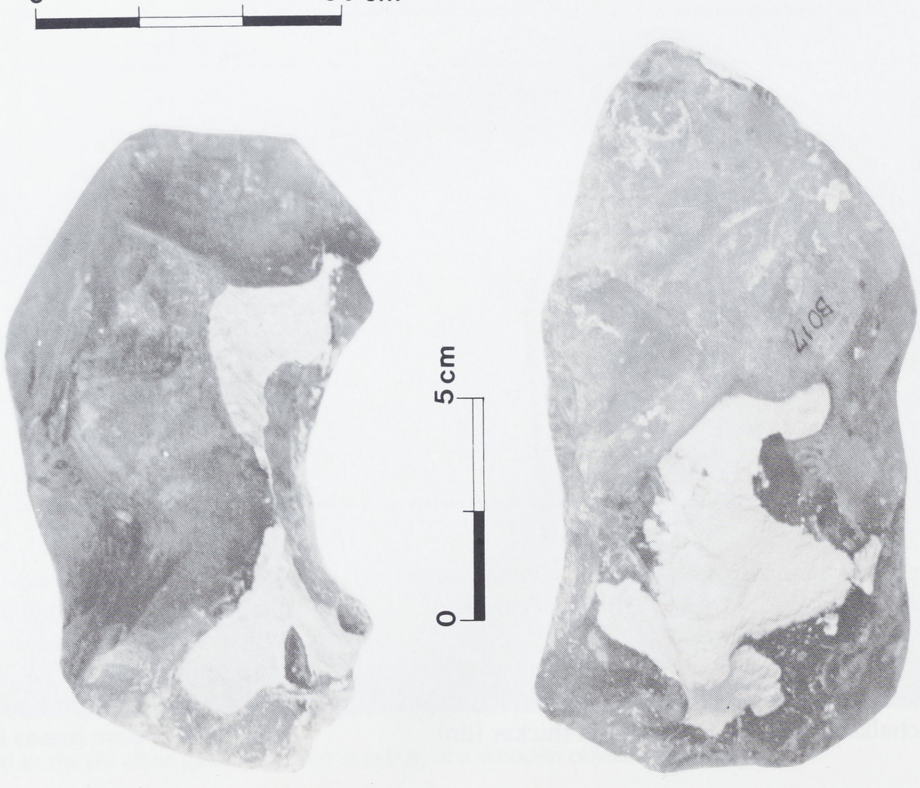


Fig. 25 Stone hammers (*Kerbschlägel*).

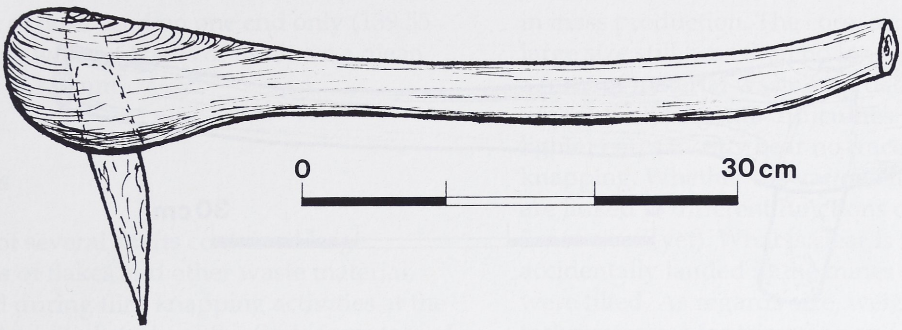


Fig. 26 Narrow picks.

heavy flint nodules. Traces of such use were in various places seen on heavy flint nodules. The majority of the heavier hammerstones are quartzites and thus 'hard', enabling a rough knapping to be performed.

Stone picks and pick fragments

Of the 14,549 artefacts found 14,217 represent stone picks or pick fragments, amounting to 97,71 %. Form the very beginning, these common finds received ample attention, but so far no generally accepted description is available.

Different forms of picks were soon distinguished, viz. 'triangular', 'quadrangular' and 'axe-shaped'. However, it proved impossible to assign each flint pick to one of these forms. All archaeologists who have so far distinguished these types have been forced to add all kinds of intermediate types (see Reports 24, 25, 27 and 29).

Ultimately, the stone mining tools were divided into three types, viz. stone hammers (*Kerbschlägel*) (Fig. 25), narrow hafted flint picks (Fig. 26) and broad or axe-shaped hafted flint picks (Fig. 27).

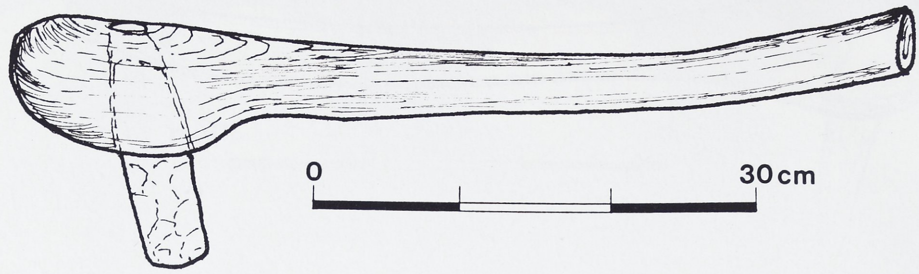


Fig. 27 Broad picks.

Stone hammers

The stone hammers found represent but a small portion of the total; they were probably used for removing hard chalk at the top of the chalk layer (in the shafts). As far as we know, they were not used in the underground galleries.

Narrow and broad flint picks

The width of these picks varies between 35 and 74 mm, their thickness between 18 and 58 mm. Depending on the width/thickness ratio triangular, quadrangular and oval forms in cross section could be produced. Naturally, many intermediate types may be distinguished. We think it likely that the cross section was determined to a large degree by the way of production. As said, two types can be distinguished, viz. narrow picks in which width more or less equals thickness and which have a sharp pointed end, and broad ones in which width exceeds thickness and which have a wide axe-shaped edge. However, intermediates between these types occur.

The length of the picks varies between 109 and 221 mm. It was easily determined which end of the picks was actually used; either a single one or both. Based on the find of hammerstones (and on calculations) it was determined that the stone picks, upon becoming blunt, were resharpened. A stone pick could thus be used more than once. Because of wear its length decreased. The mean length of picks that were used on both ends (137.3 mm)is less than that of ones used on one end only (139.55 mm). Picks without traces of use have a mean length of 161.0 mm.

2. Flakes

The fills of several shafts contained large quantities of flakes and other waste material, produced during flint knapping activities at the surface. An initial study of the finds from two of the shafts (nos 19 and 21) showed that they represent the highly incomplete debris of the initial stages of several disparate knapping events (thus not inviting attempts at refitting) in which primary and secondary decortication flakes preponderate.

The presence of some crested blades, elongated flakes with parallel dorsal ridges, core rejuvenation pieces, and broken blades shows that blade production was one of the activities performed. The few artefacts classified as cores, however, are irregular flake cores, or discarded precores. Evidence for axe making is less clear, as there are very few soft-hammer trimming flakes (such as described by ARNOLD 1981, NEWCOMER 1971, or WHITTAKER 1994). Some of the short and wide flakes with bi-directional dorsal scars may represent early stages in the production of bifacial tools rather than blade core preparation. Most of the flakes, however, are undiagnostic. One single preform of a bifacial implement could be intended for either an axe-head or a flint pick (Table 2). As a whole these assemblages form a useful addition to the many exhausted and reworked blade cores and failed axe preforms published by WATERBOLK (1994), as the flakes found during the 1964/65 BAI excavations were not recovered and studied.

3. Cores

During the excavation of the Rijckholt flint mines in the fill of the shafts and galleries a number (58) of cores were collected. These strongly vary in weight, between 300 and 2,500 gr, and were used to produce large blades, up to 20 cm long and 4 cm wide. The majority of cores clearly show that the striking of the last blade did not produce the desired result and failed on account of e.g. a coarse-grained rock structure halfway down the blade under production. The quality of the blade is the most important factor in mass production. The core, occasionally of large size still, was then no longer used, which is a form of material waste affordable at the site without running into difficulties. The smaller, lighter cores mostly bear no traces of such failed knapping. Whether the various forms of cores are linked to different functions or specialisation is not clear (yet). What is clear is that cores accidentally landed in the mines when the shafts were filled. As regards size, weight, and the techniques use for trimming and reducing them, they strongly resemble the cores found both in Waterbolk's BAI excavation (WATERBOLK 1994) and at Spiennes (HUBERT 1980).

4. Faunal remains

In the prehistoric flint mines at Rijckholt-St. Geertruid many animal remains were encountered. A very small number of these were used by prehistoric miners as tools and later discarded. The majority, however, landed in the mines without human interference. The open shafts acted as traps for small animals such as snails, amphibians and small mammals. Occasionally these small animals landed in the shafts by rain wash, either dead or alive. In some places it could be determined that rain water, mixed with mud, bones and snail shells had flowed into the mines. Live animals also landed in the mines; numerous scratch marks on the gallery walls bear witness to this. In the chalk environment the bones and shells were well preserved.

4.1. Amphibians (D.F. Cupedo)

Skeletal remains of frogs and/or toads were recovered from shafts 8, 10, 15, 16, 18, 19, 21, 32, 54, 56 and on post D.

4.2. Birds (D.F. Cupedo)

Remains of six birds were encountered. From Shaft 15, a pelvis fragment of a small bird and from Shaft 56 the remains of three birds were recovered (find no. 14600): a bird of prey and two smaller species. Skull remains show these latter two to have been insectivorous species of the size of a robin.

A left femur of a larger-sized bird (length 59 mm) was recovered from Shaft 25. Shaft 54 yielded a fragment of a right tibia.

Order Chiroptera (bats) sp. ind.			1
Order Insectivora (insectivores)			
	Family Talpidae	*Talpa europaea* (mole)	1
	Family Soricidae	*Crocidura russula* (house shrew)	1
		Sorex araneus (common shrew)	2
		Sorex minutus (pygmy shrew)	2
Order Rodentia (rodents)			
	Family Sciuridae (squirrels)		1
	Family Muridae	*Apodemus sylvaticus* (wood mouse)	5
		Apodemus flavicollis (large wood mouse)	20
		Apodemus sp.	31
	Family Microtidae	*Microtus arvalis* (common vole)	6
		Microtus agrestis (field vole)	3
		M. arvalis or *M. agrestis*	7
		Pitymus subterraneus (vole)	3
		Clethrionomys glareosus (bank vole)	11

Table 3 Small Mammals, minimum number of individuals.

4.3. Mammals (D.F. Cupedo)

The following larger mammals were encountered. Find no. 4286 consists of a number of badly crushed fragments of a deer antler. No. 4160 is a large fragment of the left antler of a red deer (used as hacking tool) (Fig. 23).

Nos 7994, 2476, 11769 and 3520 are fragments of palmate antlers. In Shaft 32 a few vertebrae, proximal rib fragments and a mandible fragment with three molars possibly of a sheep were found.

Find no. 12552 is a left scapula 14 cm in length.

In addition, a few bone fragments of bovines, used as tools, were recovered.

Of small mammals very many skeletal parts were collected, of these only the skull remains were identified. Table 3 shows the minimum number of individuals of each species.

The identification of species of the genera *Microtus* and *Apodemus* occasionally presented problems. Fragments of upper and lower jaws of *M. arvalis* and *M. agrestis* cannot be distinguished with confidence when all teeth are missing. In such cases they are here listed as *M. arvalis* or *M. agrestis*.

There are but quantitative differences between skulls and mandibles of *Apodemus sylvaticus* and *A. flavicollis*. For these species HUSSON's (1962) criteria were used in identification, viz. length of the tooth row and of the mandible. Specimens in which the length of the tooth row was less than 3.9 mm (and in lower jaw length less than 14.0 mm) were identified as *A. sylvaticus*. Specimens in which the length of the tooth row exceeded 4.1 mm (and lower jaw length exceeded 15.0 mm) were assigned to *A. flavicollis*. The number of individuals of both species should thus be looked upon as indicative only.

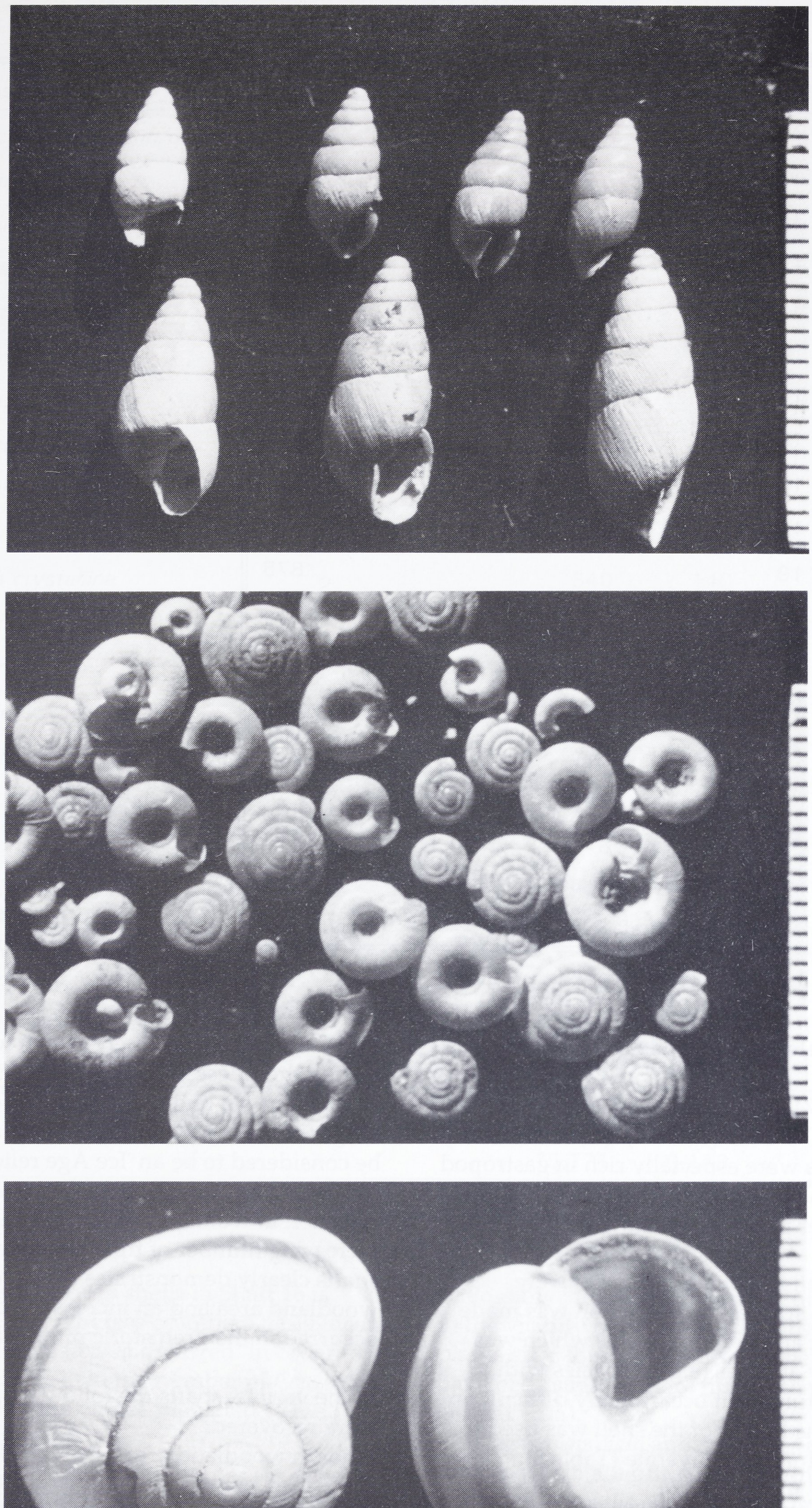


Fig. 28 A selection of gastropods collected from the shafts.

Site	Position	Number
1	shaft 2	4
2	in gallery between shafts 3 and 4	3
3	shaft 3	3
4	shaft 4	2
5	shaft 8	11
6	shaft 10	1,209
7	shaft 11	3
8	shaft 15	5,652
9	shaft 16	598
10	shaft 18	159
11	shaft 19	875
12	shaft 21	6,969
13	shaft 25	1
14	shaft 32	99
15	shaft 40	2
16	shaft 42	4
17	shaft 54	167
18	shaft at structure 53 (= vicinity of shaft 21)	4
19	post D (= vicinity shaft 21)	8

Table 4 Sites yielding gastropods.

4.4. Invertebrates (gastropods, P.J. Felder)

A total of 15,771 specimens were recovered, collected from 19 sites (Table 4). Remarkable is that a few sites were especially rich in gastropod shells; these may have been shafts that remained open for longer periods of time.

Gastropod shells recovered (Fig. 28) were assigned to 24 species. A distinction was made between adult and juvenile shells, which was relatively easy at times (e.g. in species with a reflected aperture), but occasionally difficult, in which cases the height of the shell was used to distinguish adult from juvenile (Table 5).

Carychium minimum and *C. tridentatum* are difficult to distinguish. In Shaft 15, these small species showed a curious distribution pattern, occurring in large numbers on one side of the shaft only. From this pattern we may conclude that the small shells where blown to one side during their descent by natural ventilation.

As far as we know, *Ena montana* does no longer occur in southern Limburg, and may thus be considered to be an 'Ice Age relic'.

Discus rotundatus prefers farms and is less common in woodland areas (*c.* 10%). The increasing number of this species in the various shafts clearly demonstrates that a reduction of woodland area and an increase in open fields occurred in the prehistoric mining area.

In the various shafts the following percentages were recovered:

modern woodland area	10.0%
shaft 8, at 26 m in tunnel	20.0%
shaft 10, at 25 m in tunnel	23.2%
shaft 15, at 30 m in tunnel	35.9%
shaft 16, at 46 m in tunnel	39.8% *
shaft 19, at 53 m in tunnel	33.5%
shaft 21, at 49 m in tunnel	44.3%

Genus/species	Number	Adult	Juvenile
Carychium minimum or *C.tridentatum*	2,679	2,441	438
Succinea putris	10	10	
Succinea oblonga	80	53	27
Cochlicopa lubrica	101	31	70
Acanthinula aculeata	123	63	60
Ena montana	52	37	15
Ena obscura	152	38	114
Punctum pygmaeum	157	157	
Discus rotundatus	5,861	1,496	4,365
Vitrina sp.	8		8
Vitrea crystallina	340	140	200
Aegopinella nitidula	1,620	155	1,465
Oxychilus sp.	118	77	41
Cochlodina laminata	105	70	35
Clausilia bidentata or *Iphigena lineolata*	197	106	91
Bradybaena fruticum	343	128	215
Perforatella incarnata	5	3	2
Trichia hispida	2,331	410	1,921
Helicodonta obvoluta	159	67	92
Helicigona lapicida	66	42	24
Cepaea nemoralis or *C. hortensis*	951	649	302
Unidentified	313		313
Total	15,771	6,173	9,598

Table 5 Species of gastropods recovered.

* = the number of *Cepaea* shells in Shaft 16 is very high (54.3%), whereas on other sites a mean percentage of 4.2% *Cepaea* occurred. In order to obtain comparable data the number of *Cepaea* in Shaft 16 in this table was recalculated to the average number.

Succinea, *Vitrina* and *Vitrea*: these are genera that prefer moist environments and indicate that conditions during the prehistoric mining activities were more humid than they are today. These genera no longer occur at the site.

Possibly large-leaved herbs (Butterbur) grew in the vicinity of the mines, as these are pioneer plants after forest clearance, or the climate could have been slightly more humid than it is today (Atlanticum).

Clausilia laminata and *Iphigena lineolata* are species which are difficult to distinguish.

Cepaea nemoralis and *C. hortensis*: fully-grown shells of these species can be distinguished by the coloured apertural margin. Juvenile shells lacking this margin, but also the occasionally strongly eroded and damaged adult shells,

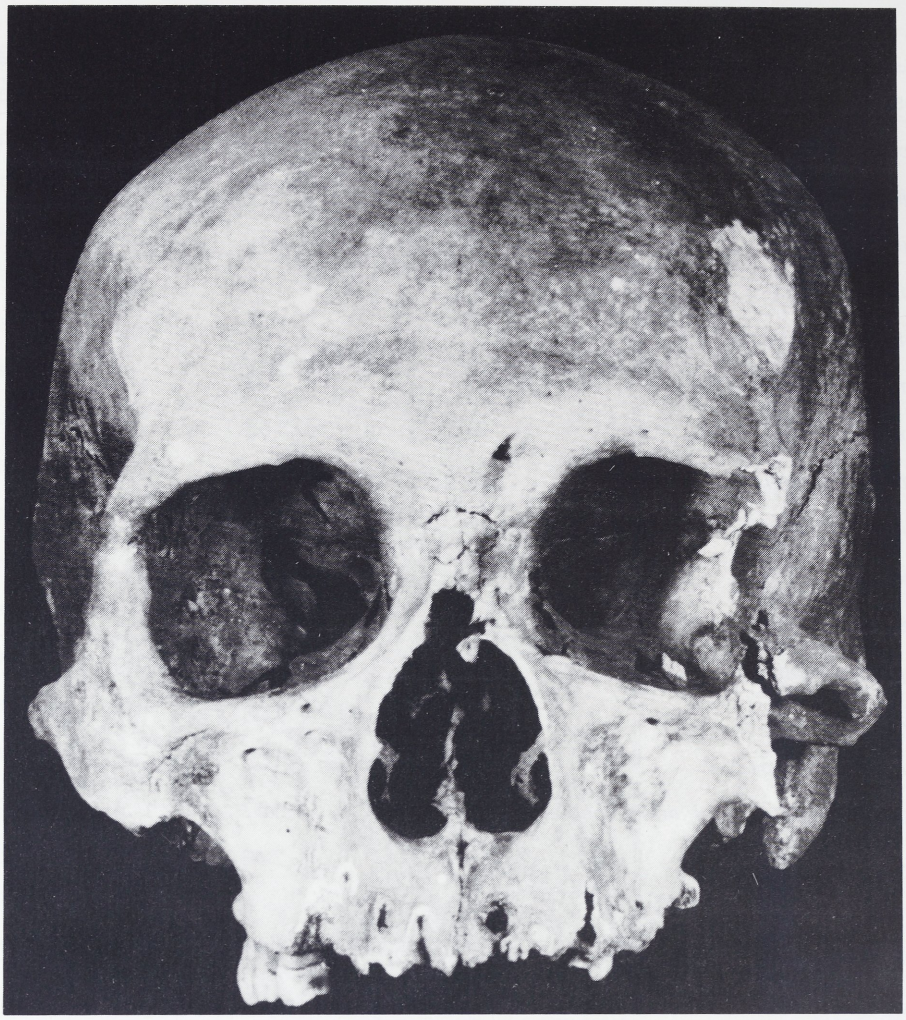


Fig. 29 The Rijckholt I skull.
(Photograph courtesy of Laboratorium voor Anatomie en Embryologie, Rijksuniversiteit Groningen).

could not be identified to species. *Cepaea* nowadays lives along the fringes of woods and in the vicinity of farms, preferably on stinging nettle. These plants prefer places where dung or rotting organic material occurs. In Shaft 16 remarkably many *Cepaea* were found, namely 325 out of a total of 598 shells. We may thus assume this shaft to have been near the edge of woodland where many stinging nettles grew (possibly as a result of the occurrence of a latrine nearby).

5. The Rijckholt skulls

5.1. 'Rijckholt I skull'

One of the most spectacular finds during the 1964-1972 excavation campaign at the Neolithic flint mines of Rijckholt, is the well-preserved human skull (Figs 29, 30), which was found on November 5, 1965.

The skull was encountered at the end of a Neolithic mine gallery (Fig. 31), at a distance to the associated shaft of *c.* 6 m. Halfway, the gallery made a right angle and came to a dead end in a solution pipe. The site was situated *c.* 8 m[5] below ground level. The dead end of the gallery was filled with chalk rubble over a

[5] In the daily find protocol, summarized in Report N° 5, a distance of 12 m was recorded. The present number derives from data obtained during the more accurate survey documented in Report N° 30.

Fig. 30 The Rijckholt I skull.
(Photograph courtesy of Laboratorium voor Anatomie en Embryologie, Rijksuniversiteit Groningen).

distance of *c.* 3 m, and to up to 60% of its height. From the roof larger chalk blocks collapsed subsequently. The first 3 m of the gallery were almost completely filled, with the fill reaching the roof. The shaft was filled as well and could not be recognised at the surface.

Important with respect to this find are the dates from a number of charcoal samples from nearby galleries (cf. Chapter VIII).

Upon discovery, the site of the skull was left undisturbed until, with Prof. Dr. Waterbolk, Prof. Dr. de Wilde and Dr. van Vark (all Rijksuniversiteit Groningen) present, a further investigation was initiated. During inspection of the site we asked Prof. de Wilde to take the skull for study to the Laboratory of Anatomy and Embryology of the Rijksuniversiteit Groningen.

In December 1971 we received the report of a preliminary study carried out by order of Prof. de Wilde by Dr. van Vark. This report is included in Report 5. The conclusion reached in this report is that the skull could be identified to period and even to population group within the Neolithic (see section VII.5.5.). The fact that only the skull was present, and the way this was placed in the gallery indicate a ritual burial. The burial in a working underground flint mine is evidence of a relationship between the dead person and the miners. Probably he was one of them at some time.

The skull was transferred to the Provincial Depot for Archaeological Finds at the Bonnefantenmuseum (Maastricht), where it is registered under collection no. 3313A.

5.2. Hamal-Nandrin's skull

Already some 40 years earlier, on April 17, 1923, human remains were found in the Rijckholterbos by Prof. Hamal-Nandrin of Liège. The site was in the central part of the northern slope of the 'Schoone Grubbe'. The finds comprised a skull and half a mandible with associated fragments of right femur, collected at a distance of *c.* 2 m. All remains were found at 2,20 m depth in the slope scree which, at that site, contained many worked flints.

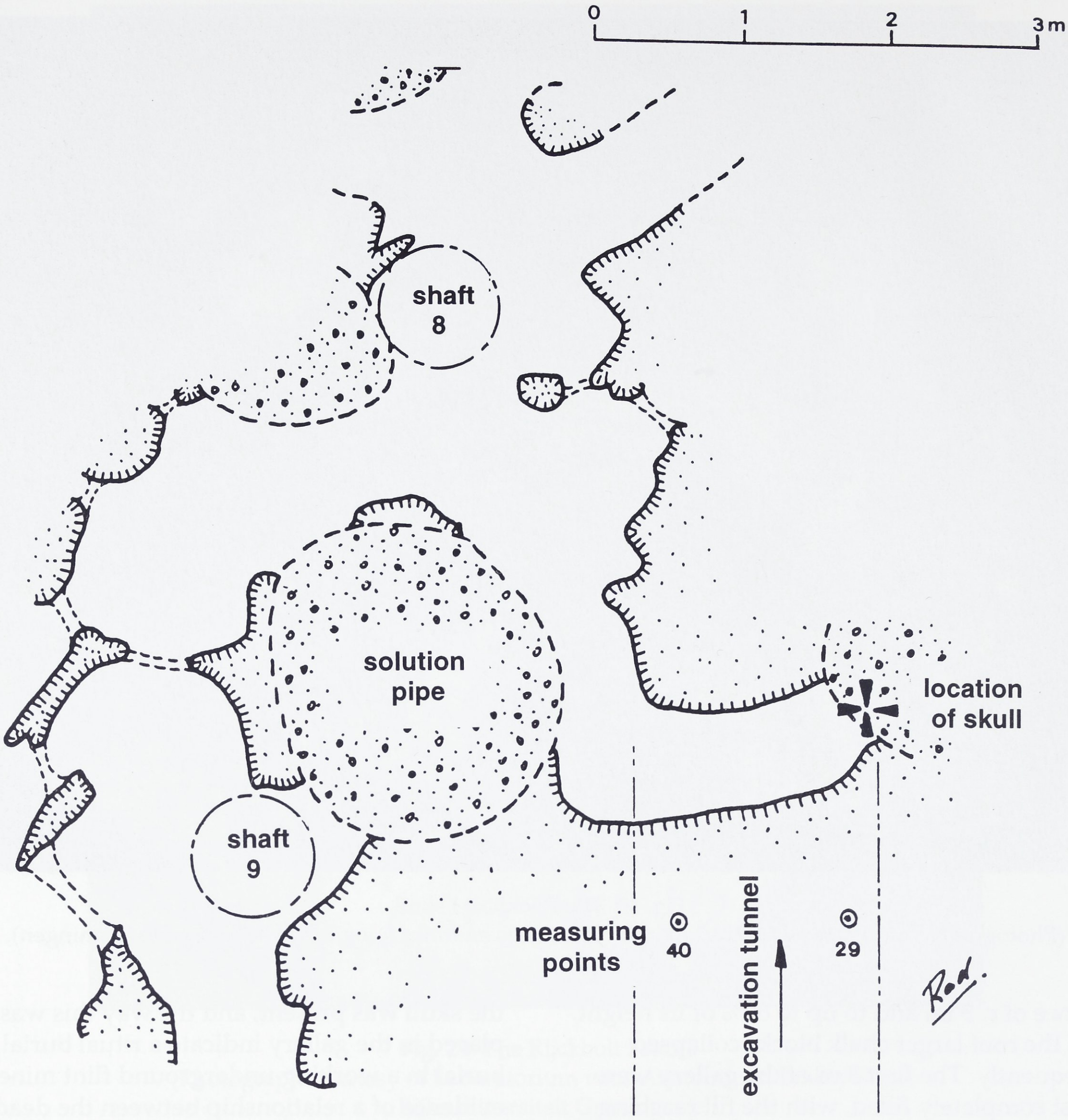


Fig. 31 Provenance of the Rijckholt I skull.

A paper on his work at Neolithic Rijckholt (HAMAL-NANDRIN & SERVAIS 1923) includes a stratigraphical description of the site (LOHEST & FOURMARIER 1923, pp. 137-140) and a detailed anthropological report (FRAIPONT *et al.* 1923, pp. 140-148). The stratigraphy of the site did not allow the age to be determined, but a Neolithic age could not be ruled out.

Shortly before his death, Prof. Hamal-Nadrin donated this skull to the Bonnefantenmuseum, where it is registered under number 2969A.

5.3. The skull of the Dominican friars

Between 1929 and 1932, French Dominican friars of the Rijckholt monastery also carried out excavations. At the 'Schoone Grubbe', they recovered '*... a very well-developed crown of a skull...*' (PÈRES MOOS *et al.* 1937, 11). No additional skeletal remains were found, at *c.* 1,40 m depth in a layer of chalk rubble with many worked flints. The horizontal distance to the edge of the 'Grubbe' was only 0,50 m.
In their paper, the friars provided but a brief description of the find and its circumstances; there are no photographs. The skull was probably taken to their mother house in France. However, we have not been able to substantiate this.

5.4. An Enigma

In *Hannonia Praehistorica* (LEFRANCQ & MOISON 1962) we came across an allusion to the find of the crown of a human skull originating from a shaft in the prehistoric mine field at Rijckholt. The specimen was donated in 1958 by Louis Tomballe (Bois de Breux) to the Museum Curtius (Liège), where it is registered under number LT/209.

During a visit to this museum the specimen appeared to consist of a fragment of a human skull. As far as we know, this find was not described at that time. The possibility of acquiring reliable data on this find must be considered out of the question.

5.5. Summing up

The Neolithic flint mines at Rijckholt-St. Geertruid have since their first discovery yielded four human skulls. Two of these are available for study and are easily classified, viz. the 'Rijckholt I skull' and that of Hamal-Nandrin.

A detailed description of the Rijckholt skulls and their find circumstances was published separately (RADEMAKERS 1972).

A comparison of the results of a preliminary study of the 'Rijckholt I skull' with data on the Hamal-Nandrin skull published in 1923, shows remarkable differences. The 'Rijckholt I man' was dolichocephalic in contrast to the 'woman' of Hamal-Nandrin, who was brachycephalic. Whereas for Hamal-Nandrin's skull obvious similarities to modern Scandinavian Lapp were claimed, 'Rijckholt I man' was determined to be definitely not assignable to a recent Lapp population. Of 'Rijckholt I' it is further assumed that he possibly belonged to an Early Neolithic population from the period prior to the invasion of population groups having completely different skull morphologies at the start of the Late Neolithic in northwest Europe. These considerations raise the question whether these are indications of differences in origin between the Neolithic miners and the other Neolithic people they lived with.

Since the publication of van VARK's report (1971) new data have become available (e.g. GERHARDT 1976; WAHL & KÖNIG 1987; WAHL & HÖHN 1988), which triggered a reappraisal of a few observations in that report. Two of his conclusions need a special reconsideration:

- 'The skull can probably be classified to period and perhaps even to population group within the Neolithic'.
- 'Rijckholt I possibly belonged to an early Neolithic population from the period predating the invasion of population groups with completely different skull morphologies in the late Neolithic in northwest Europe'.

With reference to these observations, it can now be stated, that:

- The Rijckholt I skull can still be assigned to the Neolithic, in particular to the Early and Middle Neolithic, and even falls within the range of the Michelsberg population, who are considered to be the first people to have exploited the Rijckholt flint mines (compare e.g. the chignon formation).
- With regard to the age of Hamal-Nandrin's skull less conclusive evidence is available, since modern studies are lacking. The find circumstances do not yield conclusive evidence either. With a certain amount of caution - see brachycephalic Michelsberg people from Alsace (WAHL & HÖHN 1988) - it might be concluded that this specimen is indeed of a more recent date (Bell Beaker age) than the Rijckholt I skull. 'Bell Beaker people', however, are no longer considered to have been just invaders.

From the above, it may be concluded that there is no reason to suppose that there were two different populations: the Rijckholt I skull entirely corresponds to the morphological range of potential 'users' of mined Rijckholt flint (i.e. representatives of the Michelsberg culture in general). The existence in the Late Neolithic (Bell Beaker period) of 'brachycephalic' newcomers, whether or not these represent local evolution, has no bearing upon the Rijckholt situation: the underground mining took place much earlier, in the Middle Neolithic.

6. Marks made by hafted picks

During the excavation campaign at Rijckholt thousands of miners' picks were recovered. Typical of these finds is that these were expendable tools and that their raw material is almost indestructible, which explains the large numbers found.

Fig. 32 Pick marks on chalk slab originating from the ceiling of a gallery in mine Nr. 8.

More subtle in this respect are the marks made by hafted stone picks which testify to the activities of the prehistoric miners, left behind in the soft chalk of the galleries. They are restricted to particular areas and very fragile.

Such marks occur in many places in the investigated mines (Fig. 32). In general, they consist of a limited number of marks. Larger concentrations of marks occur only in some places. The reason for this is the often impaired cohesion of the rock under the influence of pressure. Because of this, even during the early construction of the galleries or over longer periods of time, plate-like stripping or collapse occurred. Also unintentional wear by prehistoric miners during the exploitation can be demonstrated. In the limited number of occurrences of relatively large concentrations of pick marks these appear to be random as far as direction, length and form are concerned. With regard to strike direction a cerain preferential direction could be expected, in view of the limited space within the galleries. A compass rose diagram could perhaps reveal this (Fig. 33). The distribution of the lengths of marks at the various localities could possibly be clarified by means of comparative graphs. In order to achieve this it was necessary to document the strike angle of all pick marks, and, where these could be demonstrated, their direction and length.

Care was taken not to damage or soil the marks. We used sheets of transparent plastic which were attached to the gallery walls or to the ceiling by small nails. Using ballpoints, pick marks could be traced on these sheets (Fig. 34). In the early 1970s this called for a lot of experimenting in order to find ballpoints which could be used upside down/point down and this also in a humid environment on a non-hygroscopic material. These data are listed in tables, incorporated in compass rose diagrams and included in Report 31.

7. Charcoal

In a few places underground charcoal was found, at the bottom of shaft fills as well as in the fill of galleries. The locations of these sites

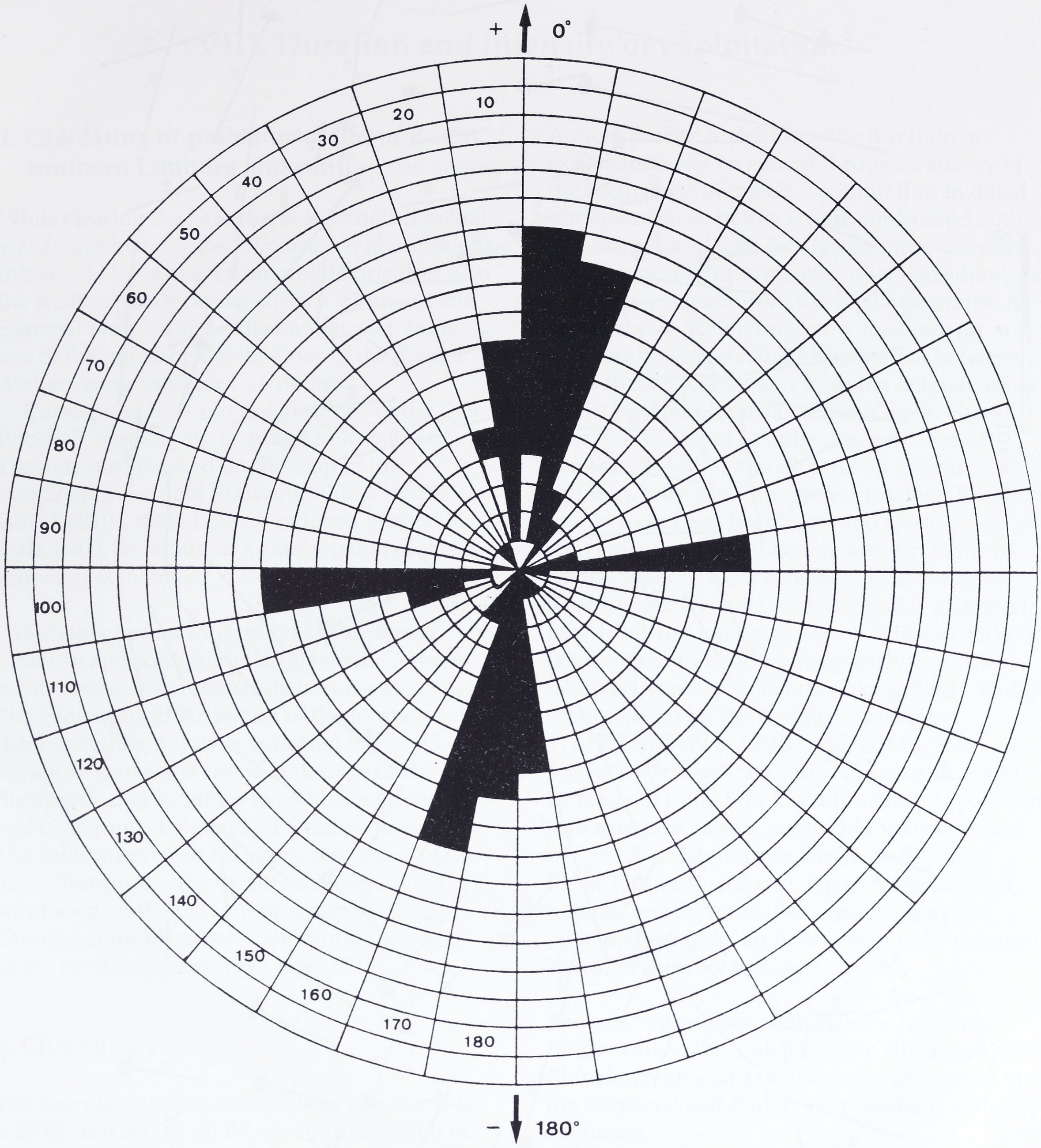


Fig. 33 Compass rose diagramm of tool marks in measuring area 4.
Open symbol: direction of strike known; closed symbol: direction of strike uncertain.

are marked on the map of the mines examined (Report 2). The charcoal samples of four locations proved suitable for C14-dating (see Section VIII.1.).

On the basis of our investigation over a number of years and in an extensive mining complex, we may definitely conclude that the charcoal did not originate from underground hearths. Open fires, whether or not representing the seat of fire of a hearth, torch or other illumination sources, would undoubtedly have left traces. Such traces could be soot traces as well as red burnt chalk surfaces. Such traces have not been encountered anywhere by us.

The use of open fire was, at least in view of the circumstances and working methods applied in the Rijckholt mines, not to be expected. During our own underground activities we noted that extra illumination was not necessary. Daylight coming in through the open shafts in a mine was sufficient for the Neolithic miner, who worked the lightly coloured rock in the galleries. There was no need for hearths, as these would have been bothersome and dangerous because

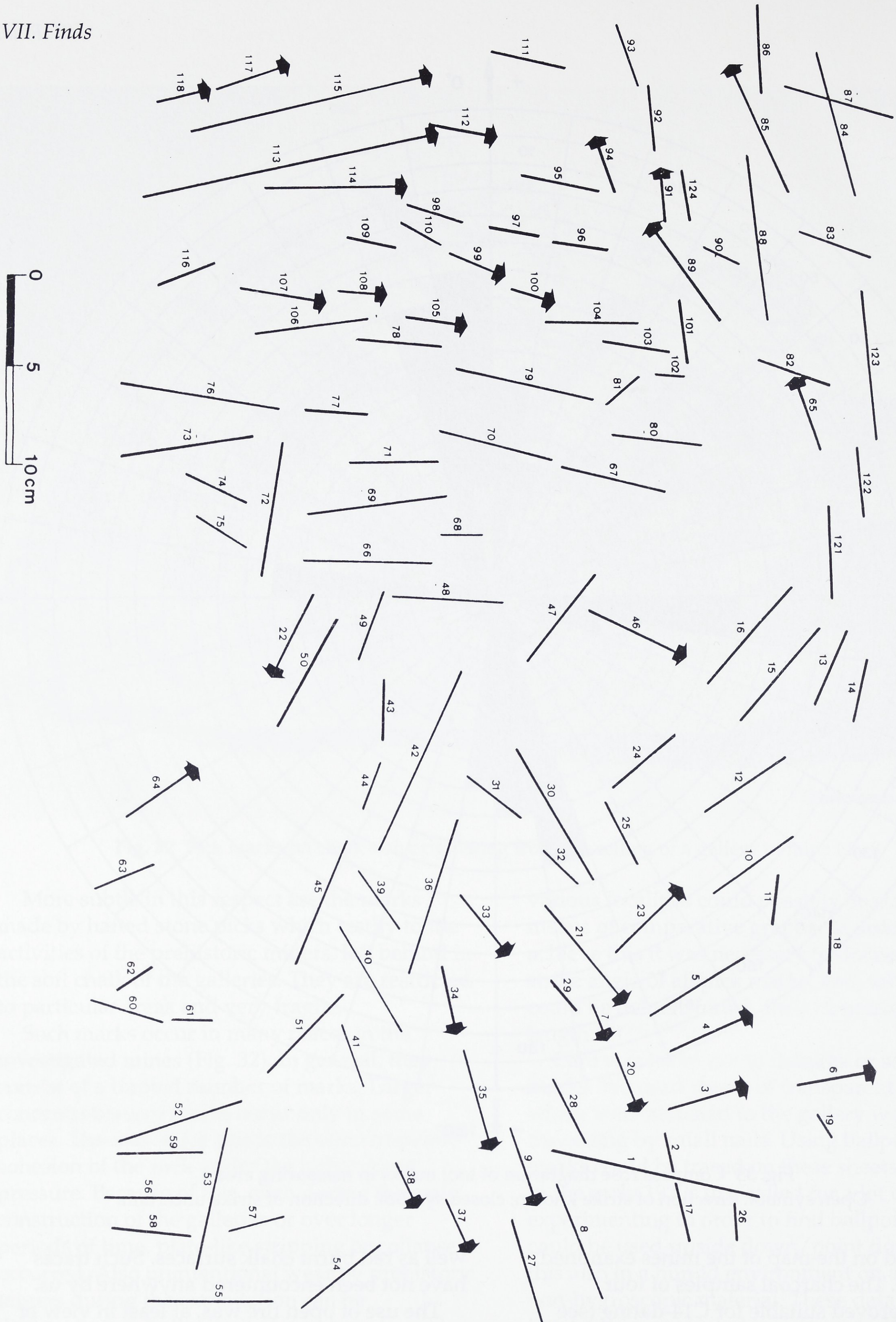


Fig. 34 Orientation of tool marks in the roof of a gallery. Arrows indicate known directions of strike.

of smoke forming below narrow shafts and in the low, narrow galleries. Fire used for ventilation was not needed either in view of the limited size of the still open, not yet infilled portions of galleries during exploitation.

The underground use of open fire by Neolithic miners at Rijckholt was not needed. No indications of such use were found. All charcoal found underground must therefore have come from fires at the surface and was dumped together with the other waste and matrix in the mines at that time.