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THE LITHIC INDUSTRY FROM LAYERS IV-V, SUSILUOLA CAVE, WESTERN FINLAND, DATED TO THE EEMIAN INTERGLACIAL

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Abstract

The excavations (1997-2000) of the Susiluola cave site in Western Finland yielded a stratigraphic sequence of seven gravel layers of different characteristic including one interglacial soil horizon. The four lower layers contained archaeological finds. The uppermost archaeological horizon (layer IV-V) was dated to the Eemian interglacial (TL- IRSL-dating, geomorphological comparisons to Eemian paleosols, an interglacial sea level transgression). The site is in many aspects interesting as well as problematic. It is the first archaeological site within the area of the Fennoscandian ice shield, which has produced evidence for human activity in Northern Fennoscandia predating the last glaciation. The cave, functioning as a sediment trap, preserved Pleistocene deposits and their archaeological find material. But littoral and glaciofluvial processes had disturbed partly even these deposits, and the lithic material suffered by abrasion. Because of the acidity of the bedrock and the gravel layers, no Pleistocene faunal material was preserved. Several rock types were used as lithic raw material: mainly small pebbles, collected in the surroundings of the site (quartzite, quartz, sandstone), a part of the material is not local (red siltstone, fine-grained quartzite). Rock species of good fracture qualities, as flint, are missing. A noticeable characteristic in the material is the coexistence of different operation chains with differing reduction techniques, depending on fracture qualities of the raw material. The lithic assemblage from Susiluola layer IV-V shows several technological and typological features, which belong to the early (Eemian) Mousterian technocomplex.

Introduction

In 1996, the Geological Survey of Finland started the examination of gravel filled cleavage in a granodiorite rock formation in Kristiinankaupunki, Western Finland. The cleavage appeared to be actually a cave with a size of at least several hundred square meters and 2.2 m maximum height. After finding some possible stone artefacts, the work was interrupted. In 1997, the National Board of Antiquities started in cooperation with the Geological Survey archaeological excavations. During four field seasons, seven layers were uncovered in an area of 25 m². The four lower layers contained archaeological finds. The purpose of this article is to present the lithic material of layers IV and V; which could be chronostratigraphically fixed to the isotope stage 5e (TL- IRSL-dating, pollen record, geomorphological comparisons of layer IV to Eemian paleosols, an interglacial sea level transgression separating the occupations of layers V and IV). The excavation results of 1997-2000 will be presented in 2001 in a preliminary study containing the research history and project organisation (P. Purhonen), the geology and sedimentology (H. Hirvas, P. Huhta & J-P. Lunkka), the TL- and OSL- dating (H. Jungner), the pollen analysis (B. Eriksson), the Holocene fauna remains (P. Ukkonen) and the lithic material (H.-P. Schulz).

I The Site

The cave is situated on the northern slope of the Susivuori hill, 2 km east of the village of Karijoki, district Southern Ostrobothnia, Western Finland. The area is rich in finds of geological deposits that predate the last Ice Age, as till covered eskers from the melting phase of the Saalian glaciation and deposits and soil formations from the Eemian interglacial (K. Nenonen *et al.* 1991; B. Eriksson 1993, Hütt *et al.* 1993). The esker that touches the Susivuori hill in the east of was dated to 140-130 ka (J. Niemelä & H. Jungner 1991). The top of the hill is outstanding Granodiorite bedrock; the slopes are mainly covered by Holocene gravels, which are littoral deposits of the Ancylus lake phase (8-8.5 ka). In the northern part of the Susivuori, there are at the foot of a several hundred meters long precipice three caves; Susiluola is the easternmost of them. The other two caves were recently discovered; their entrances are still sediment covered. The exact shape and size of the Susiluola cave are not precisely known, because it was filled up by sediments nearly to the roof. The maximum height at the entrance (altitude of 116.5 m asl.) is 1.4 m. An area of some 25 m² located near the entrance is 1.8-2.2 m in height. According to results of ground radar scans the cave is about 30 m deep and 26 m wide at the entrance. The cave is filled mainly by Pleistocene sediments, the uppermost layer originate from the Ancylus shore phase ca 8500-8000 BP.

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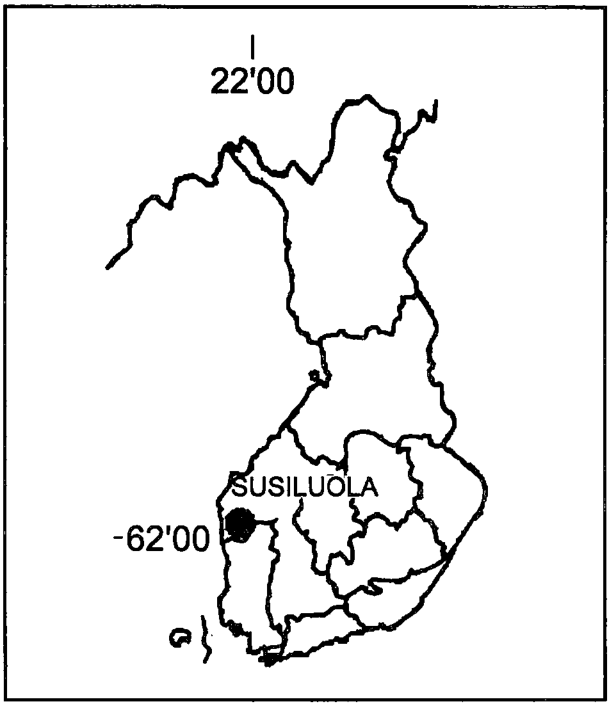


Figure I.1 : Map.

II. Lithostratigraphy and dating

The stratigraphic sequence consists of seven gravel layers of different characteristic; they were formed manly in coastal environment, one layer (IV2) is an interglacial paleosol. (H. Hirvas, P. Huhta, J-P.Lunkka, in press*). The total thickness of the deposits changes from 1.8 m near the mouth of the cave (eastern part) and 0.7 m in the back of the cave (10-13 m from the entrance).

Layer VII is a poorly sorted dark brown granulate gravel with sand and silt. The layer contains some lithic artefacts, which show clear abrasion by water. Its age and morphogenesis are yet unknown.

Layer VI is a well-sorted light yellow - greyish granulate-pebble gravel. The layer is a littoral deposit that contains lithic artefacts, which show clear abrasion by water. Its age is yet unknown.

Layer V is a well-sorted, stratified yellowish granulate-pebble gravel. The layer is a littoral deposit that contains numerous lithic artefacts, which show clear abrasion by water. Dating: Isotope stage 5c (TL and IRSL); Isotope stage 5e (sea level transgression).

Layer IV is a paleosol that developed into gravel and sand (layer V?). According to clay mineral analysis and Fe-Al extracts it developed in an interglacial environment warmer and wetter than at present (H. Hirvas, P. Huhta, in press*; W.C. Mahaney *et al.*, in press). The layer consists of two units:
-IV 2 an interglacial "floor" of the cave. In the northeastern part of the cave (squares 54-57/19-22) a pavement forms the surface of paleosol, which developed near the mouth of the cave. At the entrance the thickness of the soil is 20-25 cm, about five meters inside the cave it is running out and changing into layer V. The pavement marks the only archaeological in-situ horizon with lithic artefacts; from its borders were found several burnt stones.
-IV 1 is a paleosol redeposited in probably littoral environment, it covers layer IV 2 and in the back of the cave layer V. It contains numerous lithic artefacts, which show slight - middle abrasion by water.
Dating: Isotope stage 5c (TL and IRSL); Isotope stage 5e (interglacial paleosol formation, pollen record).

Layer III is a cobble gravel horizon, which appears only in the southeastern part of the cave. Its age and morphogenesis are yet unknown.

Layer II is a littoral deposit, which consists of two units:
-II a, a light-yellow brown, partly stratified granulate-pebble gravel, near the mouth of the cave, the layer contains big boulders, which show partly implication.
-II b, a dark brown granulate-pebble gravel.
Dating: Isotope stage 3 (IRSL).

Layer I is a cobble gravel horizon, formed during the Ancylus shore phase (dated by land-uplift to 8500-8000 BP); it contains partly a lot of Holocene faunal remains.

TL and IRSL Dating

Attempts to date the different sediment beds in the cave by luminescence techniques were made. Because of the long time span covered TL and IRSL methods using feldspar was used. The main problem is the zeroing of the luminescence signal by bleaching at time of transport of the sand into the cave. The sand minerals in the cave have the same source as sand deposits in the surrounding area and the luminescence properties of the minerals should therefore be similar. Experience from dating Late-Pleistocene sand deposits in the area could thus be utilized and the same procedures used (Niemelä and Jungner, 1991; Hütt *et al.*, 1993).

A sample from layer V (TL-447 7/1997) and one from layer IV (TL-445 3/1997) gave dates around or just above 100 ka BP, the IRSL dates being slightly younger than the TL dates.

For a sample from layer II (TL-446 4/1997) the IRSL date was about 35 ka and the TL date around 110 ka. The great difference in this case indicates very weak bleaching at time of deposition and even the IRSL date must therefore be regarded only as a maximum age. (H. Jungner, in press*).

The Pollen record

For pollen analysis, fifty samples were analysed (Eriksson, in press*). Palynomorphs were generally well preserved; a part of the ericaceous pollen and *Polypodium* spores were corroded. In the samples with rich herbaceous pollen flora the relative pollen frequency was high. The Pollen spectra of the cave sediments are preliminarily grouped into three pollen assemblages (Su 1-3). The pollen composition of the layers is slightly dissimilar between different parts of the cave, for this reason the correlation of the pollen composition to the layers is generalized.

Su-1/Layer VII
The pollen spectra are + tree pollen-dominated. The pollen values of Betula vary 12-26%, of Pinus 10-13%, of Alnus 7-32% and of Corylus 0.6-6%. Scattered *Picea* pollen were found from the upper part of the layer. The highest values of *Alnus* and *Corylus* are from the bottom of the layer, where the spectra is tree pollen-dominated; *Picea* is missing. The values of fern spores (mainly *Polypodiaceae*) are maximal 20%. The tree pollen flora indicates temperate substage of an interglacial.

Su-2/Layers VI-V
Dwarf shrubs (*Ericales*) and herbs dominate the pollen spectra, dwarf shrubs varying ind the range 44-81% and herbs 11-39% of total pollen. In the herb pollen flora only scattered *Poaceae* pollen occur. Arboreal pollen flora consists of, *Pinus*, *Betula*, *Alnus* and *Picea*; at their maximum, trees account for 35,5% and minimum 3,6% of the total pollen sum. The values of fern spores are low (<10%). Most samples with very rich herbaceous pollen flora are from the back of the cave. The herbaceous pollen flora has possibly been transported to the cave by animals/humans; the scarcity of grass pollen and missing of unripe pollen hampers the interpretation that this flora originates mainly from animal excrements. No non-pollen microfossils indicating herbivorous dung or water transport through infiltration were found.

Su-3/ Layers IV-II
The pollen assemblage is dominated by arboreal pollen; *Pinus* and *Betula* have highest values, *Alnus* is at its maximum 14% and *Picea* 8%. Fern spores (*Polypodium* and *Poypodiaceae* undiff.) have their maximum values about 50 to 70% in this assemblage, in layer II. The main part of the pollen flora of the assemblage probably originates from layer IV and was washed into the upper layers III and II during a later coastal phase; pollen of *Armeria* and some water plants and possibly also a bigger part of the fern spores may indicate this coastal phase. The main part of the arboreal pollen is considered to originate from an interglacial period predating the Weichsel glaciation. It is improbable that such considerable amounts of tree pollen were secondarily transported deeply into the caves sediments after the cave was filled up completely during the Ancylus period. This concerns especially the pollen of *Picea*; during Holocene, spruce spread into the area not until 3500 yr BP. The degree of contamination of the cave deposits by Holocene pollen was obviously very low; one of the nowadays dominating elements of the Susivuori vegetation, *Juniperus*, occurs only occasionally in the cave pollen flora.

Conclusions
The samples TL-447/71997 and TL-445/31997, although taken from different layers, date the same chronological horizon. The ancient floor of the cave consists of the paleosol IV 2 that developed into the gravel of layer V near the caves mouth and of layer V in the back of the cave. The TL and IRSL methods date the floor to the isotope stage 5c. After the occupation of layer V a littoral phase affected on the layer. This event can be connected only to the transgression of the Eemian Sea, which had been observed in several sites on partly similar altitudes in Southern Osthrobotnia (Nenonen *et al.* 1991; Eriksson 1993). The paleosol IV 2 shows interglacial morphogenesis (Mahaney et al, in press). According to those facts, the most probable date for the occupations of layers IV and V is the Eemian Interglacial (Isotope stage 5e).

III. The lithic material.

Stratigraphy and archeaological units
Four of the seven geological layers contain archaeological finds; they had been grouped into three units:

The few finds from layer II and III are from an implication-zone in the back of the cave, where sediment from layers II-IV had been mixed. The finds originate most probably from layer IV, because the layers II - III are in all other parts of the cave sterile. The material of layer IV and layer V is partly mixed (see chapter: The Lithic Industry of the layers IV - V), for this reason it was grouped into one unit. The occupations of IV and V belong both to isotope stage 5e (5c indicated by TL and IRSL dates). The difference in age between the occupations is unclear. The genesis and the age of layers VI and VII are still unknown. From layer VII has been excavated

Archaeological Unit	Description	Number of finds	Geological layer	Isotope stage
I (Layer U 2)	Sterile	-	I	1
	Short-time occupation outside of the cave	18		1
	Sterile	(12)	II	3
	Sterile	(3)	III	?
II (Layer IV-V)	Several occupations; layer IV1 is secondary; layer IV2 is a palaeosol with few in-situ structures, the material is partly in secondary place; layer V is completely secondary	748	IV V	5e(5c) 5e(5c)
III (Layer VI-VII)	Several occupations, layer VI is completely secondary	112	VI	?
	Layer VII is possibly the remain of an older palaeosol		VII	?

Table III.1.

only 2 m² (bearing 24 artefacts), up to now there is to little information about layer VII, to group it as a separate archaeological unit.

The raw material

The lithic raw material of the cave (layers IV-VII) consists of at least six rock types (table III.2) of quite different "quality". The material is partly of local origin; partly its origin is unknown. In Finland, quartz and quartzite had been commonly used during the Mesolithic and Neolithic periods, also in smaller amounts, (basic) vulcanite and fine-grained quartzite. These raw materials had been subject of archaeological studies. Red siltstone and Jotnian sandstone however, had not been (or extremely seldom) used as raw material during the Holocene. The fracture properties of these materials are not yet well known, the descriptions below base on some series of experimental striking from 1998-1999.

		N	%	Weight	% Weight
Fine-grained quartzite		10	1,2	120 g	2,4
Red siltstone		321	35,9	678 g	13,7
Vulcanite		8	0,9	6 g	0,1
Quartzite	Red quartzite	133	14,9	1348 g	27,2
	Greyish quartzite	15	1,7	442 g	8,9
Quartz	Vein quartz	134	15,0	366 g	7,4
	Pebble quartz	8	0,9	171 g	3,4
Sandstone	Jotnian sandstone	257	28,8	1577 g	31,8
	Red sandstone	5	0,6	86 g	1,7
Others		2	0,2	168 g	3,4
Σ		893		4962 g	

Table III.2: Lithic raw material from layers IV-VII.

- The fine-grained quartzite

Yellow-brown - reddish brown and grey variations. Contains quartz grains and feldspar grains (50 -200 mm) and as very fine fraction (< 20 mm) quartz, feldspar, muscovite and chlorite (SEM + EDS-analysis by the Geological Survey of Finland). The fracture quality is middle - high, the surfaces shows clear textures.

Origin: unknown, not local.

- The red siltstone

Dark red fine-grained silt- (or clay-) stone, which belongs geologically to the Jotnian-Sandstone formation. It appears as thin layers or lenses within the sandstone bedrock. Contains quartz grains < 50 mm, hematite-pigments and very fine grained material. The fracture quality is middle, surface textures are not always clear (flat bulbs, seldom ripples, coarse surface).

Origin: unknown. The Jotnian Sandstone bedrock area is situated at the bottom of the Gulf of Botnia, the sandstone appears on the Finnish mainland as Boulders and Pebbles in South-Western Finland in glacial an postglacial sediments. Pebbles of red siltstone are rather seldom, from till-covered sediments closed to the Susiluola cave, there are only very few pebbles noticed.

- The Vulcanite

Dark-grey - black variations. Vulcanite is the group name for a lot of stone species; the black flakes from Susiluola could be amphibolite (not analysed). The Fracture quality is middle.

Origin: Local (?). Appears as pebbles in the cave sediment (mainly intermediate vulcanite; amphibolite and basic vulcanite are missing. Vulcanite was unimportant as raw material source, only eight small flakes had been found.

- The Quartzite

Red and dark grey - light grey variations, partly coarse grained (> 1 mm). The fracture quality is low. Only strong direct strikes produce bulbs, usually there are no recognizable striking marks.

Origin: Local. Appears as pebbles in the cave sediment and on the slopes of the hill.

- The Quartz

White - colourless variations, appears as pebble-quartz and vein-quartz. The fracture quality of pebble-quartz can be compared to this of quartzite. Vein quartz has always been a problem for the archaeological research, because it behaves "chaotically". The fissures and cleavages in a vein quartz block prevent a systematically reduction, on the other hand a block can be split by "anvil-technique" in a short time in to a large number of irregular flakes with irregular, sharp edges (Schulz 1990). The vein quartz is at the same time a raw material of poor quality (technical/typological aspect) as well as a "good" raw material (logistical aspect). The problem for the research is, that the flakes bear seldom artificial striking marks and are seldom retouched.

Origin: Local. Appears as quartz veins in the bedrock of the Susivuori hill and pebbles on the hills slopes, few numbers of pebbles in the cave sediment.

- The Sandstone

Different red variations (grouped as Jotnian sandstone and Red sandstone). The fracture quality of the red sandstone is quite low. Only strong strikes produce bulbs, recognizable striking marks are seldom. The Jotnian sandstone is more fine-grained; flakes show partly flat bulbs.

Origin: Local. Appears as pebbles in the cave sediment and on the slopes of the hill.

The condition of the material

The lithic material shows abrasion of different degrees (see fig. III.1) caused in coastal environment. From layer IV there are also few pieces showing abrasion by wind.

Six categories of abrasion had been grouped :

0 Sharp edges, no abrasion (only material from layer U2 outside the cave)

1 Edges slightly rounded, still clear surface textures

2 Edges rounded, slight abrasion on surfaces

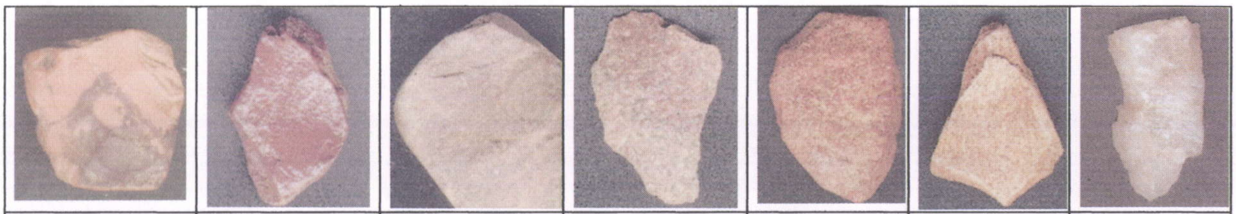
3 Edges strongly rounded, partly destroyed, clear abrasion on surfaces

4 Edges destroyed, no surface textures left

5 Completely rounded (not taken into the catalogue)

Between the different rock species there doesn't seem to be significant difference in abrasion degree. In the quartz material appear more pieces with sharp edges; this might be due to the physical fracture qualities of vain quartz.

The degree of abrasion is astonishingly similar in layer IV to VI. Probably each layer had been exposed to similar processes in coastal environment. The lithic material from the pavement of layer IV near the mouth of the cave (squares 54-56/19-21) and from the two excavated squares (54-55/20) from the block under the pavement



The fine-grained quartzite (core)	The red siltstone (core)	The quartzite, (core)	The quartzite (coarse var.)	The Jotnian sandstone	The red sandstone	The vein quartz

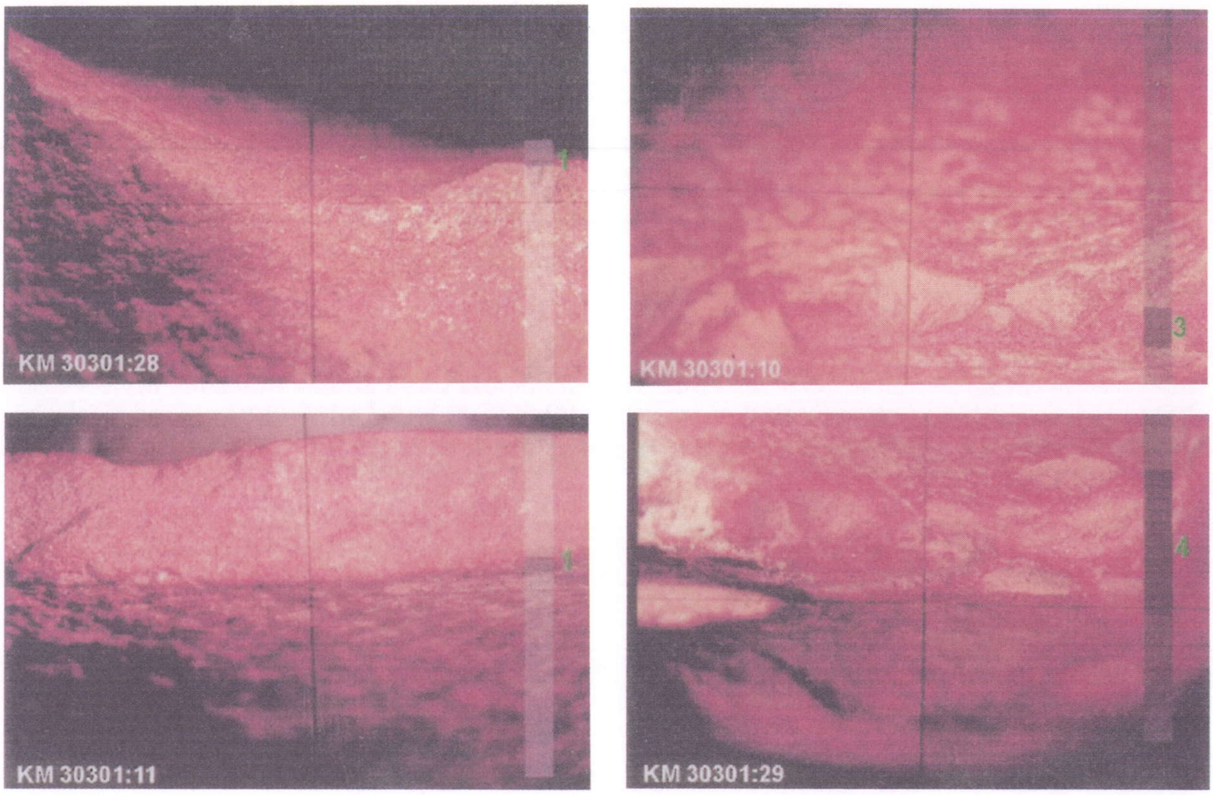


Figure III.1: Different degrees of abrasion (1-4) on red siltstone flakes.

Rock species / degree of abrasion	0	1	2	3	4
Fine-grained quartzite	-	(25%)	(50%)	(12%)	(12%)
Red siltstone	-	8%	47%	27%	17%
Quartzite	-	4%	63%	27%	6%
Sandstone	-	6%	60%	24%	9%
Quartz	-	19%	51%	30%	-

Table III.3 : Degree of abrasion of the different rock species.

Layers /degree of abrasion	0	1	2	3	4
Layer IV	-	15%	62%	19%	4%
Layer V	-	4%	52%	33%	10%
Layer VI	-	6%	51%	34%	9%
Layer VII	-	-	40%	40%	20%

Table III.4 : Degree of abrasion of the lithic material in each layer.

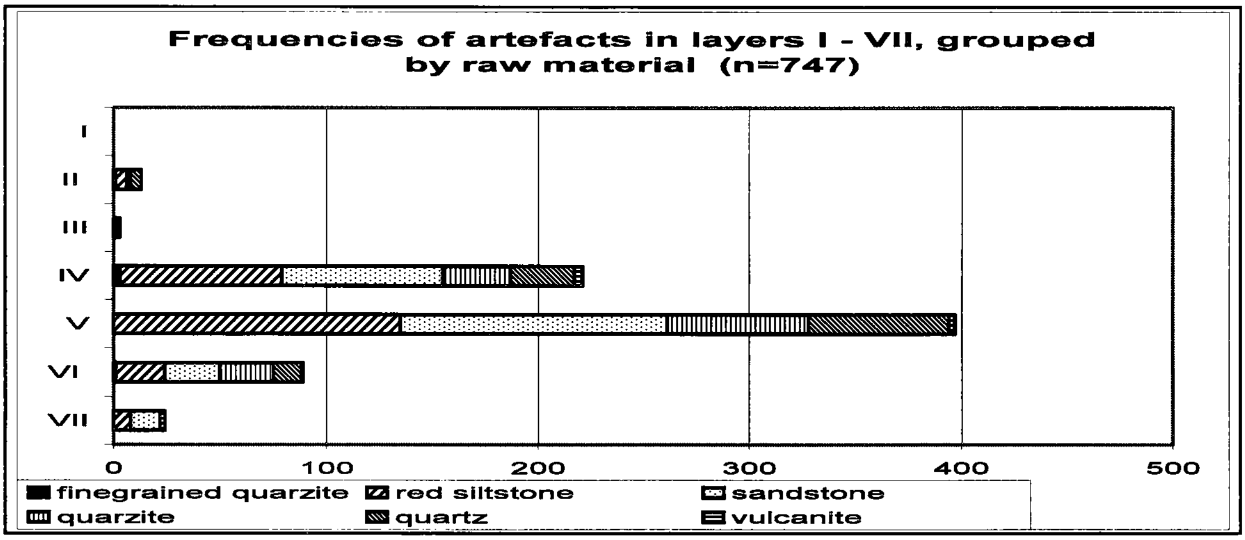


Figure III.2

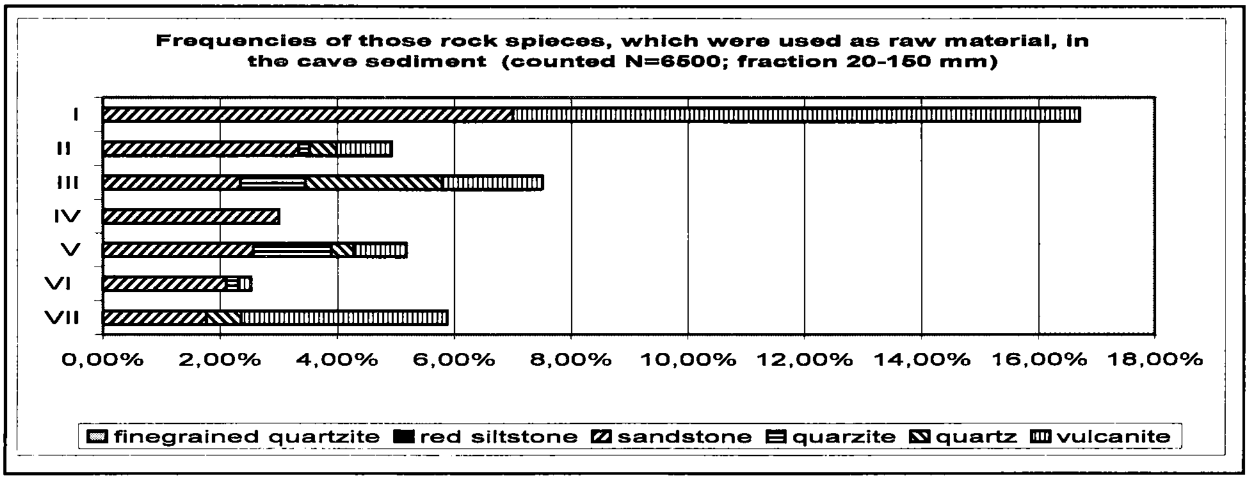


Figure III.3

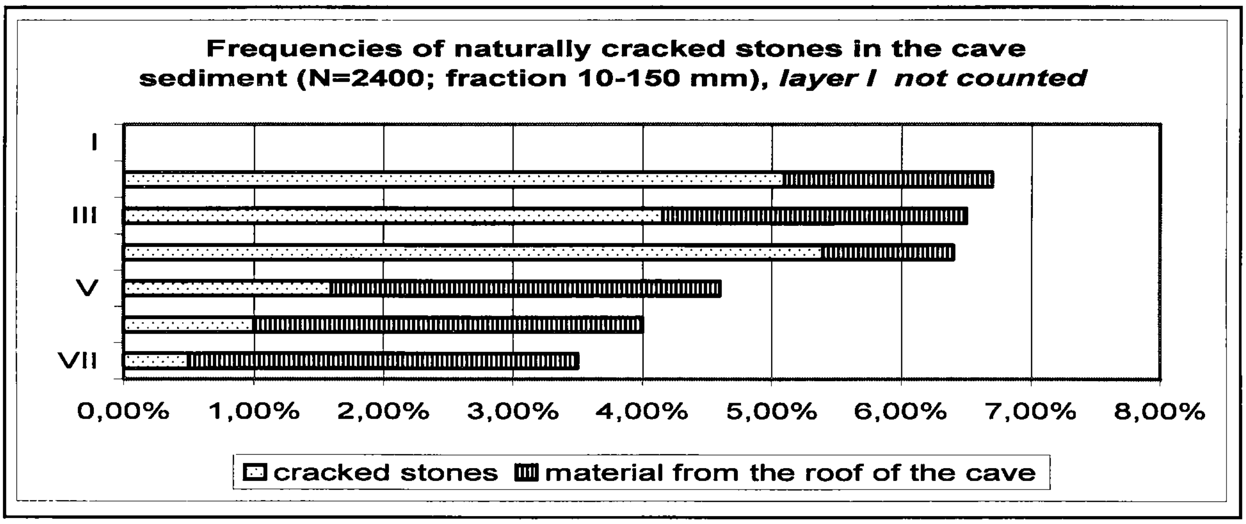


Figure III.4

(layer IV 2) was clearly better preserved as the material from the layers IV 1, V, VI and VII. That's the reason, why layer IV shows in table III.4 a higher amount of abrasion degree 1 - 2. Flakes with sharp edges (degree 0) had been found only from the younger (Holocene) layer U 2 outside the cave; some kind of erosion must have also affected on the lithic material of layer IV 2, which had not been disturbed by coastal environment.

The question of "artefacts" produced by natural forces

The analysis of the lithic material is complicated by the fact, that the sediment layers of the cave -different types of gravel- contain a big amount of pebbles, partly of the same rock species, which had been used as raw material. Naturally cracked stones, which show "artificial" marks, are known from many contexts (Clark 1958, Peacock 1991). In the case of the Susiluola cave, we can exclude "tephrofacts" (Bosinski *et al.* 1980,310; Gaudzinski 1998,44), there was no volcanic activities in Finland after the Precambrian. However, we have to consider cracking by frost and by sediment movement as well as abrasion and cracking caused by glaciofluvial processes and also coastal environment. During the quaternary glaciations, the cave was situated under the Fennoscandian ice shield and was exposed to glaciofluvial processes. After the deglaciations, the isostatic land uplift caused, that the caves mouth had been for a short while on the same altitude as the sea level; during this period, water and pushing ice (during winter) affected on the cave sediments.

From each layer was made a description of frequencies of rock species and of the amount of fractured stones (except layer I). For the analyses were separated 25 % of the excavated sediment (a quarter of each square), bigger pebbles (5-15 cm) were collected from about 50% of the excavated area. The comparisons of the frequencies of rock species with middle-good physical fracture qualities in the cave sediment with the frequencies of the defined artefact material in each layer (fig III.2 and fig III.3); as well as the comparison of the frequencies of fractured stones per layer (the complete material) to those of the artefacts (fig III.2 and fig. III.4) show very clear differences:

- the artefacts appear in layers IV-VII and concentrate clearly to the layers IV and V(the few pieces from layer II and III are from the implication zone in the back of the cave)
- in the cave sediment, sandstone, quartzite and quartz appear in nearly the same frequencies in layers II -III and V, layer IV contains only sandstone, layer one in clearly bigger amount sandstone and vulcanite.
- vulcanite is common in all layers except layer IV, the find material contains only 0.9 % vulcanite.
- the mostly used artefact raw material, red siltstone (35.9%), is missing in the cave sediment
- the amount of fractured stones in the cave sediment rises clearly from layer VII to layer II, disregarding the material from the roof of the cave, there are frequencies of 0,5-1,5 % in layers VII - V and 4,2-5,4 % in layers IV - II.

If natural processes would have originated the whole or a bigger part of the lithic material, which has been classified as artefacts, the frequencies shown in figs. III.2-4 should be at least similar. This is not the case, in the opposite; they differ clearly from each other.

Because the red siltstone, as well as the fine-grained quartzite, is not local, the material must have been brought into the cave. Quartz, quartzite and sandstone show quite often unclear striking marks; especially in case of smaller flakes, the differentiation between naturally fractured and artificial surfaces is problematic. For those flakes, the following selection criteria had been used:

- platform remnant (primary) + clear texture on ventral surface
- platform remnant (negative) + ventral surface textures or at least one clear dorsal negative

unclear or missing platform remnant + bipolar splintering (prox./dist.) or at least on surface with clear striking texture.

The lithic industry of the layers IV-V

Layer V covers the bottom of the cave in the eastern part; in the back part, where are older layers beneath, it fills the cave nearly until the roof. The layer is completely secondary; it was deposited into the cave during an interglacial sea level transgression). During this period, the whole cave was partly under water and was nearly completely "washed out", except the layers VI and VII, which had been preserved in the back of the cave. Streaming processes filled parts of the cave with gravel, which originated from sediments in the environment of the cave (a long distanced transport can be excluded, during a shore period, the Susivuori-hill was small island many kilometres from the mainland). The archaeological finds of layer V are remains of human activity in an area the closed to the cave.

Layer IV is consists of two geological units: the undisturbed (in-situ) layer IV 2, which was preserved in a depression of the caves floor near the mouth (about 6 m2 uncovered) and the secondary layer IV 1, which was pushed into the cave during a coastal period after the occupation. IV 1 and IV 2 belong probably to the same paleosol-formation, the layer IV 1 must be a remains of a soil, which has been originally in front of the cave. So the artefacts as well as the burnt stones from layer IV 1 originate from activities outside the cave.

Layer IV 2 is a paleosol, which developed into the gravel of layer V. Because of this fact, layer IV contains also lithic material from the older occupation(s) of layer V. Although this older material has been exposed to stronger abrasion, an exact differentiation is not possible. For this reason the lithic material of both layers has been grouped into one archaeological unit. To this unit was included material from layer IV and V, which had been removed from the cave in 1996, when the Geological Survey of Finland started to empty the cave (4 modified pieces, 4 cores and 49 flakes).

The lithic material of this unit originates from at least two occupations, but we have to consider several occupations for each of the layers. Because most of the artefacts are out of their original context in secondary position, which was caused by several natural processes, the lithic material is not representative for one or several of the occupations. As well, it cannot be treated as a statistical spot sample, because the spatial location, quantity and quality of the activities, which produced this material, are unknown. The present excavation results allow presenting some technological and typological features of the lithic industry of the Susiluola site, dated to the last Interglacial.

Material of middle fracture qualities: red siltstone, fine grained quartzite and vulkanite

The analysis is based mainly on red siltstone (N=325); fine-grained quartzite is represented by 3 cores and 7 small flakes and vulcanite by 8 small flakes.

The tools

Only 4.3 % of the lithic material show secondary modification by retouch, strike or use. To exclude "retouches" caused by sediment movement or edge forming by abrasion, there was taken into account only regular series of retouch/strike. Two of the cores have splintered edges, which were probably caused by use as striking stone. One cracked pebble (or thick flake?) was formed by striking; it bears a denticulate edge. All retouched flakes have primary (cortical) dorsal surface, the butt is either primary or negative. The edge modification is always simple marginal retouch. A typological classification of the Susiluola cave material is problematic, because its physical fracture qualities are different to those of high quality flint. Nevertheless there can be distinguished four morphological types: (simple convex) side scrapers (table I: 1,2), denticules (table I: 4), notches (table I: 3) and retouched flakes. Some flakes show bipolar splintering on proximal and/or distal end.

The Lithic Production (fig. III.5)

The Red siltstone was probably brought into the cave as small pebbles (< 10 cm, possibly manly oval shaped, with flat sides). They were cracked near one end; a part of the primary flakes had been modified (> denticules, > notches). The reduction continued with flaking in direction of the long axe, the lateral flakes (with negative platform remnant and primary dorsal surface) were partly used for production of side scrapers. Because of the abrasion and the insufficiency of the material, refitting was not yet possible. A series of flakes (plate I:9-16) and three cores (plate III:1-3) indicate a special reduction technique:

Flakes < 15 mm	256
Flakes > 15 mm	61
Cores	7
Others/waste	2
Modified flakes	14
Modified cores	2
Modified pebbles	1
Σ	343

Table III.5 : Lithic material; red siltstone, fine-grained quartzite and vulcanite

Side scrapers	2
Denticulates	4
Notched tools	4
Retouches flakes	4
Coarse tool (pebble)	1
Striking stones (cores)	2

Table III.6 : Tools: red siltstone, fine grained quartzite.

The flakes have parallel sides and
- 2 parallel dorsal negatives (same flaking direction)
or - 1-2 (parallel) dorsal negatives and cortex rest
or - 1 dorsal negative (same flaking direction) and lateral negatives (transversal flaking direction)

The butts are negative or (seldom) dihedral, faceted butts are missing.

The cores are polyedric with 2-3 platforms; they have series of parallel negatives in two each other crossing axes. A part of the cores surface (within the smaller angle between the axes) is cortical.

These cores as well as a part of the flakes indicate a reduction starting with parallel flaking from one platform, rotating the core and using the negative surface

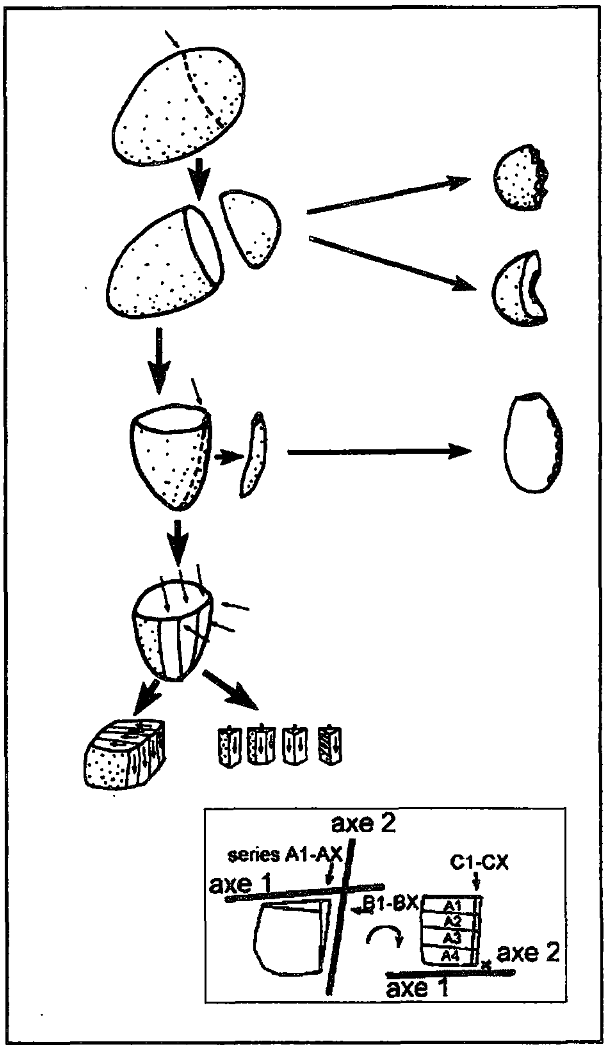


Figure III. 5: Red siltstone, (fine-grained quartzite): Reduction technique.

as new platform (without preparation), removing the second series of flakes, rotating the core again, and continuing the reduction in the same way. This reduction technique could be compared to those of some well-investigated assemblages of the isotope stage 5e (V. Sitlivy 1996, M.-H. Moncel 1998, L. Bourguignon 1998; see next chapter). Nevertheless the technique cannot be confirmed by core refitting; at that moment, we are only able to say " That's what it looks like". Some of the flakes with parallel sides could originate from different reduction technique (Levallois-flake?, plate III.12); but this remains speculation, there are no other indications, and Red siltstone is a material of probably too low quality for the Levallois-technique.

Material of low fracture qualities : Quartzite, Sandstone and Quartz

The analysis includes middle-grained greyish quartzite (n=15), coarse-grained red quartzite (n=133), red sandstone (n=5), Jotnian sandstone (n=257), and pebble quartz (n=8). The investigation of the vein quartz material (n=134) has not yet been finished; the reduction technique will not be presented in this context.

The Tools

Five pebbles were modified by striking (plate II:1-2); only three of the flakes (0.7 %) had been modified by retouch (comparatively 6% of the vein quartz flakes or waste). The pebbles selected for modification had been flat and more or less oval shaped, among those also one ventifact ("Dreikanter"; plate II:2). In all cases was used the same technique, strong direct strikes from one side, either a centripetal series covering about a third of the periphery, or a series of few strikes on one edge. Of course the discussion comes up, are these implements cores or tools. Because they are found in clear stratigraphical context, from which is evidence of different reduction technique on the same raw materials; we consider the pieces as coarse pebble tools ("choppers").

The few modified flakes are rather large, with manly cortical dorsal surface and large (negative) butts (plate II:3-4). The striking angle and the bulb indicate strong direct strike. Unfortunately the pieces had suffered from strong abrasion and the surface textures are unclear. Because of the edge damage the retouches are not completely preserved, which complicates the morphological classification. Also the retouched edges are somewhat irregular, according the other morphological features, the pieces were classified as side scrapers.

A	N	B	N
Flakes < 15 mm	311	Splinters/waste < 15 mm	86
Flakes > 15 mm	83	Flakes/waste > 15 mm	35
Cores	11		-
Splintered pieces	2	Splintered pieces	3
Others	4	Others	2
Modified flakes	3	Modified flakes/waste	8
Modified pebbles	5		-
Σ	419	Σ	134

Tableau III.7 : Lithic material A : quartzite, sandstone, pebble quartz. B: vein quartz

The lithic production (fig. III.6.)

The raw materials are local, they appear in frequencies of 1.5 to 3 % in the cave sediment (layers IV and V). There can be distinguished three different production chains:

- I : Direct modification of the pebble by flaking from one side (coarse quartzite, sandstone).
- II : Cracking the pebble, using the half with acute angles between the platform and the cortical surfaces, and starting reduction by alternate flaking on one axe (parallel to the platform). The technique produces flakes with cortical butts, negative dorsal surface and partly lateral cortical surface. The cores show 40-60 % cortical surface and have one side (sometimes flat, often prismatic) with alternating negatives (quartzite, sandstone, pebble quartz; plate III:4,7,8,10).
- III : Cracking the pebble; the reduction continued with flaking in direction of the long axe, the lateral flakes (with negative platform remnant and primary dorsal surface) were in some cases used for production of side scrapers. The next step is unclear. In the find material, there is up to now no evidence for core preparation. The remaining cores (plate III:6,9) indicate alternate flaking in two each other crossing axes. 35% of the flakes have cortical butts (including flakes from production chain II) and 65% negative butts. Dihedral and facetted butts are missing. (Middle-grained quartzite, pebble quartz).

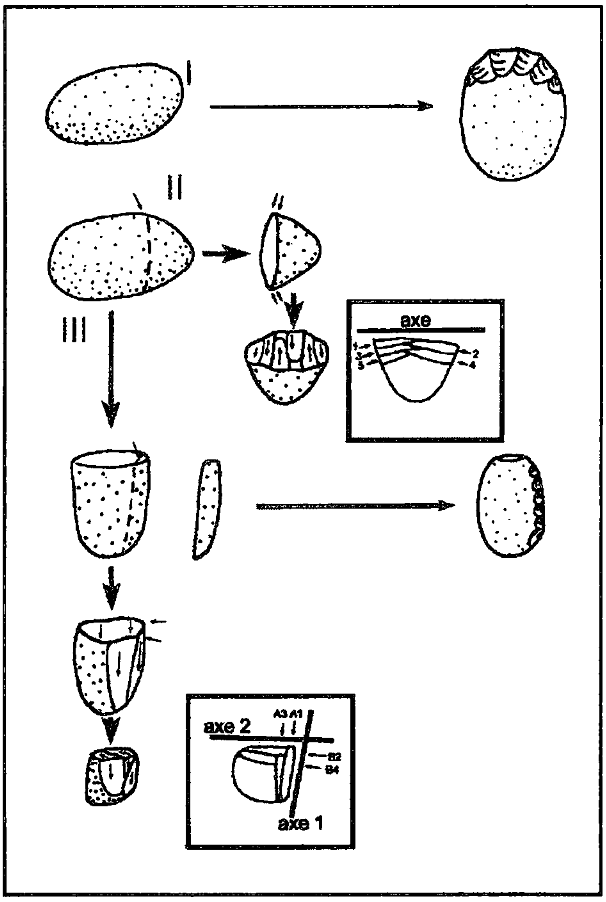


Figure III.6 : Quartzite, Sandstone, (Pebble-quartz): Reduction technique

Rock species	Occurrence	Preparation	Production	Utilize
Red siltstone ----------------- Fine-grained quartzite	unknown, not local	missing ------------- ?	*reduction: parallel flaking on 2 crossing axes, rotation of the core;* polyedric cores, flakes with parallel dorsal negatives; negative/dihedral butts	denticules and notches (primary flakes) side scrapers flakes ?
Middle-grained quartzite ----------------------------- Pebble quartz	cave, local	? ------------- missing	*reduction: alternate flaking on 2 crossing axes* cores with two plains, flakes with cortical or negative dorsal surface and negative butt	side scrapers flakes?
Coarse-grained quartzite Sandstone Pebble quartz	cave, local	missing	*"nucleus-chopper" reduction* -------------------------------- *reduction: alternate flaking on one axe* cores with one (prismatic) reduction surface, flakes with cortical butt	"choppers" -------------------- flakes?
Vein quartz	cave, local	missing	*reduction by anvil-technique* bipolar cores, splintered pieces *(to be presented later)*	flakes

Figure III.8 : The operation chains of the different raw materials of layers IV-V.

IV. Discussion

The Susiluola cave-site is in many aspects interesting as well as problematic. It is the first archaeological site within the area of the Fennoscandian ice shield, which has produced evidence for human activity in Northern Fennoscandia predating the last glaciation. The lithic material is from clear stratigraphical context, the uppermost layers that contain archaeological finds (layer IV and V) are dated to the last (Eemian) Interglacial. The age of the lower layers VI and VII is yet unknown. The interpretation of the site is complicated by several factors. It is chronologically and geographically "isolated": the first known traces of human occupation in Finland after the Eemian interglacial are from the Early Holocene; and the nearest Central European sites dated to the isotope stage 5e are in distance of more than 1400 km. The biggest part of the traces, which were left by the occupations on the Susivuori hill had been destroyed by the following glaciation and littoral phases; only the cave itself, functioning as a sediment trap, preserved Pleistocene deposits and their archaeological find material. But several (glaciofluvial or littoral) processes had disturbed partly even these deposits, and the lithic material suffered by abrasion. Because of the acidity of the bedrock and the gravel layers, no Pleistocene faunal material was preserved. At this moment, the excavation results allow only presenting some technological and typological features of the lithic industry of the interglacial layers IV and V.

A noticeable characteristic of the lithic material of Susiluola cave layers IV-V is the coexistence of different operation chains with especially differing reduction techniques. "Clacton" technique appears on sandstone, quartz and quartzite: "nucleus-chopper" reduction; alternating flaking on one axe; alternating flaking on two crossing axes and series of flakes which show typical marks of pebble core reduction (V. Chabay,V. Sitlivy1993; V. Sitlivy 1996). Technological parallels for these reduction techniques are for example in the quartz and quartzite material from the Eemian levels of Predmosti II (M.-H. Moncel and J. Svoboda 1998) and in the quartzite material of the Eemian level 5 of the Scladina cave (D. Bonjean 1998, M.-H. Moncel 1998, M. Otte 1998). On the other hand, the raw materials with better physical fracture qualities; fine-grained quartzite and red siltstone had been reduced by a more developed technique: parallel flaking on each other crossing axes by rotating the core. The technique belongs to the Middle Palaeolithic (Boëda *et al.* 1990; V. Chabay, V. Sitlivy 1993); for the isotope stage 5e it has parallels in the lithic material of the Scladina cave (Sclayn, Belgium; M. Otte et D. Bonjean 1998, L. Bourguignon 1998, M.-H. Moncel 1998,). The few cores and flakes from the Susiluola cave are not giving enough evidence for an exact typological classification, but the indicated reduction technique can be regarded as Mousterian. The quartzite and siltstone flake tools (side scrapers, notches and denticules) fit as well into this frame. Because these different reduction techniques are from the same stratigraphical context, they obviously do not represent technological or typological tradition, but are caused by the occurrence, cobble size and fracture qualities of the lithic raw material. The very hard middle-coarse grained quartzite can be flaked only by very strong direct strikes, for its reduction has to be used "Clacton"-

technique. Red siltstone and fine-grained quartzite allow using more developed core reduction techniques, but the small size of the Red siltstone pebbles clearly affected the lithic production. The absence of high quality flint in the Susiluola raw material might be the reason that there is no clear indication of Levallois technique. Nevertheless, the other indicators allow placing the lithic assemblage from Susiluola layer IV-V into the early (Eemian) Mousterian technocomplex.

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References

BOEDA E., GENESTE J.M., MEIGNEN L., 1990, Identification de chaînes opératoires lithiques du Paleolithique ancien et moyen. *Paléo* 2, 43-80.

BONJEAN D., 1998, Répartition spatiale de l'industrie lithique. In: Otte M., Patou-Mathis M., Bonjean D. (eds.). *Recherches aux grottes de Sclayn, vol 2, L'ARCHEOLOGIE*, E.R.A.U.L., 79 Liège, 1998, 340-376.

BOSINSKI G., BRUNNACKER K., LANSER K.P., STEPHAN S., URBAN B. and WÜRGES K., 1980, Altpaläolithische Funde von Kärlich, Kreis Mayen Koblenz (Neuwieder Becken). *Archäologisches Korrespondenzblatt* 10, 295-314.

BOURGUIGNON L., 1998, Le débitage Quina de la couche 5 de Sclayn: elements d'interprétation. In: Otte M., Patou-Mathis M., Bonjean D. (eds.). *Recherches aux grottes de Sclayn, vol 2, L'ARCHEOLOGIE*, E.R.A.U.L., 79 Liège, 1998, 249-276.

CHABAY V., SITLIVY V., 1993, The Periodisation of Core Reduction Strategies of the Ancient, Lower and Middle Palaeolithic. *Préhistoire Européenne* 5, 9-88.

CLARK J.D., 1958, The natural fracture of pebbles from the Batoka Gorge, Northern Rhodesia, and its bearings on the Kafuan Industries of Africa. *Proceedings of the Prehistoric Society* 24, 64-77.

ERIKSSON B., 1993, The Eemian pollen stratigraphy and vegetational history of Ostrobothnia, Finland. *Geological Survey of Finland. Bulletin* 372.

GAUDZINSKI S. 1998, Kärlich-Seeufer, Untersuchungen zu einer altpaläolithischen Fundstelle im Neuwieder Becken (Rheinland-Pfalz). *Jahrbuch RGZM*, 43. Jahrgang 1996, Teil 1,3-240. Mainz 1998.

HÜTT G., JUNGNER H., KUJANSUU R., SAARNISTO M., 1993, OSL and TL dating of buried podsols and overlying sands in Ostrobothnia, Western Finland. *Journal of Quaternary Science* 8 (2), 125-132.

MAHANEY W.C., MILNER M.W. *et al.* (in prnt), Last Interglacial Age of Layer IV in Susiluola Cave (Finland) confirmed from comparative horizon morphology, clay mineralogy and clay skins on sands. (Cryosol conference, Copenhagen Aug. 2001)

MONCEL M.-H. 1998, L'industrie lithique de la grotte Scladina (Sclayn). La couche moustérienne eémienne 5. In: Otte M., Patou-Mathis M., Bonjean D. (eds.). *Recherches aux grottes de Sclayn, vol 2, L'ARCHEOLOGIE*, E.R.A.U.L., 79 Liège, 1998, 181-247.

MONCEL M.-H., SVOBODA J. 1998, L'industrie lithique des niveaux Eemiens de Predmosti II. *Préhistoire Européenne* 12, 11-48.

NENONEN K., ERIKSSON B. and GRÖNLUND T., 1991, The till stratigraphy of Ostrobothnia, Western Finland, with reference to new Eemian interglacial sites. In: *Late Quaternary stratigraphy in Nordic Countries 150 000 - 15 000 BP*. The XXIV. Uppsala Symposium in Quaternary Geology. Striae 34, 65-76.

NIEMELÄ J. and JUNGNER H., 1991, Thermoluminescence dating of late Pleistocene sediments related to till-covered eskers from Ostrobothnia, Finland. In AUTIO S. (ed.) 1991. *Current Research 1989-90. Geological Survey of Finland. Special Papers* 12, 135-138.

OTTE M. et BONJEAN D. 1998, L'outillage. In: Otte M., Patou-Mathis M., Bonjean D. (eds.). *Recherches aux grottes de Sclayn, vol 2, L'ARCHEOLOGIE*, E.R.A.U.L., 79 Liège, 1998, 127-180.

PEACOCK E., 1991, Distinguishing between artifacts and geofacts: a test case from Eastern England. *Journal of Field Archaeology* 18, 345-361.

SCHULZ H.-P. 1990, On the Mesolithic Quartz Industry in Finland. *Iskos* 9, 7-23.

SITLIVY V., 1996, Le paléolithique moyen ancien: variabilité technologique, tyoplogique et fonctionelle en Europe. *Préhistoire Européenne* 9, 117-155.

**THE SUSILUOLA EXCAVATIONS 1997-2000* (in press), with contributions of B. Eriksson (Pollen record), H. Hirvas & P. Huhta (geology of the cave), H. Jungner (TL and OSL dating), J-P. Lunkka (sedimentology), P. Purhonen (research history and project organisation), H.-P. Schulz (archaeology: stratigraphy, structures, lithic material) and P. Ukkonen (the Holocene faunal remains).

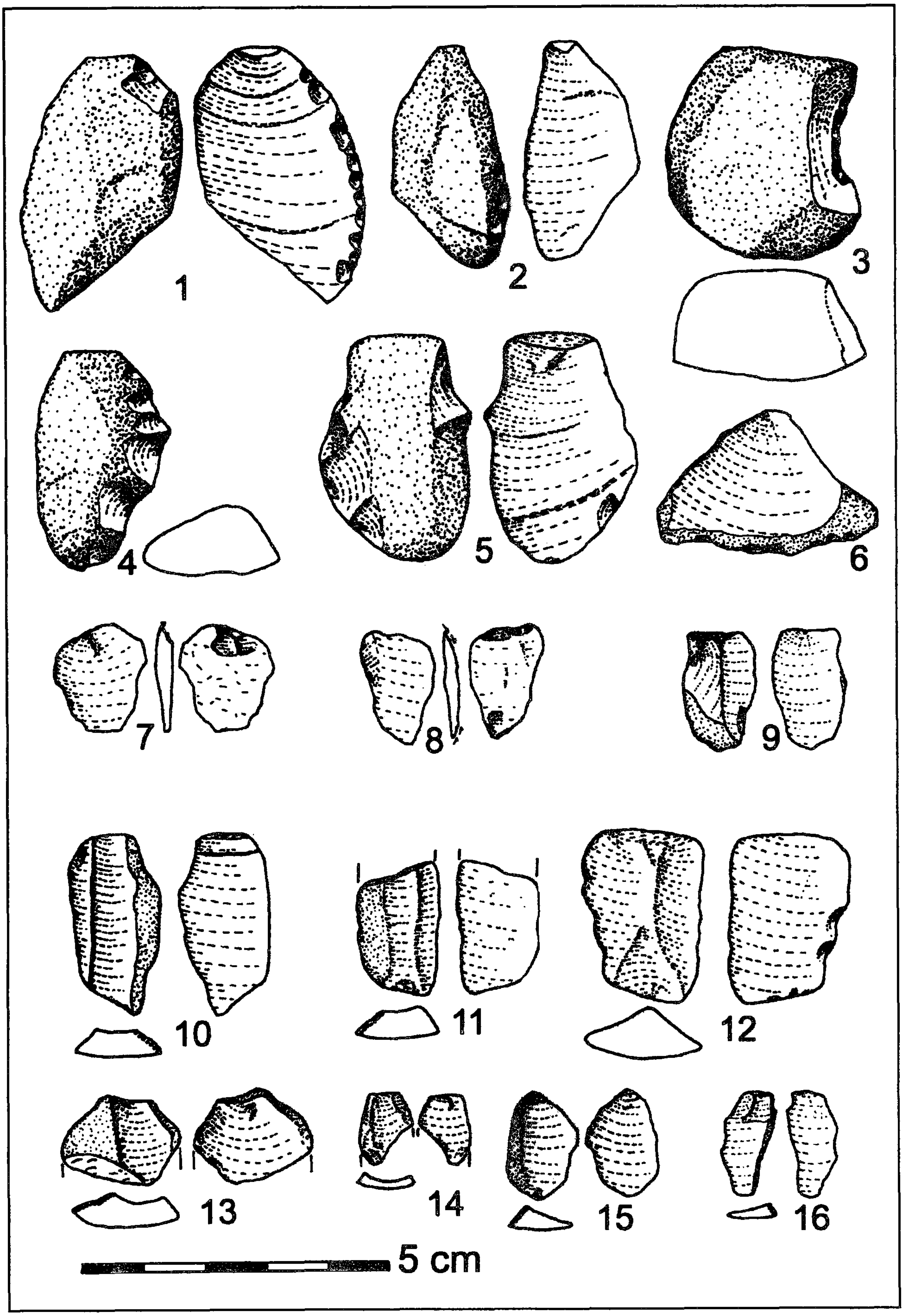

Plate I : Red siltstone, flakes ; 1-5, modified primary flakes; 7-8, prox./bipolar flakes.

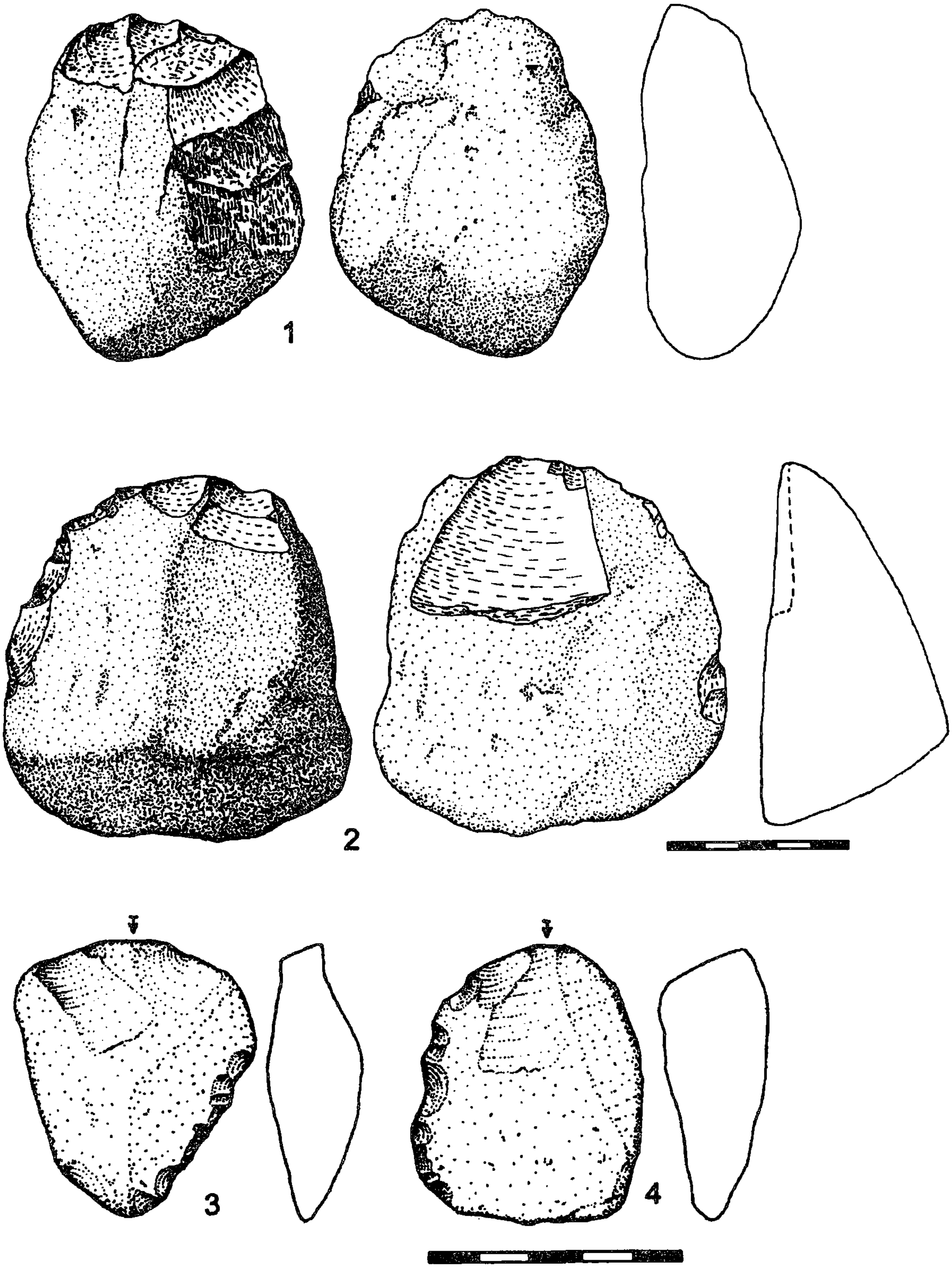

Plate II : Quartzite, sandstone, 1-2 "Choppers", 2-4 Sidescrapers

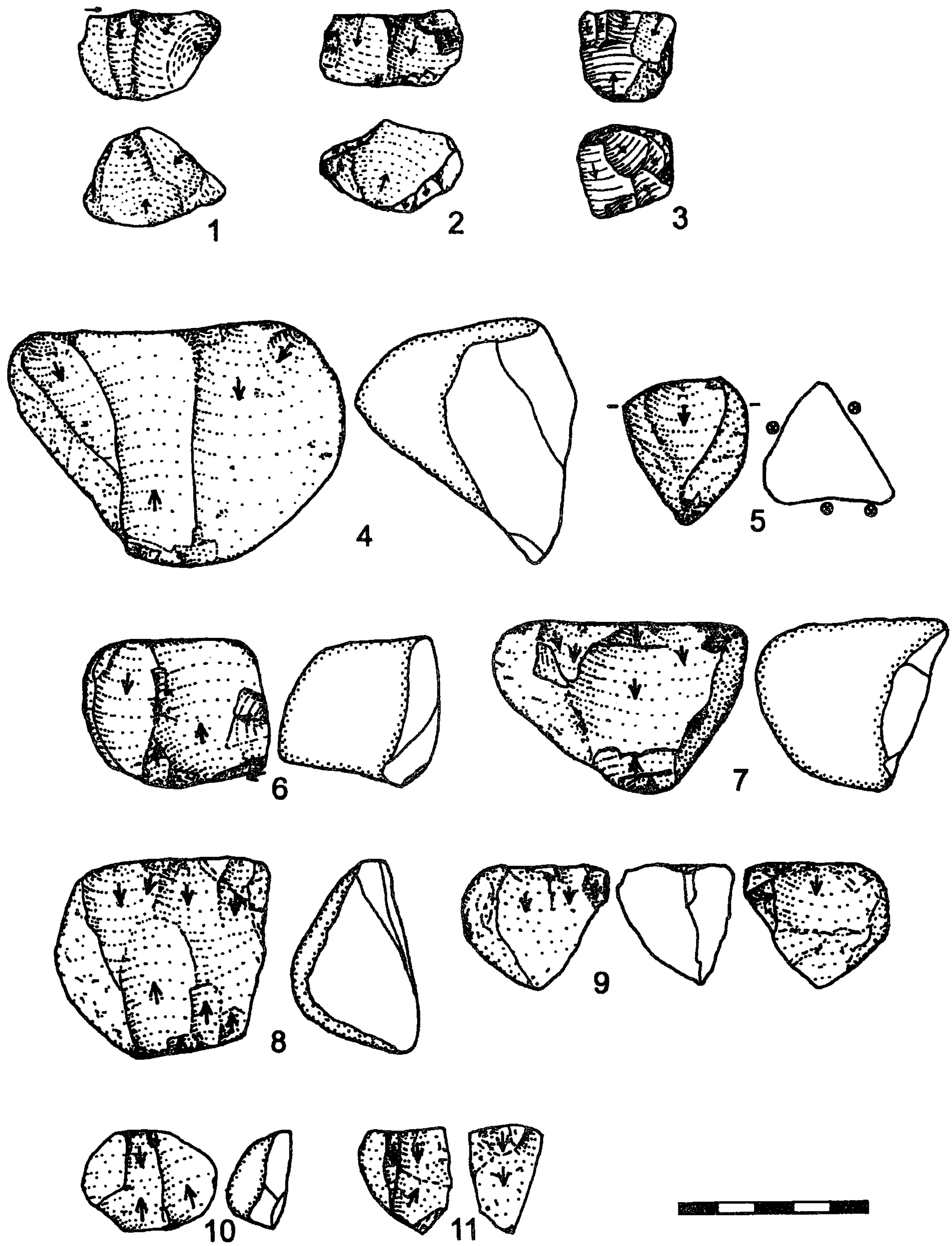

Plate III : Cores : 1-2 Red siltstone; 3 fine grained quartzite; 4,6 quartzite; 5, 7, 10 sandstone; 9,11 pebble quartz.