Préhistoire Européenne, volume 10, 1997, p. 193 à 207.

NOTCHED EXTRACTION TOOLS MADE OF ROCK AND FLINT FROM THE LATE NEOLITHIC FLINT-MINE "LOUSBERG" IN AACHEN, NORTHRHINE-WESTPHALIA (GERMANY) [1]

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THE SITE

Between 1978 and 1980 three excavation campaigns have been carried out on the plateau of the Lousberg in Aachen[2] [2]. Until now the Lousberg is the only prehistoric flint-mine known in North-Western Germany. Axe blades of Lousberg-Flint have been found not only in the Rhineland but also about 200 kms to the east near the City of Kassel in Hesse, about 130 kms away in Southern Belgium, and about 250 kms to the north in the Province of Drenthe (NL); recently they have been reported for the first time from the Frankfurt region in Southern Hesse, about 200 kms away[3]. The excavations revealed that several layers of Upper Cretaceous tabular flint have been extracted by Late Neolithic miners (5.650 - 5.250 cal B.P.) employing exclusively open-cast-mining. Due to this mining method the former matrix, i.e. a package of horizontally deposited limestone layers of varying hardness (soft-loamy to highly silicified, very hard), covering the top of the Lousberg, has been nearly totally destroyd, hardly leaving a possibility to determine its original thickness.

During the 1980 campaign we finally found in one of our test trenches an in situ extraction site formed by a 1.4 m high, 1.7 m thick and about 1.4 m wide vertical ridge of solid limestone containing one layer of first grade flint at its base.

One of the walls was partially covered by very clear traces of the prehistoric miner's tools. As the limestone here was made up of the highly silicified variety, the traces consisted of typical shattering or battering marks, i.e. points of impact being surrounded by "ring-cracks" also typical for uncontrolled breaking of flint. Similar traces have been reported from other European prehistoric flint-mines [4].

The excavations not only revealed traces of mining activities but also of working the extracted pieces of tabular flint on the spot.

In 1980 we uncovered a feature which turned out to be an in situ flint workshop (atelier de taille), situated in the direct vicinity of the mining area. It was characterized by a flint scatter covering not more than 7.5 m^2. In the workshop's center a big rectangular block of limestone was uncovered, which, due to the distribution of the waste material, could only be interpreted as the seat of the former flint knapper(s).

The flint scatter was not exclusively built up by waste material from the production of axe blades; it also contained broken and discarded axe blade roughouts as well as knapping tools made of non-local rock

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1 This is a slightly updated version of the original manuscript presented at the Vesoul Meeting in 1991 and subsequently accepted for print by the editors. Without asking for the author's permission it was translated into French and published in 1995 (see Weiner 1995). I owe greatly to Marcel Otte for the chance to publish this paper again but now in the previously intended way. And I do hope that it will finally reach all of those English speaking colleagues who are interested in the matter but unfortunately have no knowledge of French.

2 Weiner (1986).

3 Gronenborn 1992.

4 Schmid (1980).

and highly specialised knapping hammers of reddeer antler[5].

Additionally the scatter contained typical extraction tools made of flint and non-local rock in different stages of use as well as shaping flakes which could be refitted to some of these extraction tools. Especially the very intensive refitting allowed to prove that not only roughouts for flint axe blades but also the extraction tools have been manufactured in the workshop[6]. As we have also found extremely used and thus discarded extraction tools, it might be highly likely that these probably have been repaired, i.e. after intensive use they were changed against brandnew examples, casually re-using the old haft.

GENERAL REMARKS ON EXTRACTION TOOLS

Nearly all prehistoric flint-mines have delivered extraction tools. It has to be taken for granted that the miners being highly specialized craftsmen of course made abundant use of perishable materials, especially wood, rope, leather etc., manufacturing a lot of their mining accessories. The employment of wood could only be inferred by some rare traces, i.e. imprints of rotten posts being left in the chalky matrix. Due to the specific conditions of preservation within flint-mines until now only tools of bone, antler and stone have been found.

In 1973 E. Schmid published an article presenting types of prehistoric miner's tools made of antler and stone[7].

Though the most common antler tool is the so called "antler pick" there are several other tool types made of this material, sometimes occuring as composite tools with shaftholes for wooden handles. The latter types are missing on the plate given by Schmid.

Concerning extraction tools of stone, Schmid delivers another plate showing nine different types. The rawmaterial of eight types is rock. Besides hand held "navettes" and a smaller hand held hammerstone type there are four types which show special hafting devices.

The most common one is called "grooved hammer" (Schmid's type e) indicating that we deal with a composite tool type. The designating feature is a groove, intenionally pecked into the surface around the tool's mid-section. This groove (sometimes more grooves) is produced to obtain an elastic haft made of split twigs.

Though this type of extraction tool is very well known, it has to be stressed that there is also a type without a groove. Instead this one shows two notches at the mid-section of the tool's longer edges (Schmid's type b).

Schmid depicts only one tool type of flint (Schmid's type g). This is an elongated narrow object showing a triangular or biconvex cross-section the name of which is "pick", too. It is generally assumed that these picks have been hafted in wooden handles, thus forming part of another composite tool type.

Concerning extraction tools of flint it has to be remarked that Schmid's typology is incomplete. Another important and common type is the notched hammer. This type finds its striking analogy in the notched hammer of rock, now only a little smaller and of flint.

One reason for the missing of the notched flint hammer in Schmid's typology could be the overwhelming amount of "simple" flint picks which have been reported from French and Belgium flint mines, and especially in the Dutch mine of Rijckholt-St. Geertruid. Here the excavators state that they have found 15.000 (!) of these picks[8].

It is a matter of fact that there is a strong relationship between the structure and hardness of the flintbearing chalk or limestone and the appropriate extraction tools employd by the prehistoric miners. Consequently in regions with soft chalk that occurs in horizontal layers which are vertically broken into massive blocks we find mostly if not exclusively antler picks, like in England.

5 Weiner (1990 b).
6 Weiner (1990 a).
7 Schmid 1973.

8 Kraaienhagen (1981).

In regions where the chalk is soft but forms a compact mass, like in the Netherlands, Belgium and some french mines, the flint pick predominates.

It was L. Desailly who, as early as 1927, published an article dealing with hafted flint implements from Spiennes[9]. These tools are made of big flakes or rejected blade cores and show all more or less pronounced notches at their longer sides. These notches have been retouched and afterwards intensively pecked. The tool's size ranges between 12 cm and 24 cm long, their weight between 280 grs. and 1.560 grs. It seems no more than reasonable to combine these tools with extraction work.

In 1932 H. Danthine deals with the same type of tools which were all found at classical mining sites in Dutch and Belgian Limburg, and at Spiennes. She states "A Sainte-Gertrude, ... ont été trouvés deux pièces dont ... l'autre porte des traces d'utilisation qui permettent de la considérer comme marteau ou percuteur"..."Une pièce semblable à notre marteau de Sainte-Gertrude et provenant du meme endroit se trouve au musée de Maestricht"[10].

The depicted flint tool from Rijckholt is nothing else but a veritable notched hammer heavily used at both ends. This is insofar very interesting as - to my knowledge - it was only flint picks that have been published in more recent articles on this flint mine[11].

Obviously notched hammers of flint have been used by the Rijckholt miners, and I can confirm the note by Danthine as I have seen myself a heavily used example at Rijckholt some years ago which was found during the excavation of the second-floor-gallery[12]. Resuming these observations we have to note that the notched flint hammers form an integral part of the miner's extraction tools even in areas where until now only "simple" flint picks have been reported.

GENERAL REMARKS ON NOTCHED HAMMERS

The most important common feature of this type of extraction tool are in all cases the more or less clearly visible notches on the longer edges of the tools. These notches have been produced intentionally using direct hard percussion technique. Relative to the shape of the blank used, i.e. piece of rawmaterial, one can expect between two and four notches.

Provided the blank used shows a flattish, rectangular to oval cross-section there are two notches. If on the other hand the blank's cross-section is more or less quadrangular with rounded or pronounced right angles between the surfaces one can expect four notches.

These statements, of course, can only be taken as rough hints, as there are several observations indicating that the miners deliberately selected blanks which depict already "natural notches" formed by natural depressions either on the broad side(s) of flat rawpieces or by natural "waistes" around the blank's mid-section, with no regards to the shape of the rawpiece.

Consequently it is possible to find notched hammers made of heavier blanks with quadrangular cross-section with only two or three intentionally retouched notches while the remaining are formed naturally.

The second common feature are the more or less pronounced traces of use at one or both ends. These traces occur mostly as a rounding of the area of impact, i.e. as shattering marks. Depending to the force the individual tool was subjected to, in several cases additionally there are distinct negatives which extend quite often widely onto the tool's surface, sometimes removing the notches. In many cases the tools have been devoted to such an excessive use, their working ends are totally and irregularly smashed, thus becoming too short and unusable, and had to be discarded.

Another striking indication of the tool's use as a veritable hammer is the presence of fine chalk- or limestone-dust, embedded within the cracks in the working end's shattered surface(s).

9 Desailly 1927.
10 Danthine (1932).
11 See note 8.
12 I would like to thank Mr. Werner Felder, former member of the "Werkgroep Prehistorische Vuursteenmijnbow", who kindly showed me this tool and delivered additional informations.

NOTCHED HAMMERS FROM THE LOUSBERG

Raw material

Besides extraction tools of well known types made of reddeer antler[13] we have found other types of this tool category on the Lousberg, which are exclusively made of nonorganic material. One small group comprises the so called wedges, which I shall not deal with in detail here.

The other group comprises the notched hammers, a total of 101 complete examples of which are known, being either of flint or different classes of rock. Besides the extensive use of typical tabular Lousberg-Flint which of course was easy at hand, one can distinguish three different classes of rock that cannot be found on the mountain itself. Characteristic surface features of the different rock classes indicate clearly their provenance from gravel beds. Thus we have to infer that the prehistoric miners intentionally collected well suited boulders by material and size from pleistocene gravel beds which occur in the direct vicinity at the foot of the Lousberg, filling the Aachen Depression.

The three rock classes share the same physical properties, i.e. they are not only dense and heavy but also hard and - last but not least - especially tough. Besides class 1 which is quartzite/quartzitic sandstone there is class 2, the so called "Wetzschiefer", a highly metamorphic rock also known as "Quarzite de Vielsalm", and finally class 3, the so called "Karbonkalk" or carboniferous limestone.

There is only one tool of quite a soft, certainly heavily weathered rock type, the material of which could not be determined yet. The frequencies of rock types are presented on Table 1.

From the total of 101 tools, 91 examples were uncovered during the excavation of the workshop. Among these were 22 of rock and 69 of flint. So about 90% of the total assemblage have been found on an area of only 7.5 m^2, underlining the specific character of this feature.

13 See note 2.

Notched hammers of flint

During the three excavation campaigns we found 78 notched hammers of Lousberg-Flint. These have been classified typologically using morphological features. From the very beginning my investigation based on the complete spectrum of extraction tools, i.e. complete tools of flint and rock, fragmented pieces, and characteristic flakes from their working ends.

In the course of the work it rapidly became clear that there is no basic typological difference between the tools of flint and rock.

So I could define 3 different possible types of notched hammers for both rawmaterials which are:

Type 1 : Typical notched hammers (Kerbschlägel). They show at least one clearly visible notch which is situated symmetrically at the tool's mid-section and definite use-wear at one or both ends. This type comprises also preforms for notched hammers (Vorarbeiten für Kerbschlägel). Same as type 1 but no visible use-wear.

Type 2 : Pick-axes (Keilhauen). At least one clearly visible notch which is situated asymmetrically near the tool's end and definite use wear mostly at one end. This type comprises also preforms for pick-axes (Vorarbeiten für Keilhauen). Same as type 3 but no visible use-wear.

Type 3 : Uncertain notched hammers (fragliche Kerbschlägel). Pieces with use wear at one or both ends without at least one definite artificial notch.

These types are depicted on Plates 1 and 2, the distribution of the flint notched hammers to types 1 to 3 are presented on Table 2.

Preforms for typical notched hammers (type 1) are no. 1, Plate 1, and nos. 5 and 6, Plate 2.

Even the bifacially retouched piece no. 5 does not show the slightest trace of wear at either end, indicating that the negatives on the smaller sides do definitely result from shaping the tool and not from working with it.

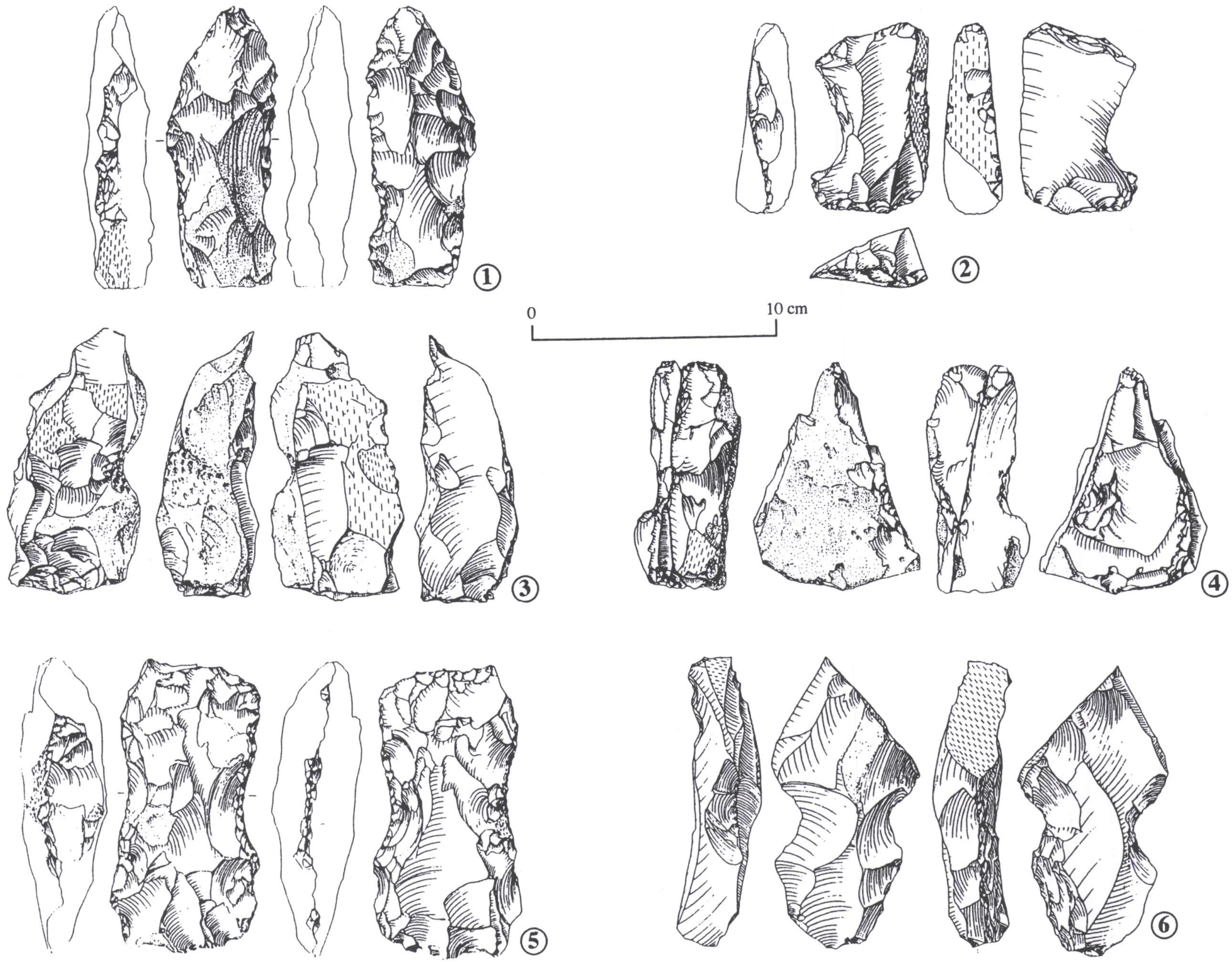

Plate 2. Notched hammers of Lousberg-Flint

Heavily used tools of type 1 are nos. 2 and 3, Plate 1 and 2-4, Plate 2. Especially tool no. 3 on this plate has been devoted to intensive use as the second notch has completely been removed by a flake, leaving a negative that runs down all along the tool's one side. Piece no. 4, Plate 2 could be refitted from two symmetrical halves.

It is broken along one natural cleavage plane, a feature to be found quite often within the tabular Lousberg-Flint. That even this tool represents a type 1 notched hammer is clearly proven by at least one notch, supported by intensive wear traces on both ends. The elongated hammer no. 3, plate 1 was found embedded in the fine chalky rubble in front of the in situ limestone ridge that is covered with extraction marks, mentioned above. It was possible to refit one small flake which was also found in the rubble to its pointed end, too, thus proving the employment of this tool during extraction work at this very spot.

Furthermore we found another flake in the direct vicinity of this hammer which could be refitted to one of the notches, this time proving the manufacture of the hammer on the spot.

As one can see the miners made use of rawpieces of all shapes which suited their needs. Besides flat pieces with rectangular cross-section they used more massive ones with quadrangular to triangular cross-sections. Besides rawpieces of tabular flint even flakes have been used as blanks (no. 2, Plate 2). While most blanks exhibit only roughly retouched notches without further shaping there are some examples which have been retouched more or less bifacially (nos. 1, 5 and 6, Plate 2). Sometimes the notches have been retouched and finally pecked, probably to avoid damage of the haft (no. 6, Plate 2), and in two cases, the notch resembles a real groove (no. 3, Plate 2). This can easily be explained as this "groove" has been pecked into a massive but relatively soft portion of chalk still adhering to the rawpiece.

Among the 78 notched flint hammers there are 71 (90.03%) representing type 1, and only 3 (3.84%) representing type 2, the pick-axes (Table 2).

One of these tools is depicted as no. 1, Plate 2. Both notches are clearly visible and there is definite use-wear at the tool's pointed end.

The dimensions of the flint notched hammers are presented on Table 3.

Notched hammers of rock

As stated above the miners used almost exclusively 3 different types of rock for the production of the heavier extraction tools. The distribution of these types are presented on Table 2.

The majority of these hammers are made of quartzite/quartzitic sandstone (47.83%), followed by Wetzschiefer (30.43%) and finally Karbonkalk (17.34%). The material of only one hammer (no. 1, Plate 5) remained undetermined (4.34%). Type 1 is represented by 91.3% while there are only 2 examples representing type 2 (8.7%).

Within this group of notched hammers only one preform, this time for a pick-axe, is known which is not presented on the Plates.

Heavily used hammers are no. 1, Plate 3, nos. 1-4, Plate 4, and especially no. 3, Plate 5. This hammer could be refitted from 5 fragments. All rock hammers belong to type 1 with the exeption of 2 examples of typical pick-axes (type 2). One used example of this type is presented as no. 2, Plate 5.

As with the flint hammers it can be seen that the miners used rawpieces of rock of all shapes as blanks. So again there are pieces with flat rectangular or flat oval or biconvex cross-section to quadrangular cross-section. Due to the flat tabular shape of the Lousberg-Flint, there are virtually no natural depressions or "waistes" to be found on this material. In contrary the miners oviously searched blanks of suitable rock which bear more or less pronounced natural "waistes" or natural notches in order to facilitate the hafting of the future hammers. The use of these natural features can be seen on the heavy hammer no. 2, Plate 3. This example depicts only three artificial notches, the fourth is missing because one face is slightly waisted by a natural depression.

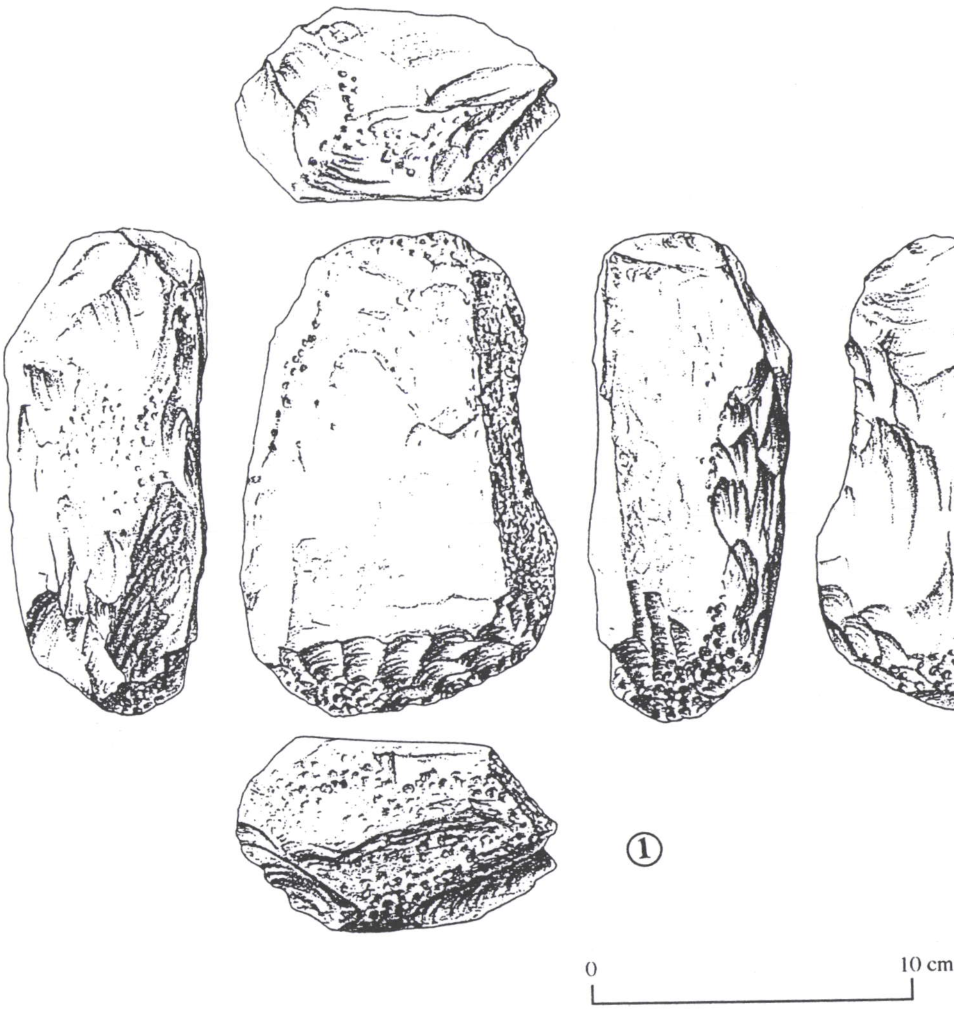

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Plate 3. Notched hammers of rock. 1: Wetzschiefer, 2: Karbonkalk.

The most striking evidence for this type of palaeo-behaviour is found on hammer no. 1, Plate 4. This heavily used hammer with flat rectangular cross-section shows a natural depression spreading across the center of its dorsal face.

Thus the two notches were retouched exactly at this position on both narrow sides.

If we compare the notches on the flint hammers with the ones on the rock hammers there is no basic difference; here as there they have been produced using direct hard percussion. But it has to be noted, that quite often the notches have been smoothed subsequently by additional pecking to remove sharp edges, again to avoid damage of the haft. Furthermore we can observe that some notches resemble grooves (no. 2, Plate 5). Of course the reason for this has to be seen within the used rawmaterial this time quartzitic sandstone, a material which is easily worked employing exclusively the pecking technique. In one case the prehistoric workman produced a very flat "groove" that runs all around the tool's mid-section (no. 3, Plate 5). Despite of this singular feature one cannot really speak of a "grooved hammer" in analogy to tools of this type from Southeastern France. As a matter of fact this hafting device represents nothing else than some sort of roughening of the blank's surface. Tools with roughening marks are mentioned by Schmid in her article as type d[14].The heavily used hammer no. 4, Plate 4 was unfortunately found on the modern waste heaps artificially produced when digging our test trenches. On the other side we found a shaping flake about 75 cm away from the seat of the flint knapper(s) in the center of the workshop which could be refitted to one of this hammer's notches. Among several other examples this is a convincing hint for the production of extraction tools in the workshop.

The dimensions of the rock notched hammers are presented on Table 4.

CONCLUSIONS

Already when looking at the drawings it becomes quite obvious that the hammers of rock are representing the more heavier and massive examples. This is underlined by a comparison of the quantitative measurements from flint and rock hammers. The mean weight of the rock hammers is 2.8 times higher than that of the flint hammers. The weight of the heaviest rock hammer (2.670.5 grs.) is nearly 3.9 times higher than the one of the heaviest flint hammer (689.8 grs.), and one has to bear in mind that in both cases we mostly deal with used examples, i.e. the weight of the ready to use tools was even higher.

The frequencies of both rawmaterial classes indicates that flint was used 3.4 times more than rock (Table 1).

Besides the obvious efficiency of the flint hammers the main reason for this obviously must have been the easy accessability to flint in comparison to the non-local rock which had to be provided from elsewhere in the vicinity.

So I am convinced that the miners would probably have exclusively employd flint blanks for their notched hammers if the rawmaterial would have allowed the production of heavier and bigger hammers. But Lousberg-Flint occurs in layers with a maximum thickness of 8 cm which are secondarily broken into pieces with maximum dimensions of 20 cm by 20 cm thus restricting the production of heavier hammers. As on the other hand the best quality Lousberg-Flint is embedded in highly silicified, very hard limestone the miners desperately needed heavier hammers. So they consequently switched to another probably even more suitable rawmaterial, heavy, hard and tough rock.

But it is interesting to see, that not only heavy, massive hammers have been produced from rock. The hammers nos. 4, and especially 2 and 3, Plate 4 are good examples to support this statement. There must be at least one reason why sometimes very small notched hammers of rock have been produced and - as we can see - were intensively employd.

14 See note 7.

Concerning rock one reason might be that this material is much tougher than flint, an attribute which delivers durability and longevity. Another important reason is the fact that we have to accept all mining tools, i.e. here the notched hammers of both rawmaterial classes, as highly specialised tools being designed for special extraction tasks.

On this basis it seems quite logic to create groups of notched hammers according to special extraction tasks, no matter of which rawmaterial. As there is no indication from other sources, i.e. we did not find any specific traces on the original extraction spot at the chalk ridge exept battering marks, again this can only be performed using typological features of the tools themselves. For me the most promising feature seems to be the overall shape or ground pattern of the tools. On this basis one could create three main groups of specialised notched hammers.

Group 1 are the massive, heavy examples with subrectangular or quadrangular to triangular cross-section, which were employd for the most heaviest work, crushing the hardest limestone layers.

Group 2 is represented by all hammers with flat rectangular to biconvex or oval cross-section. I assume that these tools have been employd when the miners had to perform more delicate extraction work in the direct vicinity of the flint layers.

Finally group 3 tools are elongated, narrow hammers with rectangular to subquadrangular cross-section and at least one pointed end (pick-axes, our type 2). This group probably represents a special class of tools which could be used producing narrow grooves in semihard limestone or weathered chalk layers to facilitate breaking off bigger blocks of the matrix.

Similar explanations have been given by Schmid for special rock tools that have been found in Kleinkems in Southern Germany[15].

15 See note 4.

REMARKS ON THE HAFTING OF NOTCHED HAMMERS

Obviously all notched extraction tools have been hafted, and the notches were produced for this purpose. Since a long time the question of how this haft might have looked has been answered. Several Egyptian illustrations, i.e. the ones from the Vth Dynasty tomb of Ti at Sakkara, show clearly the employment of hammers being hafted in split (?) twigs and used for the shaping of stone statues, and even some completely hafted hammers have been found in Egypt[16]. Then there is the fascinating find of the miner's mummy from Chuquicamata in the Atacama Desert in Norhern Chile that was preserved in a collapsed copper mine dating to the 17th century A.D. The preservation was surprisingly good, and among other finds of perishable material "This miner was found with four hafted stone hammers, ..."[17]. One of the hammers has been depicted in several publications, and it can be found in the very interesting and still important publication by J. Andree dating to 1922[18]. More recently there is an article by Ph. C. Weigand, dealing with the mines of the Chalchiuites Culture in Mexico. Miners of this Culture exploited heamatite, flint, rhyolite and weathered chert during the 7th century A.D. In one of the investigated mines, the Cueva de Maria Lizardo, a total of 16 handles of grooved hammers ("mauls") have been found, the lenght of which varies between 63 cm and 114 cm, and one completely hafted grooved hammer was found, too[19].

Finally there is the book by F.P. Dickson on Australian stone hatches which delivers many examples of sling hafted stone tools manufactured until recently by Australian Aborigines[20].

From all these sources we learn that the hafts of the notched or grooved stone artefacts were made, using whole or split twigs which have been wound around the groove or notch, and the protruding longer ends have then been placed parallely or twisted one around the other.

16 Zuber 1956.
17 Shimada, Epstein and Craig 1983.
18 Andree (1922).
19 Weigang 1968.
20 Dickson (1981).

Sometimes the hafts have been secured by binding with rawhide or even by using some kind of adhesive ("spinifex gum" in Australia).

Having these informations it seems quite obvious that the neolithic miners on the Lousberg as well as on the other European flint mines hafted their notched hammers more or less following a comparable hafting technique. Consequently we have to ask which kind of wood was used for the hafts.

Following the results of the charcoal analysis from the three excavation campaigns on the Lousberg, delivered by W. Schoch, Switzerland, the predominating wood is hazel (corylus avellana) with 29.5% which is perfectly suited for the production of split twig rods for sling hafts. Other probably suitable kinds of wood as willow (salix sp.) is only represented by 0.2% and has thus to be neglected.

If we assume that split hazel rods were used for sling hafts one has to infer that a special method for making the wood pliable had to be employd. The appropriate method, using the heat of a simple campfire, has been comprehensively discussed by F.P. Dickson in connection with the production of sling hafts for Australian stone axe blades[21].

Taken this into account, I am not astonished that, during the excavation of the workshop in 1980, we have found the remains of a campfire, a depression filled with charcoal, in front of the sitting stone. In order to further clear the question of hafting our notched hammers, experiments are planned, and I hope to present the results within the next future.

21 See note 20, 158ff.

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Table 1 : Frequency of notched hammers and their raw materials from the Lousberg

Rawmaterial	n	%	%
Lousberg-Flint	78	77.23	
Nonlocal Rock	23	22.77	
Total	101	100.00	
Quartzite	11	10.89	47.83
Wetzschiefer	7	6.93	30.43
Karbonkalk	4	3.96	17.40
undetermined	1	0,99	4.34
Total	23	22.77	100.00

Table 2 : Distribution of notched hammers to types 1-3. Material: Flint (F) and Rock (R)

	n	%	n	%
Type 1	71	91.03	21	91.30
Type 2	3	3.84	2	8.70
Type 3	4	5.13	0	
Total	78 (F)	100.00	23 (R)	100.00

Table 3 : Dimensions of notched hammers from the Lousberg. Material: Flint

	Length mm	Width mm	Tickness mm	Weight grs
Max	179.00	93.00	59.00	689.80
Min	62.00	39.00	20.00	79.50
Mean	109.86	62.17	38.83	302.34

Table 4 : Dimensions of notched hammers from the Lousberg. Material: Rock

	Length mm	Width mm	Tickness mm	Weight grs
Max	203.00	140.00	100.00	2670.50
Min	104.00	58.00	17.00	172.90
Mean	144.83	88.52	49.30	850.27

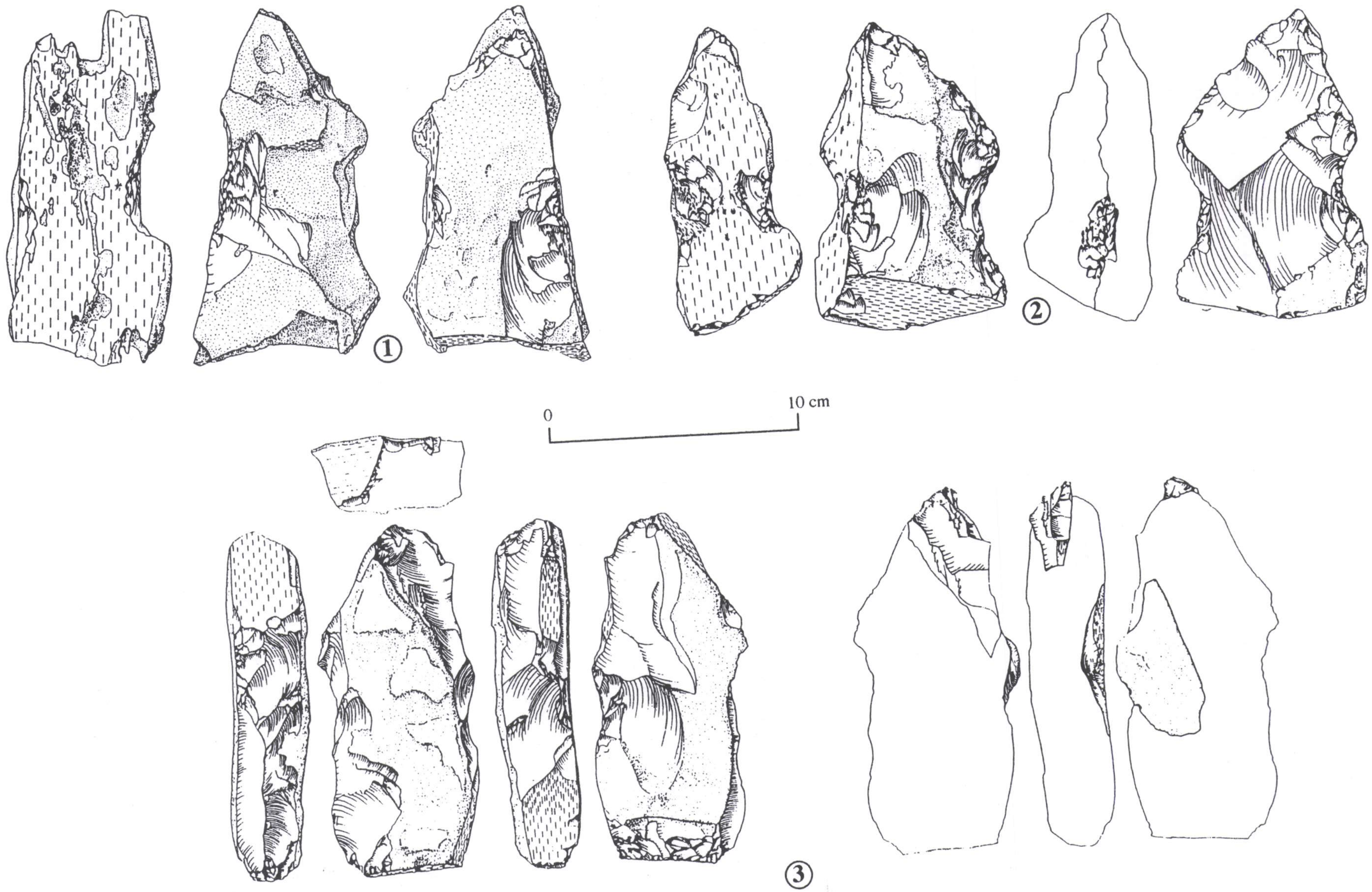

Plate 1. Notched hammers of Lousberg-Flint

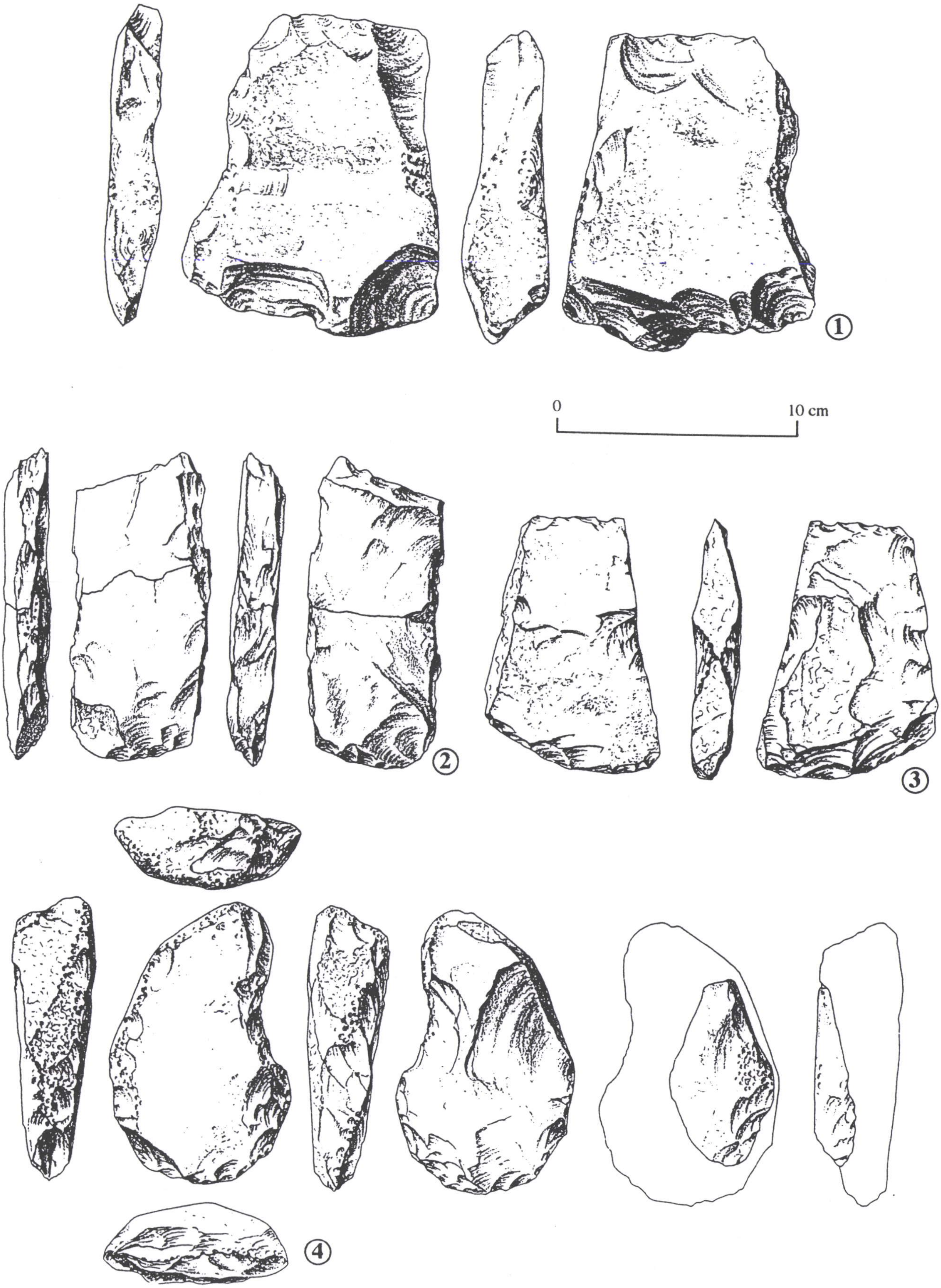

Plate 4. Notched hammers of rock. 1: Quartzite, 2-4: Wetzschiefer.

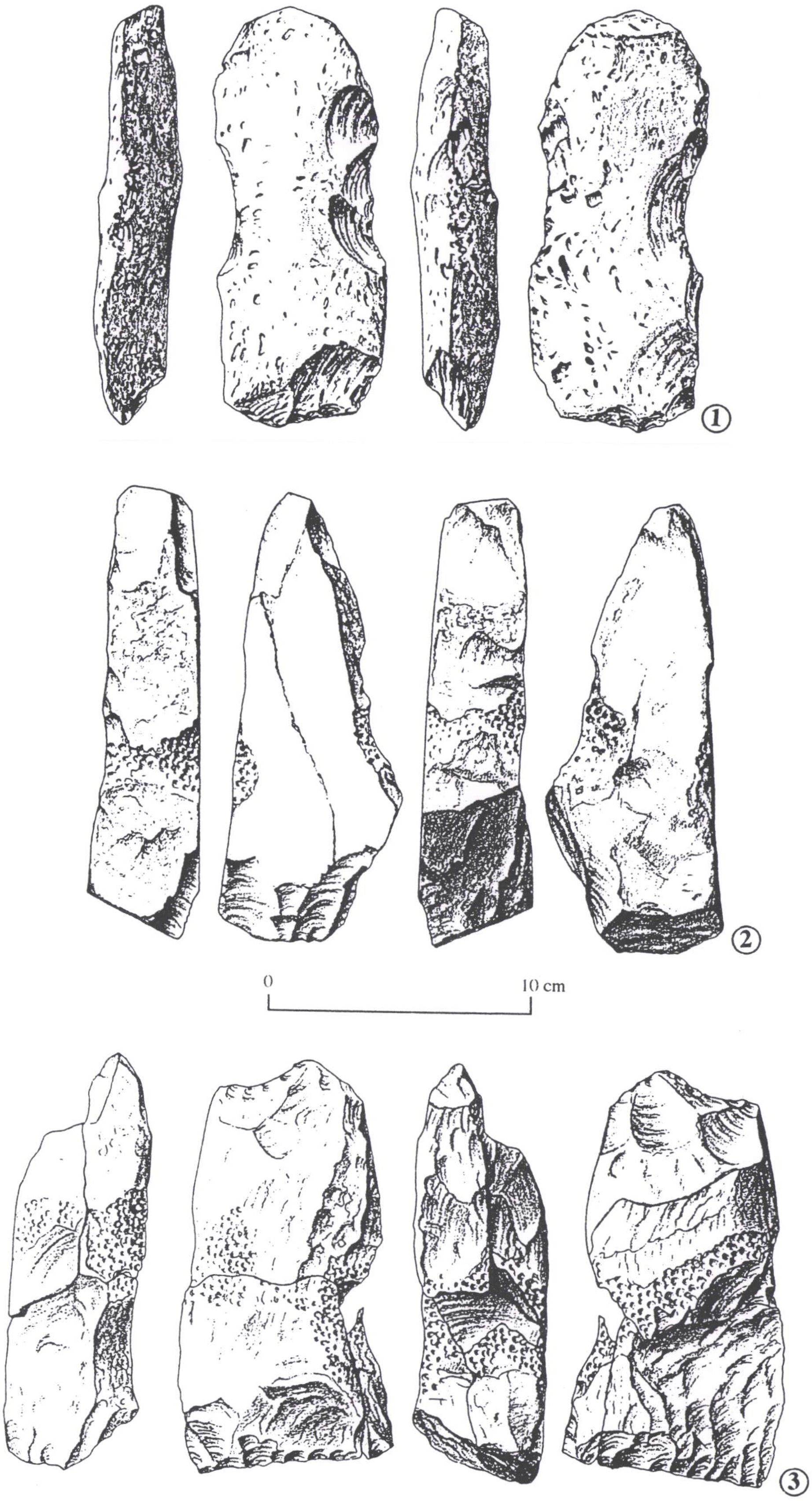

Plate 5. Notched hammers of rock. 1: Undetermined, 2: Quartzite, 3: Karbonkalk.