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## New light on the Middle Palaeolithic quartzite extraction site Troisdorf-Ravensberg

*Introduction (A. P. and E. C.).* The evidence of Middle Palaeolithic quartzite extraction sites at primary outcrops is well provided in western Germany: Reutersruh, Rörshain and Lenderscheid-Voßberg are particularly noteworthy in this respect<sup>1</sup>. What they have in common are essentially widespread find scatters of numerous artefacts in zones where the natural quartzite occur at the surface or is close to it. The recovered collections, which are to be regarded as palimpsests, are usually so extensive that the high effort of scientific analysis does not correspond to the expected results. The situation is further hampered by the fact that each time the sites are visited, new finds are discovered. As a result, the picture of how people used these sites in the Palaeolithic is still relatively vague today. This is a deficiency, because at these quartzite extraction sites at primary outcrops the technological behaviour in dealing with shapeless stones can be observed. For physical-technological reasons, if the natural stones found cannot be used directly for the blank production process, they must first be brought into the appropriate shape. This initialisation of the raw material pieces cannot be observed at most archaeological sites that are not located in the vicinity of a primary outcrop, as these usually only contain pieces that have already been processed.

Against this background, the new investigations in Troisdorf-Ravensberg presented here are to be seen as a contribution to the comprehension of this unique site type. In contrast to the sites mentioned above, the site can be relatively well delimited spatially and has so far yielded manageable quantities of finds.

The site Troisdorf-Ravensberg is located at the south-eastern border of the Lower Rhine Embayment (Niederrheinische Bucht) near the confluence of Rivers Agger and Sieg and in the

The investigations of the Troisdorf-Ravensberg site were only possible with the support of a number of persons and institutions. The Fritz Thyssen Foundation has covered a large part of the costs (20.15.0.021AA). The work of Alejandro Prieto is funded by the Education Department of the Government of the Basque Country through a postdoctoral fellowship (POS\_2018\_1\_0021). The team of the Overath branch of the LVR-ABR (Christian Schwabroh, Günter Richter, Dieter Kempis and Thomas Weber), together with students from Germany and abroad (Susana Alonso, Julia Blumenröther, Karen Kulhanek, Davide Delpiano, Aitor Freán, Henning Hundsdörfer and Akash Srinivas), did a very professional excavation. PD Dr. Ralf W. Schmitz (curator at the LVR-LMB) made access to the finds of the 1967 excavation possible and generously gave permission to study the material. Eva Roggatz (Mettmann)

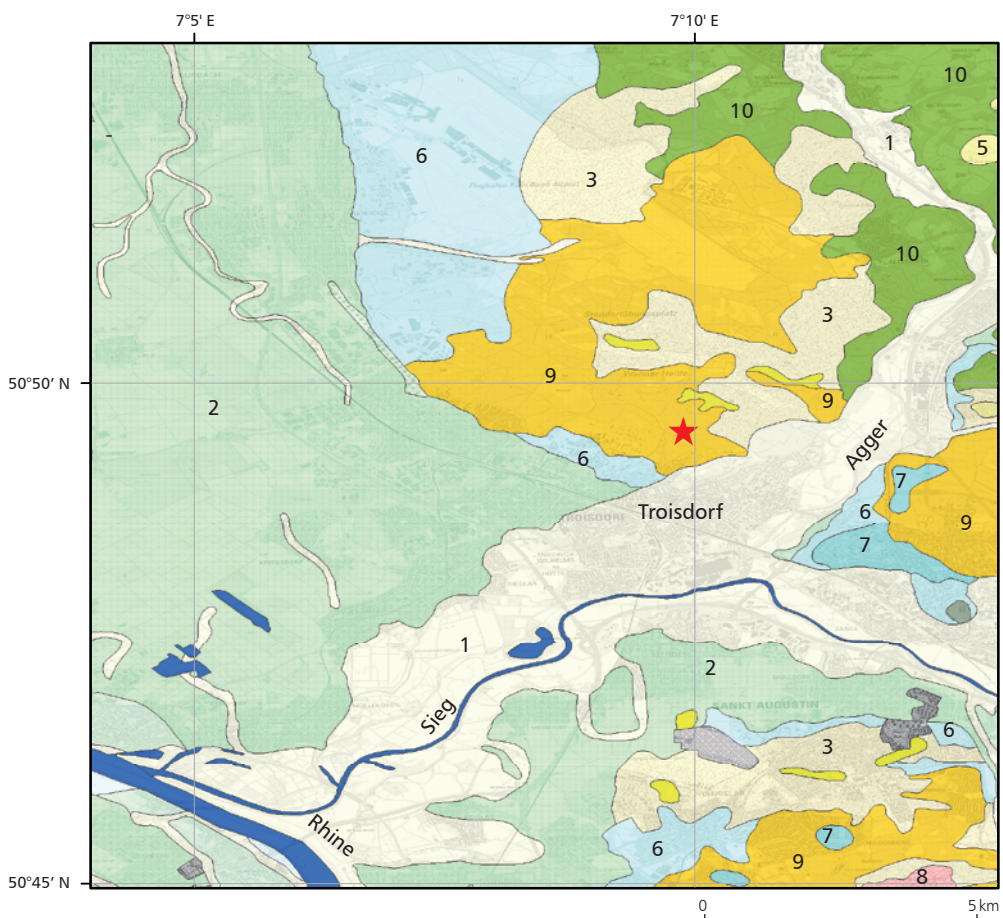
produced the 3D scans in meticulous detail work. At this point we would like to thank all of them. Furthermore, the authors thank the Department of Mineralogy and Petrology of UPV/EHU and Iñaki Yusta for access to the Laboratories and thin-section of rock preparation, also the Research Group in Prehistory of the Basque Country University (IT-1223-19) and the projects HAR2016-76760-C3-2-P and HAR2017-82483-C3-1-P (funded by the Spanish Ministry of Science and FEDER funds) which Alejandro Prieto is part of. – All chapters not marked separately were authored by A. P., M. P., M. V., and E. C.

<sup>1</sup> Luttrupp/Bosinski, Reutersruh; Bosinski, Rörshain; A. Luttrupp / G. Bosinski, Rörshain, Kreis Ziegenhain. Fundber. Hessen 7, 1967, 13–18; Heidenreich, Lenderscheid.



northeast of the city of Troisdorf in North-Rhine Westphalia (Figures 1–3). The geomorphological context comprises fluvial terraces of Rhine River and the southwest-sloping hills of the Bergisches Land. Unconsolidated fluvial and aeolian deposits of Neogene (Oligocene/Miocene) or Quaternary age as well as sedimentary bedrock of the Devonian occur in the wider area (Figure 2).

The track of the Mauspfad (Figure 3), an important historical trade route, cuts into the flank of the slightly sloping Ravensberg hill. The Ravensberg itself constitutes a 123 metres a.s.l. high elevation at the southern border of the Wahner Heide, a natural landscape on the middle terrace of the River Rhine. Close to the excavation area the ruins of a chapel from the seventeenth century – the Eremitage – are situated. The excavation area is located between about 97,5 and 93,5 metres a.s.l. north of the Mauspfad



Figures 1–3 Location of the site Troisdorf-Ravensberg in North Rhine-Westphalia, Germany (1, above) and close to the area of interest (2 and 3, opposite page). – Deposits of Late Pleistocene and Holocene: (1) ›Ablagerungen in Bach- und Flussauen‹: fluvial silt and sand of young floodplains. (2) ›Ältere Niederterrasse‹: sand and gravel of the Older Lower Terrace partly covered by sandy or loamy overbank flood deposits. (3) ›Flugsand‹: Aeolian sand. (4) ›Düne‹: dunes consisting of Aeolian sand. (5) ›Löss‹: Aeolian silt. – Middle and early Pleistocene deposits: (6) ›Jüngere Mittelterrasse‹: sand and gravel of the Younger Middle Terrace. (7) ›Ältere Mittelterrasse‹: sand and gravel of the Older Middle Terrace. (8) ›Jüngere Hauptterrasse‹: sand and gravel of the Younger Upper Terrace. – Neogene and older deposits: (9) ›Köln-Schichten‹: sand, clay and locally lignite accumulated during the Oligocene and Miocene. (10) ›Oberes Siegen‹: Clay-, silt- or sandstone of the Devonian.

at the foot of a gently inclined slope (about seven percent) facing to the southwest. On the other side of the Mauspfad, the slope slightly increases to eleven percent and ends at about 75 metres a.s.l., at the level of the Younger Middle Terrace (Figure 2). The Mauspfad itself was enlarged by roadworks in 1967 leaving a steep embankment (about forty percent). The geological strata at the site and its vicinity consists of Miocene to Oligocene marine or fluvial clays, silts and sands, the so-called ›Köln-Schichten‹. Upslope and to the north of the excavation area aeolian sand occurs, partly forming dune deposits. These have formed during the Last Glacial and Early Holocene. The ›Köln-Schichten‹ themselves may be buried by thin periglacial cover beds accumulated by solifluction or by aeolian sands.

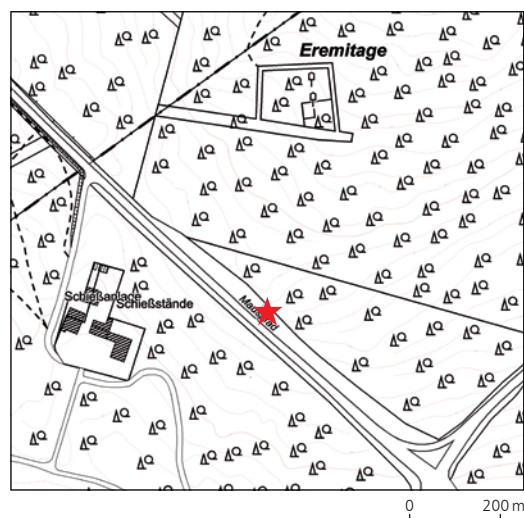
First indications of archaeological findings go back to the beginning of the twentieth century. Hermann Schwabedissen refers to single finds of tertiary quartzite artefacts from 1912 in the southwestern part of the Ravensberg<sup>2</sup>. Details of the circumstances of these finds are unfortunately unknown. In 1966 Josef Halm reported about prehistoric artefacts from the Ravensberg to the University of Cologne. Gerhard Bosinski in February 1967 initiated a first test trench of one and a half square meters<sup>3</sup>. In December of the same year he undertook a five days rescue excavation (OV1967/0013) conditioned by the extension of the Mauspfad. This time the excavated area comprised twenty-one square meters. Detailed analysis of the herein uncovered finds was published by Lutz Fiedler and Stephan Veil<sup>4</sup>.

The exact location of Bosinski's rescue excavation could not be determined sufficiently on the basis of his publications. Thanks to a series of previously inaccessible photos taken by Josef Halm just after the roadworks in December 1967, the area could be located (Figures 4 and 5). On some of these photos Halm marked Bosinski's rescue excavation. It turns out that by chance the new excavation area was very close to the former one that was about ten metres closer to the Mauspfad and completely destroyed by the roadworks.

During the two field campaigns in 1967 sediment was not sieved. In addition, a non-documented selection of the finds took place on site<sup>5</sup>.

Concerning the rescue excavation, the excavators described quartzite blocks of diverse size in the sand in different concentrations<sup>6</sup>. The material varies in quality and structure from sandy and porous to fine-grained and solid stones. The surfaces of the objects are differently pronounced: flat cortex with holes and humps, large uniform fissure surfaces with varying degrees of weathering, conchoidal surfaces as a sign of thermal influence as well as abrasion from wind polishing. The finds originate from today's surface to about one metre depth of the documented sequence of layers of humic and slightly loamy sand<sup>7</sup>.

This corresponds approximately to the observations made in the test trench in the same year, where the archaeological finds were found in a horizon of seventy centimetres thickness. Unfortunately, the exact position of the test trench of one and a half square metres in the area is not documented. One possible feature deserves special mention. A pit was observed in the longitudi-



<sup>2</sup> Schwabedissen, Quarzit-Fundplätze.

<sup>3</sup> Schwabedissen, Quarzit-Fundplätze.

<sup>4</sup> Fiedler/Veil, Ravensberg.

<sup>5</sup> Fiedler/Veil, Ravensberg.

<sup>6</sup> Fiedler/Veil, Ravensberg.

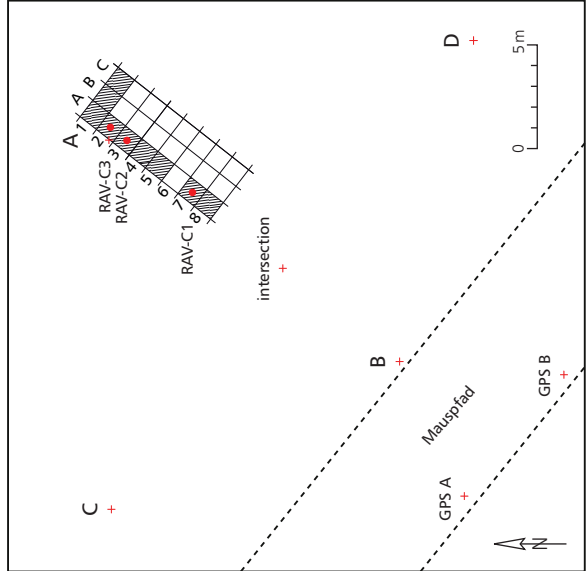
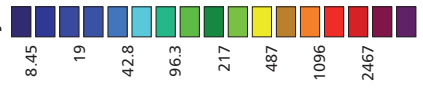
<sup>7</sup> Fiedler/Veil, Ravensberg 378.

Situation December 1967



Figures 4 and 5 Troisdorf, Ravensberg. View from the Mauspfad in north direction to the slope at Ravensberg. The area of the 1967 excavation (4) was located at the indicated position left of manhole cover C, the area of the 2015 excavation (5) on the right of it.

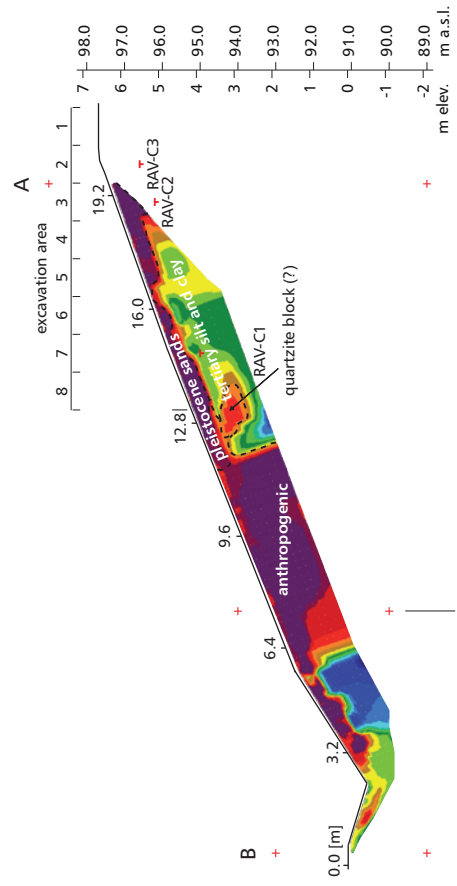
**Resistivity ( $\Omega$  m)**



**Ravensberg I (A-B)**  
Schlumberger configuration

Model resistivity with topography  
Iteration 7 Abs. error 3.5

Vertical exaggeration in model section display = 1.0  
First electrode is located at -0.0 m  
Last electrode is located at 19.8 m  
Unit Electrode Spacing = 0.2 m



**Ravensberg II (C-D)**  
Schlumberger configuration

Model resistivity with topography  
Iteration 6 Abs. error 2.3

Vertical exaggeration in model section display = 1.0  
First electrode is located at -0.0 m  
Last electrode is located at 30.0 m  
Unit Electrode Spacing = 0.15 m

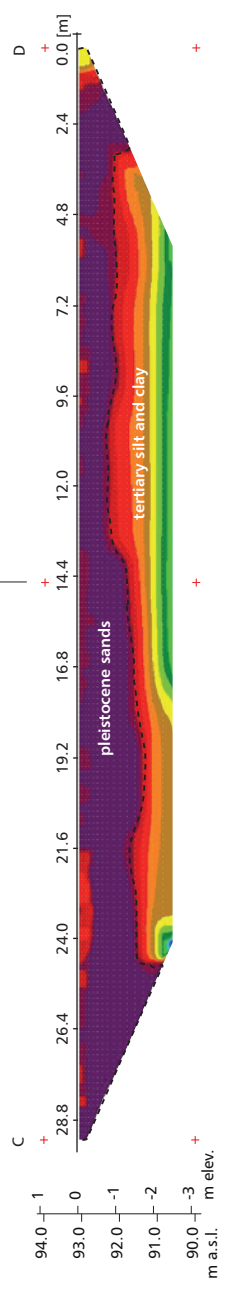
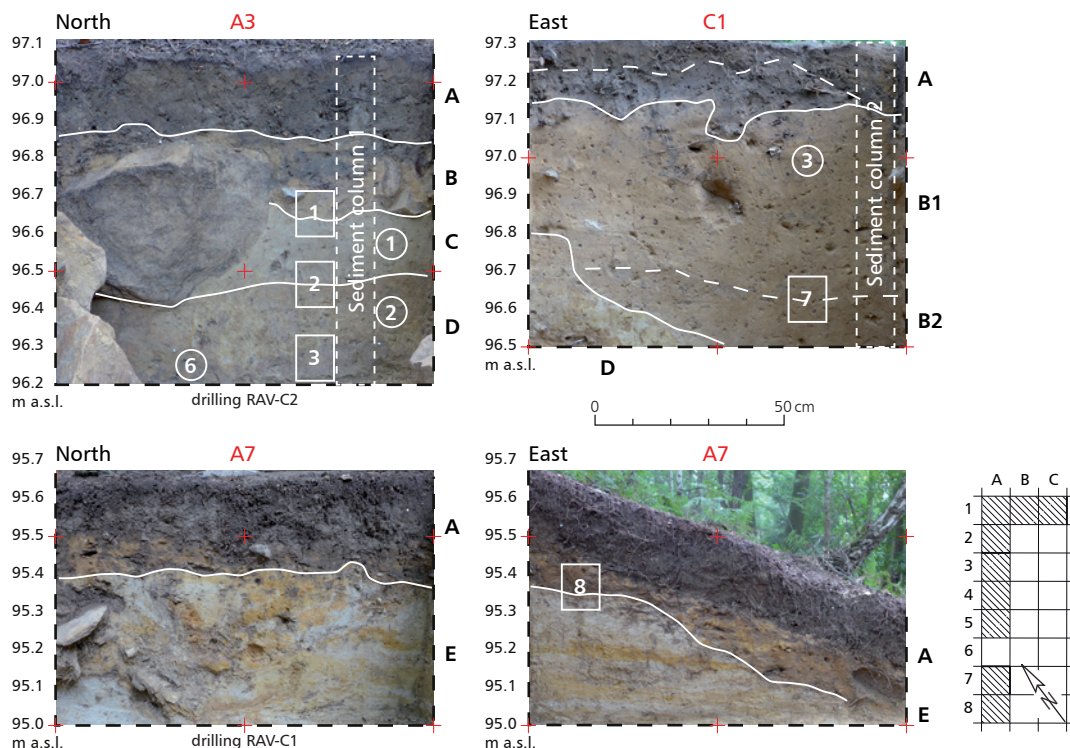


Figure 6 Calculated apparent resistivity values for ERT profiles Ravensberg I (A-B) with topographic correction and Ravensberg II (C-D).



Figures 7–10 Profiles at squares A3, A7 and C1 with geological units (A to E) and sampling (OSL – circles and micromorphology – rectangles).

nal profile of the investigated trench, which reached down to the clay through the brown sand. It was filled with grey-brown-humic sediment and ended on a massive block of tertiary quartzite. There were many quartzites in the pit, including numerous artefacts. According to Schwabedissen, the pit was anthropogenic and iron deposits at the base marked its contours<sup>8</sup>.

Due to acidic and aerobic conditions in the sedimentary context, no organic remains have persisted in Troisdorf-Ravensberg. As a result, only lithic artefacts from the various archaeological activities are available as a source of information for further analysis. These include, beside the excavation finds, surface finds reported to the LVR-State Service for Archaeological Heritage in the course of the last eighty years, of which some were recovered during construction works<sup>9</sup>. The mentioned surface finds concentrate in three areas. These are located on the eastern, southern and western slopes of the Ravensberg. Thanks to the investigations of the known finds, at least the locations on the eastern and southern slopes can be addressed to the Middle Palaeolithic. The finds from the western slope are unfortunately too indifferent so far to be classified more precisely.

The new investigations at the Troisdorf-Ravensberg site have the following main objectives:

(1) Specification and dating of the stratigraphical sequence: The information on the stratigraphical sequence of Bosinski's field work is so sparse that it is not sufficient to assess the find circumstances and to give an age estimation.

(2) Classification and dating of the lithic assemblage: In connection with the clarification of the find circumstances, it is the aim to examine the technological behaviour that can be observed in the stone artefacts. In addition, an attempt of the chrono-cultural attribution will be made.

## Material and methods

*Geophysical prospection (F. H.).* A geophysical prospection using Electrical Resistivity Tomography (ERT) was done in addition to the archaeological survey to get insights into the subsurface of the area with most surface finds. In addition, ETR allows a non-destructive detection of possible disturbances in the underground, which may help to avoid zones of strong anthropogenic impact due to former excavations or road construction and is a very valuable method in geoarchaeological prospection<sup>10</sup>. Two ERT-profiles were measured using a GeoTOM MK1E100 with Schlumberger configuration<sup>11</sup>. The first profile (Ravensberg I) with an extension of twenty metres was running from northeast to southwest (Figure 6, profile A to B) and used an electrode spacing of twenty centimetres with twenty measurement levels. The second profile (Ravensberg II) extended from northwest to southeast nearly parallel to the Mauspfad (Figure 6, profile C to D) with a length of thirty metres.

*Sedimentology and micromorphology (M. K.).* Sediment profiles exposed in all squares were photographed, sketched and described in the field. Orthophotos were prepared using QGIS software (version 3.10.11–A Coruña) and combined to show the orientation of geological strata in single profiles (Figures 7–10) and across the excavation scheme in horizontal (Figures 11 and 12) and vertical direction (Figures 13 and 14). Profiles in squares A1, A3, A7, and C1 were sampled for laboratory analyses. Two sediment columns were extracted from profiles C1-East and A3-North down to a depth of eighty centimetres below surface (Figures 7 and 8). Vertical intervals of five centimetres were selected for sampling, while a sample distance of ten centimetres was used for the uppermost ten or twenty centimetres. The samples were mechanically homogenised, dried (40 °C) and passed through a two millimetres size sieve. The fine fraction, less than two millimetres in diameter, was used for determination of grain size distribution using a Beckman Coulter LS 13320 laser diffractometer and aliquots of 0,5 to 0,75 gram. Prior to the analyses, organic matter was destroyed using H<sub>2</sub>O<sub>2</sub>. Dispersion of particles was attained by adding two millilitres of 0,01 mol Na<sub>4</sub>P<sub>2</sub>O<sub>7</sub> × 10 H<sub>2</sub>O and end-over-end shaking for twenty-four hours. The calculation of grain sizes was carried out applying the Fraunhofer model<sup>12</sup>. Statistical analyses used the spread sheet GRADISTAT, vs. 8.0 and granulometrical parameters as suggested<sup>13</sup>.

Sediment blocks were retrieved from several sediment units for preparation of thin sections. Three blocks were taken each from profiles A3-North (Figure 7) and A1-North (Figure 11), extracting samples from Units D, C and B, while one block each was taken from profiles C1-East and A7-East to study deposits of Units B and E respectively (Figures 8 and 10). The blocks were

<sup>8</sup> Schwabedissen, Quarzit-Fundplätze 103.

<sup>9</sup> H. Schulte, Von Jahr zu Jahr neue Erkenntnisse zur Vorgeschichte. Troisdorfer Jahresh. 17, 1987, 107–131; id., Paläolithische Funde vom Osthang des Ravensbergs. Troisdorfer Jahresh. 20, 1990, 109 s.; id., Alt-, mittel-, jungsteinzeitliche und mittelalterliche Neufunde aus dem Stadtgebiet. Troisdorfer Jahresh. 22, 1992, 107–113; id. / H. E. Joachim, Bonner Jahrb. 189, 1989, 371–374.

<sup>10</sup> A. Sarris et al., An Introduction to Geophysical and Geochemical Methods in Digital Geoarchaeology. In: C. Siart / M. Forbriger / O. Bubbenzer (eds.), Digital Geoarchaeology. Natural Science in Archaeology (Cham 2018) 215–236.

<sup>11</sup> M. H. Loke, Electrical imaging surveys for environmental and engineering studies. A practical guide to 2-D and

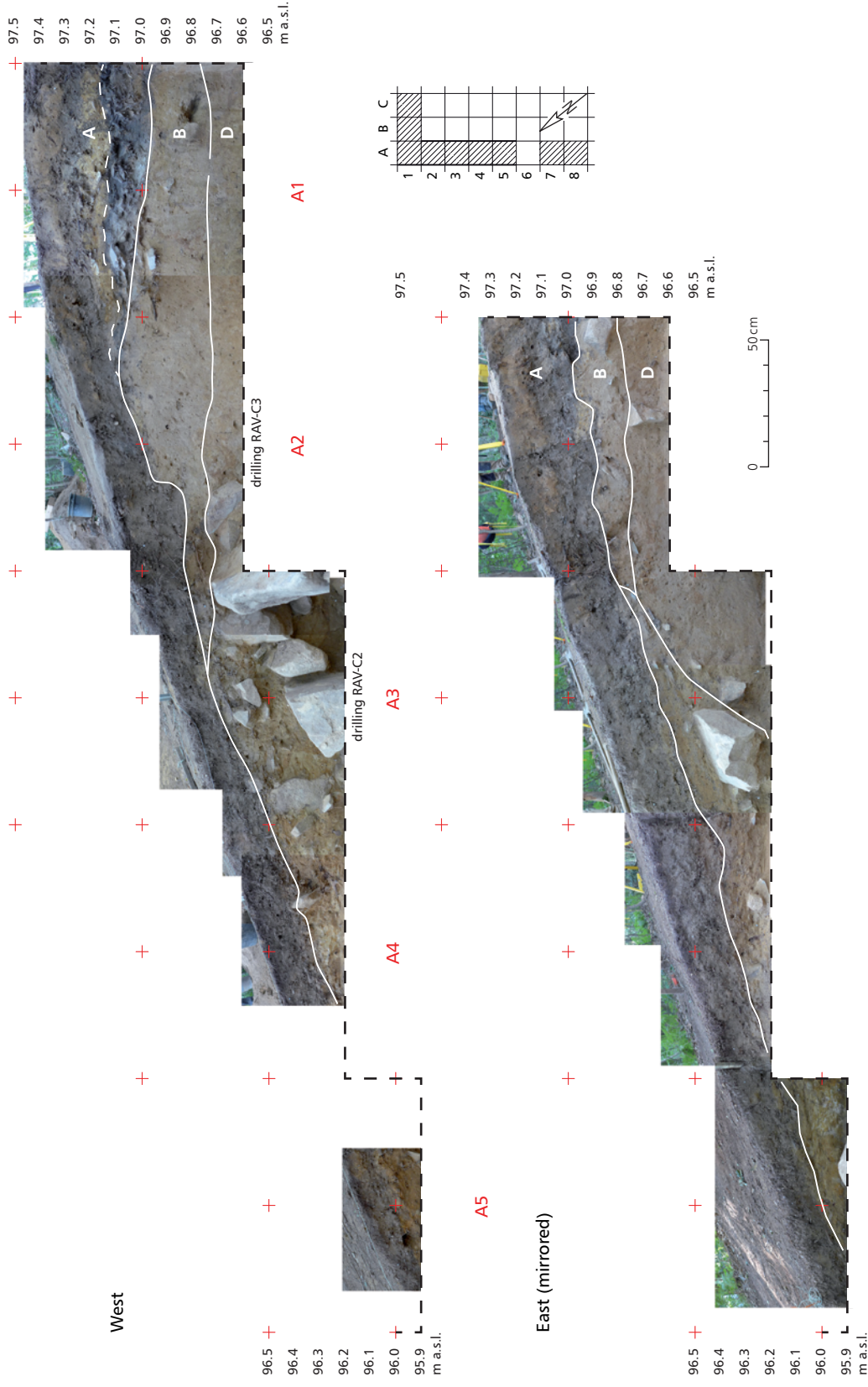
3-D surveys. Geotomo Software (Malaysia 2001). <http://www.geotomosoftware.com/downloads.php>.

<sup>12</sup> M. Konert / J. E. F. Vandenberghe, Comparison of laser grain size analysis with pipette and sieve analysis: a solution for the underestimation of the clay fraction. Sedimentology 44, 1997, 523–535; K. Pye / S. J. Blott, Particle size analysis of sediments, soils and related particulate materials for forensic purposes using laser granulometry. Forensic Sci. Intern. 144, 2004, 19–27.

<sup>13</sup> S. J. Blott / K. Pye, GRADISTAT. A grain size distribution and statistics package for the analysis of unconsolidated sediments. Earth Surface Processes and Landforms 26, 11, 2001, 1237–1248.



Figures II-12 Profiles at squares A1 to C1 with geological units (A to E) and sampling (micromorphology – rectangles).



Figures 13–14 Profiles at squares A1 to A5 with geological units (A to E).

allowed to dry at 40 °C before they were impregnated under vacuum with polyester resin. Preparation of thin sections, six centimetres wide, eight centimetres high and ~25 µm thick followed the methods described by Thomas Beckmann<sup>14</sup>. For micromorphological descriptions the terminology of Georges Stoops<sup>15</sup> was used.

*OSL-Dating (G. K.)*. Four samples were extracted using steel cylinders driven at least ten centimetres deep into the freshly exposed sediment of profiles A3-North (samples RAV-1, RAV-2, and RAV-6, Figure 7) and C1-East (sample RAV-3, Figure 8). The samples were prepared using standard methods to extract the coarse grain quartz fraction (100–200 µm), i. e., samples were treated with HCl and H<sub>2</sub>O<sub>2</sub> to remove carbonates and organics respectively, prior to density separation to isolate a quartz rich fraction which was then purified using HF etching.

Luminescence measurements were made in the Cologne Luminescence Laboratory. Samples were mounted as two millimetres diameter aliquots and were measured using a single aliquot regenerative dose protocol<sup>16</sup>. A preheat and cut-heat of 220 °C and 200 °C, both held for ten seconds, were selected on the basis of a preheat plateau experiment and the measurement protocol was validated using a dose recovery test. Aliquots were accepted if they fulfilled the following acceptance criteria: recycling ratio, recuperation of the natural signal, palaeodose error and IR depletion ratio below ten percent and provided that the equivalent dose (D<sub>e</sub>) could be interpolated between regenerative dose points.

The equivalent dose (D<sub>e</sub>) distributions for the different samples indicates that there may be some partial bleaching of the sediments, particularly for the youngest sample (RAV-3, overdispersion more than fifty percent). Partial bleaching is best detected using single-grain measurements, however a single grain test demonstrated that these samples are not sufficiently bright to allow practical single grain measurement.

The environmental dose rate was determined from high-resolution gamma spectrometry measurements also made at the Cologne Luminescence Laboratory.

*Archaeological fieldwork*. Prior to the excavation (OV2015/0066), a systematic survey was carried out in order to specify the location of the excavation area. Several Middle Palaeolithic artefacts were detected and their position in the field documented with GPS (Garmin GPSMAP 64s) on an area of one hundred per twenty-five metres on the southern slope of the Ravensberg, which overlaps with the find concentration area known before. For the excavation area the zone with the highest density of finds was chosen<sup>17</sup>.

The L-shaped excavation area extended over three square meters on the top (the plane) and eight metres down the embankment of the road (Figure 6), providing insights into different stratigraphic layers. In total, nine square meters were excavated.

The documentation followed the so called Stellensystem<sup>18</sup> in order to label every artificial horizontal removal of ten centimetres (spit) as a new ›Stelle‹ and all activities and discoveries therein as ›Position‹. The sediments from each removal were sieved with a mesh size of ten millimetres and all stratigraphically relevant points registered with a total station. All profiles and plana were

<sup>14</sup> Th. Beckmann, Präparation bodenkundlicher Dünnschliffe für mikromorphologische Untersuchungen. Hohenheimer Bodenkde. H. 40, 1997, 89–103.

<sup>15</sup> G. Stoops, Guidelines for Analysis and Description of Soil and Regolith Thin Sections (Madison 2003).

<sup>16</sup> A. S. Murray / A. G. Wintle, Luminescence dating of quartz using an improved single aliquot regenerative-dose protocol. Radiation measurements 32, 1, 2000, 57–73.

<sup>17</sup> A. Pastoors et al., Die mittelpaläolithische Steinbearbeitungswerkstatt Troisdorf-Ravensberg im Licht neuer Forschung. Arch. Rheinland 2015, 64–66.

<sup>18</sup> J. Goebels, Dokumentation archäologischer Grabungen. Methode des Rheinischen Amtes für Bodendenkmalpflege. Grabung aktuell 3, 1990, 12–18.

<sup>19</sup> E. Boëda, Techno-logique [et] Technologie. Une Paléohistoire des objets lithiques tranchants (Paris 2013).

documented. The finds could thus be assigned to single, clearly identifiable, artificial removals and thus enable further spatial investigations.

It is important to note that in contrast to the 1967 excavation, no selection of the finds took place on site. All objects found in the excavation area, being either natural or artificial, were documented according to their location and taken to the laboratory for further analysis.

*Analyses of lithic artefacts.* The knapping of stones is subject to strict physical principles at all times and is far from being directed randomly<sup>19</sup>. This general statement about the cognitive processes of stone knapping has a great influence on the analytical significance of this category of finds. With the distinction between curated and expedient assemblages proposed by Louis R. Binford in the nineteen-seventies, the importance of technological analyses of lithic artefacts has increased. According to Binford, curated technologies are very much organised, expedient technologies in contrast are poorly organised<sup>20</sup>. The dichotomy of curated and expedient technologies is based on the different time and effort that must be invested in the implementation of the respective technological concepts, but does not doubt the cognitive processes involved in both<sup>21</sup>. In the context of this discussion, Margaret Nelson proposes a distinction between expedient and opportunistic technological behaviour. The first requires a minimum of planning, while the second is the reaction to immediate and unanticipated needs<sup>22</sup>. It is not possible to discuss this in detail here. It should only be noted that both technological behaviours have the same goal of minimizing the investment of time and effort. Unfortunately, the different cognitive processes of expedient and opportunistic technological behaviour cannot be identified in the archaeological material. Therefore, both terms will be used as synonyms in the following.

The surfaces preserved on the lithic artefacts (negative flake scars, ventral surface, natural cortex, fissures, etc.) can still be explained today as a result of the deliberate implementation of physical principles. Only the physical framework is given, but the conception of the single working stages is not. At this point various methodological approaches (e.g. chaîne opératoire, transformation analysis, working stage analysis, typological classification) are available to reconstruct the respective working stages and explain the composition of a given assemblage of finds<sup>23</sup>. In the context of this article, those aspects of the technological observations are of particular interest, which are related to the exploitation of the raw material available on site. Of relevance are:

*Chaîne opératoire:* The methodological approach of the chaîne opératoire is a holistic process that attempts to place each find in the logical sequence of successive operations. This concerns the selection of the raw material pieces, as well as the conception of blank production and tool manufacturing, and recycling<sup>24</sup>. The concrete analyses on the reconstruction of human technological behaviour presented here follow Ofer Bar-Yosef and Philip van Peer<sup>25</sup>, to be understood as a typological sorting of cores and blanks with technological descriptions of processes

<sup>20</sup> L. R. Binford, Interassemblage variability. The Mousterian and the functional argument. In: C. Renfrew (ed.), *The explanation of culture change. Models in prehistory* (London 1973) 227–254; Forty-seven trips. A case study in the character of archaeological formation processes. In: R. V. S. Wright (ed.), *Stone Tools as Cultural Markers. Change, Evolution and Complexity*. Australian Institute of Aboriginal Studies (Canberra 1977) 24–36; Organization and formation processes. Looking at curated technologies. *Journal Anthr. Research* 35, 3, 1979, 255–273.

<sup>21</sup> Vaquero/Romagnoli, *Assemblages*.

<sup>22</sup> M. C. Nelson, The study of technological organization. *Arch. Method and Theory* 3, 1991, 57–100.

<sup>23</sup> T. Uthmeier, Micoquien, Aurignacien und Gravettien in Bayern. Eine regionale Studie zum Übergang vom Mittel- zum Jungpaläolithikum. *Arch. Ber.* 18 (Bonn 2004); Y. Tafelmaier u. a., *Methoden zur Analyse von Steinartefakten* (Wiesbaden 2020).

<sup>24</sup> See A. Leroi-Gourhan, *Le geste et la parole. Technique et langage* (Paris 1964); Boëda, Levallois; E. Boëda / J. M. Geneste / L. Meignen, Identification des chaînes opératoires lithiques du Paléolithiques ancien et moyen. *Paléo* 2, 1991, 43–80.

<sup>25</sup> O. Bar-Yosef / Ph. van Peer, The chaîne opératoire approach in Middle Paleolithic Archaeology. *Current Anthr.* 50, 2009, 103–131

involved in core configuration. Blanks themselves were analysed according to their technological validity<sup>26</sup>.

The differentiation between Levallois recurrent centripetal and unifacial discoidal-cores is problematic and has been object of several discussions<sup>27</sup>. The shallower the reduction surface, the more recognizable the surface conception seems. In the case of unifacial discoidal-cores, the relations are inverted. However, differences in the inclination angle of the reduction surface are fluent thus; a distinction based on this argument seems to be an academic one. In contrast the hierarchization between reduction surface and lower surface results from a conceptual approach. For that reason, cores, configured following the Levallois recurrent centripetal method and the unifacial discoidal method, are subsumed under the recurrent centripetal method; their configuration is not either constructed nor completed<sup>28</sup>.

It should be noted at this point that only cores configured according to surface conception without integration of natural surfaces are labelled as Levallois cores. This follows Boëda's argument that only in this way the implementation of surface conception can be proven with archaeological arguments<sup>29</sup>. Cores with integrated natural surfaces can follow the same surface conception, but their implementation can also be of purely random origin. In summary, Levallois cores are mathematically understood as subset of the surface conception.

The natural products were divided into blocks (sharp- and round-edged), frost shards, pebbles, and slabs. Blocks are angular stone fragments of different geometry and size. Such blocks also occur at Troisdorf-Ravensberg with weathered edges. Slabs are also blocks, but they stand out clearly from the group of amorphous blocks due to their cuboid-like three-dimensional shape. In such pieces, the two largest surfaces are approximately parallel to each other and one edge length (height) is significantly shorter than that of the other two edges (length and width). Pebbles are stones with more or less rounded shape due to transport by running water or in the coastal surf. Frost shards are treated separately due to their special geometric shape. They result from freezing and defrosting processes. According to Joachim Hahn, stones broken by frost show a certain characteristic of the fractured surfaces. The parting surfaces are shell-like (conchoidal), convex for the blown-off parts and concave for the remaining parts. Heavily curved ripples can occur during breaking<sup>30</sup>.

Working stage analysis: In contrast to a typological description of the artefacts, the working stage analysis aims not at describing the appearance of the entire artefact but at analysing the dynamic production process that gave the artefact its shape<sup>31</sup>. The working stage analysis is a method for analysing the production process of lithic artefacts; the term »production process« covers all alterations of the artefact including those caused by usage or thermal influence, modern damage, and

<sup>26</sup> Technological terms and definitions adhere mainly to Boëda, Levallois; Boëda/Geneste/Meignen, Identification (note 24); A. Delagnes / L. Meignen, Diversity of lithic production systems during the Middle Paleolithic in France. Are there any chronological trends? In: E. Hovers / S.L. Kuhn (eds.), Transitions before the transition. Evolution and stability in the Middle Paleolithic and Middle Stone Age. Interdisciplinary Contributions to Archaeology (New York 2006) 85–108; S. Révillion / A. Tuffreau (eds.), Les industries laminaires au Paléolithique moyen. Actes de la table ronde internationale organisée par l'ERA 37 du CRA-CNRS à Villeneuve-d'Ascq 1991. Dossier documentation arch. 18 (Paris 1994).

<sup>27</sup> M. Peresani (ed.), Discoid lithic technology. Advances and implications. BAR Internat. Ser. 1120 (Oxford 2003).

<sup>28</sup> A. Pastoors / Y. Tafelmaier, Bladelet production, core reduction strategies, and efficiency of core configuration at the Middle Palaeolithic site Balver Höhle (North Rhine Westphalia, Germany). *Quartär* 57, 2010, 25–41.

<sup>29</sup> Boëda, Levallois.

<sup>30</sup> J. Hahn, Erkennen und Bestimmen von Stein- und Knochenartefakten. Einführung in die Artefaktmorphologie. *Arch. Venatoria* 10 (Tübingen 1991) 34.

<sup>31</sup> Richter, Sesselfelsgrötte III; A. Pastoors / J. Schäfer, Analyse des états techniques de transformation, d'utilisation et états post dépositionnels. Illustrée par un outil bifacial de Salzgitter-Lebenstedt (FRG). *Préhist. Européenne* 14, 1999, 33–47; A. Pastoors, Die mittelpaläolithische Freilandstation von Salzgitter-Lebenstedt. Genese der Fundstelle und Systematik der Steinbearbeitung. *Salzgitter Forsch.* 3 (Braunschweig 2001).

other. The basic idea is to interpret one or more interconnected negatives having the same function as one working stage. These working stages are in turn classified according to production method, appearance and subsequently chronologically related to neighbouring working stages. Thus, the production process of the entire artefact is described in chronological order.

Typological classification: In archaeological research, this concept has been established since the nineteenth century. According to Eggert, a type is a combination of features that characterises a group of specific phenomena<sup>32</sup>. In this sense, a lithic tool type is characterised by the combination of certain features. To underline the formal character of the lithic tool types, the term formal tool is used in current research. In this paper the formal tools are categorised following the list compiled by Thorsten Uthmeier<sup>33</sup>, which is based on Bosinski<sup>34</sup> for the Middle Palaeolithic.

*Petrographic characterisation of quartzites (A. Pr.)*. Despite being the second most often used lithic raw material in European Palaeolithic, quartzite has not received the same geoarchaeological interest as flint and obsidian. This omission generates a serious loss of information and bias in understanding the reasons this material was used along the Palaeolithic. This is especially relevant in sites such as Troisdorf-Ravensberg with a lithic assemblage almost fully composed by quartzites.

The formal definition and characterisation of quartzite is difficult because the ambiguity of its very names in archaeological and geological literature. The term ›quartzite‹ refers to the mineralogical composition of the rock, in fact considering rocks with a quartz content of over ninety percent<sup>35</sup>. These authors also refer to characteristics such as the degree of granularity, conchoidal fracturing and strength of the material. They consider that the genesis of the material may be as wide as sedimentary or metamorphic. In recent years, some studies have been carried out on quartzite in archaeological deposits using geoarchaeological approaches<sup>36</sup>. They also emphasize the ambiguity of the term, which can refer to different kinds of geological origin, from clearly metamorphic to sedimentary.

The geo-archaeological analysis applied here constitutes a description of eleven artefacts of rock sampled from the complete assemblage. These items of rocks were prepared for thin section and they were analysed petrographically<sup>37</sup>. The main aims of this work are to understand the fea-

<sup>32</sup> M. K. H. Eggert, *Prähistorische Archäologie. Konzepte und Methoden* (Tübingen 2001) 134.

<sup>33</sup> Uthmeier, Micoquien (note 23).

<sup>34</sup> G. Bosinski, *Die mittelpaläolithischen Funde im westlichen Mitteleuropa*. *Fundamenta A4* (Köln und Graz 1967).

<sup>35</sup> J. L. Howard, The quartzite problem revisited. *Journal of Geology* 113, 6, 2005, 707–713; H. Skolnick, The quartzite problem. *Journal of Sedimentary Petrology* 35, 1, 1965, 12–21.

<sup>36</sup> A. Blomme et al., The characterization of sedimentary quartzite artefacts from Mesolithic sites, Belgium. *Geologica Belgica* 15, 3, 2012, 193–199; V. Cnudde et al., Preliminary structural and chemical study of two quartzite varieties from the same geological formation. A first step in the sourcing of quartzites utilized during the Mesolithic in northwest Europe. *Geologica Belgica* 16, 1–2, 2013, 27–34; C. L. Dalpra / B. L. Pitblado, Discriminating quartzite sources petrographically in the Upper Gunnison Basin, Colorado. Implications for Paleoamerican lithic-procurement studies. *PaleoAmerica* 2016, 1–10; B. L. Pitblado et al., LA-ICP-MS analysis of quartzite from the Upper Gunnison Basin, Colorado. *Journal of Arch. Sci.* 40, 4, 2013, 2196–2216; A. Pri-

eto, Procurement and management of quartzite in the Cantabrian Region. The Middle and Upper Palaeolithic in the Deva, Cares and Güeña valleys (Diss. País Vasco 2018); id. / I. Yusta / A. Arrizabalaga, Defining and characterizing archaeological quartzite. Sedimentary and metamorphic processes in the lithic assemblages of El Habario and El Arteu (Cantabrian Mountains, Northern Spain). *Archaeometry* 61, 1, 2019, 14–30; id., From petrographic analysis to stereomicroscopic characterisation. A geoarchaeological approach to identify quartzite artefacts in the Cantabrian Region. *Archaeological and Anthr. Sci.* 12, 2020; M. Roy Sunyer et al., Quartzite selection in fluvial deposits. The N12 level of Rocadels Bous (Middle Palaeolithic, southeastern Pyrenees). *Quaternary Internat.* 435, B, 2017, 49–60; I. Veldeman et al., Characterizing the hypersiliceous rocks of Belgium used in (pre-)history. A case study on sourcing sedimentary quartzites. *Journal of Geophysics and Engineering* 9, 4, 2012, 118–128.

<sup>37</sup> A. Prieto u. a., Petrological characterisation of the ›Tertiary quartzites‹ from the site of Troisdorf-Ravensberg (North Rhine-Westphalia, Germany). First insights in Middle Palaeolithic outcrop exploitation. *Quartär* 66, 2019, 33–50.

depth [m]	colour [Munsell]	grain size
<b>RAV-C3 (square A2; 96,6 m a,s,l)</b>		
0,00–0,39	10 YR 6/8	Su3
0,39–0,68	10 YR 5/8	Ut2
0,68–0,80	2,5 Y 6/4	Su2
0,80–1,35	10 YR 5/8	Ss
<b>RAV-C2 (square A3; 96,2 m a,s,l)</b>		
0,16–0,38	10 YR 7/6	Su2
0,38–1,02	10 YR 7/8	Uls
1,02	plant fragments	
1,02–1,85	10 YR 7/4	Su2
<b>RAV-C1 (square A7; 95,0 m a,s,l)</b>		
0,00–0,11	10 YR 6/6 to 6/8	Su3
0,11–0,18	2,5 Y 7/1 to 7/2	Su2
0,18–0,30	2,5 Y 7/1	Ss
0,30–1,00	2,5 Y 7/1	Su2

Table 1 Vibracore sediment cores of RAV-C1, RAV-C2 and CRAV-C3 with according division into sediment units based on field based description of colour (Munsell-colour schema) and grain size distribution, see Figure 15.

ments with lower resistivity.

The middle part (six to eleven metres) of profile Ravensberg I shows a remarkable anomaly, characterised by high resistivity sediments down to the lowermost levels. The anomaly is bounded by sharp vertical edges to the upper and lower part and is not visible on the surface. The anomaly runs some metres parallel to the actual road bank and represents therefore a limit of the excavation area in this direction. The high resistivity values suggest an infilling with sandy material, probably derived from the excavated surface material and deposited during operations for

	sand	silt	clay	vcSi	mS	>vcSi/mS
<b>Profile A3-North</b>						
Unit A	79,9	13,4	6,6	4,2	44,3	0,09
Unit B	73,0	19,9	7,1	9,0	35,6	0,25
Unit C	70,1	24,0	5,9	11,4	33,5	0,34
Unit D	47,7	40,5	11,8	17,8	18,6	0,96
<b>Profile C1-East</b>						
Unit A	67,7	22,8	9,5	8,6	30,8	0,28
Unit B1	78,4	14,7	6,8	6,6	39,4	0,17
Unit B2	87,8	8,2	4,0	3,8	46,2	0,08

Table 2 Grain size distribution of profiles A3-North and C1-East. – Sand 2000–63 µm, silt 63–4 µm, clay <4 µm, very coarse silt (vcSi) 32–63 µm, medium sand (mS) 250–500 µm. – The clay size fraction here includes the very fine silt (4–2 µm).

tures of the quartzites, describe their types, and try to understand the reasons humans used this site as a raw material procurement area. For an in-depth characterisation of the quartzites, a more robust description of their physical properties and to understand the formation condition of this rock<sup>38</sup>.

## Results

*Electrical Resistivity Tomography profiles (F.H.).* The geophysical prospection of the investigated area at the Ravensberg reveals a detailed sediment structure with undisturbed and disturbed parts. This coexistence is particularly visible in profile Ravensberg I, running from the Mauspfad upslope (Figure 6). Sediments with high resistivity (above 2000 ohm/m) occur within the first meter below surface above sediments with moderate resistivity (between 100 and 500 ohm/m). An anomaly is located at twelve to thirteen metres with higher resistivity in comparison to its surrounding. This anomaly could indicate a buried quartzite block within the tertiary silt and clay dominated sedi-

ments with lower resistivity. The undisturbed stratigraphy above this section, starting at an altitude of around 95 metres, was chosen for the excavation area.

Profile Ravensberg II shows a comparable stratification with high resistivity values at the surface and lower values in the subsurface, here at a depth of one to two metres. The high resistivity sediments are thicker towards the northwestern part of the profile at the crossing of both profiles. Another anomaly in the subsurface is indicated for the lower part of the northwestern part of the profile at around two and a half metres. The sediments show a more horizontal deposition with no indication of disturbance in the southeastern part of the profile.

The profile Ravensberg II shows that the anomaly identified in profile Ravensberg I only extends to a depth of one to two metres at this point, but

is likely to extend further northwest into the tertiary silt and clay. From an archaeological point of view, no finds are expected in the entire area. In this respect the situation in the southeast of the anomaly cannot be further assessed.

*Sediment stratigraphy (M. K.).* The sediment sequence exposed in the excavated squares was divided into five main geological units. Unit E at the base was exposed in excavation square A7 and consisted of marmorate whitish light grey to orange very densely packed silts and fine sands (Figure 9, profile A7-North). Several drill cores show that sediments of Unit E underlie excavated deposits in squares A2, A3 and A7 as well (Figure 15 and Table 1). Here, the sediment composition of Unit E varies between sands and silty sands up to a maximum depth of 1,85 metres below the final plana of excavation squares. They occur as partly layered marmorate whitish (bleached) and orange (oxidation) sediments with no indications of anthropogenic disturbance. These sediments are terrestrial deposits of the ›Köln-Schichten‹. Few stones and blocks of quartzite were intermixed testifying to reworking of the Oligocene or Miocene deposit by gelifluction during cold stages of the Pleistocene.

Sediments of Unit D were strongly to moderately compacted and had a light brown colour with light grey to orange brown veins and patches (Figures 7–10). Granulometry was either dominated by sand or silt and sediment texture was either sandy loam or loam. In profile A3-North silt and sand proportions were ranging between 40 to 52 percent and 37 to 47 percent, respectively, while the clay content (particles below 4 µm in diameter) ranged from 11 to 13 percent. The ratio between very coarse silt and medium sand attained an average value of 0,96 (Table 2), hence much higher than in the other investigated units which were dominated by sand. Unit D deposits formed the lower strata of profiles A1-North to C1-North in the northern transect of the excavation reaching a maximum thickness of about twenty centimetres (Figure 11). While they were also exposed in squares A1 to A3, they were absent in the southern profiles B1 and C1. The loamy sediments contained stones and blocks of tertiary quartzite. These admixtures and the fact that the grain size distribution within the level showed considerable variation in sand and silt contents (Figure 16) point to slope transport by gelifluction.

Unit C was a sediment lens, about twenty centimetres thick, which was rather homogeneous, both in respect to sediment colour and granulometry. The light yellowish grey deposits were clearly dominated by sand, but still showed averages of 24 percent of silt and about 6 percent

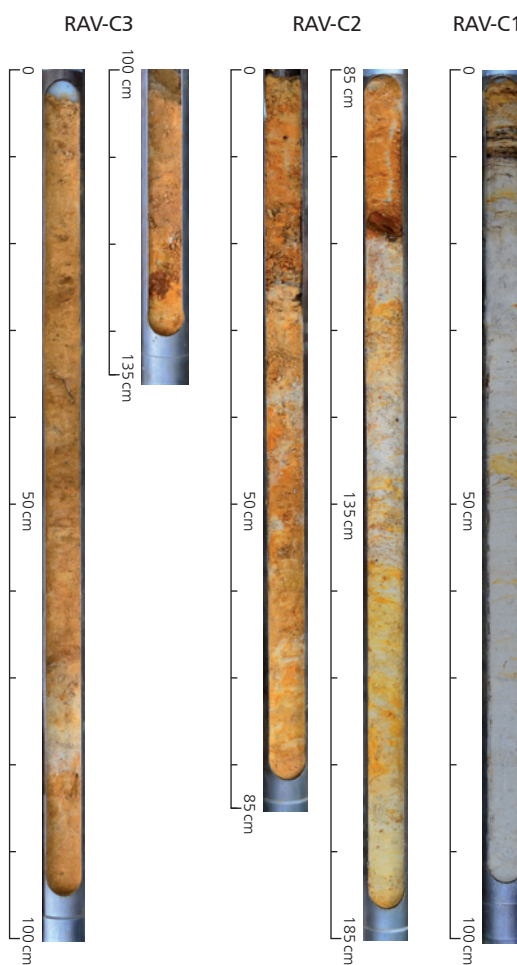


Figure 15 See Table 1.

<sup>38</sup> Prieto/Yusta/Arrizabalaga, Defining (note 36) 14–30.

of clay (Table 2). The lateral extent of this unit appeared to be quite limited to the A3 square. Other sediment packages either had less sand and more silt (Unit D) or more sand and less silt (sediments of units B and A).

In the course of the excavation the stratigraphic Unit B was identified as an archaeological find horizon due to its richness of prehistoric artefacts. But it has to be stated, that the large vertical distribution of the finds, that even extended into the neighbouring stratigraphic units, made a more detailed stratigraphic delimitation impossible. Samples extracted from Unit B showed a pronounced dominance of sand reaching maximum sand contents of about ninety percent in Subunit B2 within profile C1-East (Table 2, Figure 8). Towards the top of profile C1-East, the sand content slightly decreased and silt and clay contents increased (Figure 16). The sand was mostly of medium grain size. This unit showed a homogenous light brown to brown colour and moderate degree of compaction mostly exhibiting single grain to massive soil structure. In profile B2-South the sand was weakly compacted. Related with the local preservation of Unit C deposits, Unit B mostly covered Unit D sediments. In profile A3-North, Unit B had a brown colour, but showed large inclusions of dark grey sediment rich in organic matter intermixed from the humic deposits of Unit A on top of Unit B (Figure 7).

Unit A consisted of sandy either dark grey sediments rich in humus or of sandy to loamy brown sediments. The boundary of Unit A towards the underlying strata was often sharp and locally several superimposed packages of grey and brown sediments were found such as in profile A1-West or in profile C1-East. Unit A deposits covered the whole downslope profile. Downwards

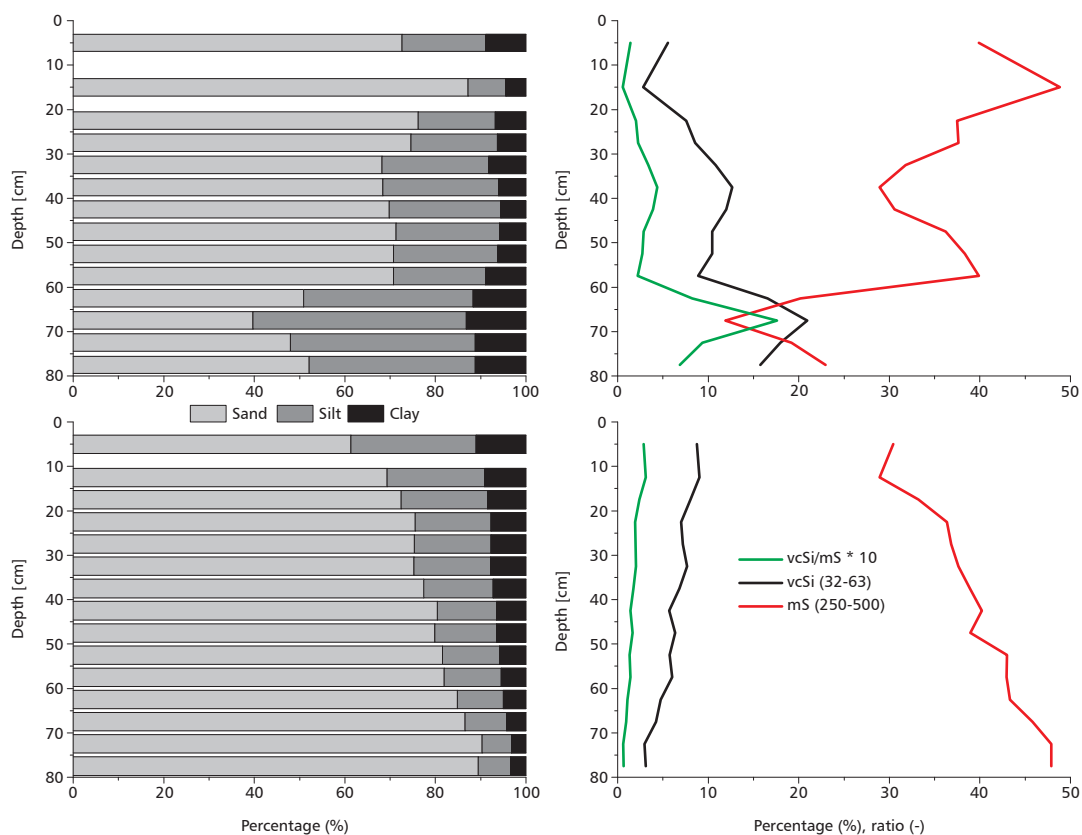
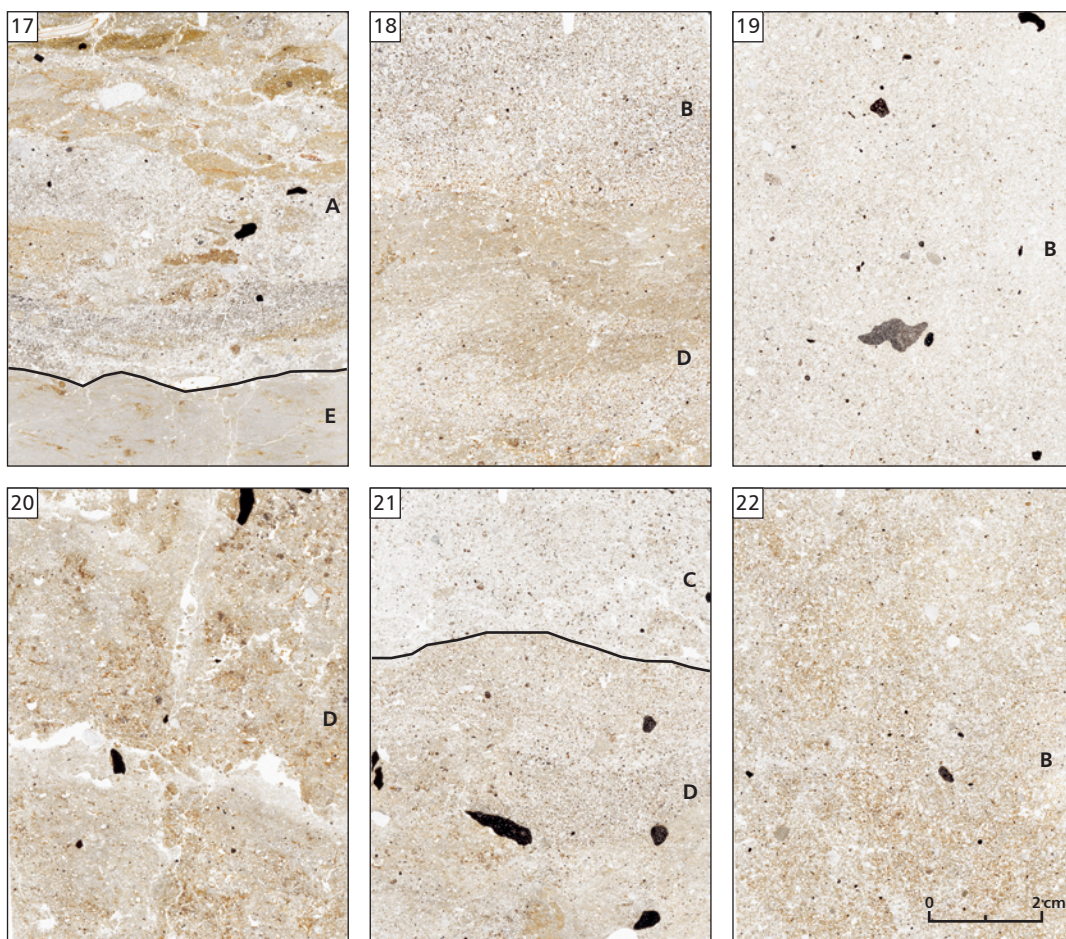


Figure 16 Grain size distribution of profiles A3-North (upper row) and C1-East (lower row) showing the proportions of sand, silt and clay as well as the contents of very coarse silt (vcSi) and medium sand (mS) and the ratio between those parameters.



Figures 17–22 Flatbed scans of selected thin sections. (17) Thin section OV 15/66-8 from profile A7-E showing Unit E topped by several microlayers of Unit A deposited during or after road construction; (18) layered sediments of Unit D topped by clay enriched lower part of Unit B (thin section OV 15/66-6, profile A1-N); (19) sand-rich deposits of Unit B with few fine gravel (thin section OV 15/66-4, profile A1-N); (20) lower part of the loamy deposits of Unit D showing abundant pedofeatures of redoximorphic mottling and clay illuviation (thin section OV 15/66-3 from profile A3-N); (21) sharp boundary between Units C and D (thin section OV 15/66-2, profile A3-N); (22) darker coloured lower part of Unit B with abundant clay illuviation pedofeatures (thin section OV 66-5, profile A1-N).

of square A3, sediments of Units B, C and D were not clearly identified. In this lower part of the profile, the original sediments were probably mixed during road construction.

While stones and boulders were observed in low abundance in all units, a concentration of large boulders was observed in squares A3 and A4. During excavation, the long axes of these boulders did not show obvious preferential orientation. Upslope of the boulder-rich part, sediments were oriented in a sub-horizontal way, probably parallel to a gently inclined palaeoslope and possibly trapped upslope of the boulders. The embankment of the modern road intersected into the sequence exposing the underlying Oligocene/Miocene deposits of Unit E near the surface in squares A5 and A7.

*Micromorphology (M.K.).* The thin sections (ts) showed specific micromorphological features for each sedimentary unit. The silt rich deposits of Unit E (lowermost part of ts OV15/66-8, Figure 17) had a massive, partly platy microstructure with few horizontal to sub-horizontal planes and vughs

labor. no.	sample	unit	n	Od (%)	$\delta$ Od	CAM De (Gy)	$\delta$ De*	MAM De (Gy)	$\delta$ De*	$\dot{D}$ (Gy/ka)	$\delta\dot{D}$	CAM Age (ka)	$\delta$ Age	MAM Age (ka)	$\delta$ Age
C-L3999	RAV-1	C	40	26	5	65,62	3,44	48,06	5,25	1,92	0,14	34,19	3,06	25,04	3,28
C-L4000	RAV-2	D	55	28	4	84,08	4,00	58,35	5,29	2,50	0,18	33,59	2,94	23,31	2,72
C-L4001	RAV-3	B,1	32	54	8	4,81	0,49	2,70	0,34	1,55	0,11	3,10	0,39	1,74	0,25
C-L4004	RAV-6	D	42	32	5	90,64	5,34	59,95	6,14	2,37	0,17	38,31	3,61	25,34	3,19

Table 3 Luminescence equivalent dose values calculated from n aliquots using the central age model (CAM) and minimum age model (MAM). Uncertainties are cited at  $1\sigma$ . Environmental dose rates  $\dot{D}$  were calculated using DRAC v.1 by means of radioisotope concentrations summarised in Table 4. See Figure 4 for the exact position of the sampling. – (\*) Uncertainties are calculated at  $1\sigma$ .

(Figures 23 and 26). The groundmass showed a coarse monic and locally close porphyric coarse to fine related distribution pattern (c/f rdp) and a grey micromass with dotted limpidity and stipple-speckled to parallel striated birefringence fabric (b-fabric). The coarse material mainly consisted of quartz grains and very few mica particles. Pedofeatures comprised few typical iron hydroxide nodules and elongated concentrations of illuvial clay. Furthermore, silt patches occurred.

The sandy loams and loams of Unit D were covered in ts OV<sub>15/66-2</sub>, 66-3 and 66-6 (Figures 18, 20 and 21). The granulometric composition of the sediment was spatially heterogeneous with pockets or discontinuous microlayers of sand adjacent to fine grained parts (Figures 17–22 as well as 29 and 32). The degree of compaction was quite variable, too. Pore space in the upper part was dominated by simple packing voids, while few vughs, burrows and channels occurred as well. The latter two pore types are biogenic. Microstructure was dominantly single grain and locally massive. In the lower part (OV<sub>15/66-3</sub>) many large burrows and planes were found and the sediment was less densely packed. Here, microstructure was spatially diverse and classified as single grain, spongy or weakly developed subangular blocky types. The groundmass showed a coarse monic or close porphyric c/frdp, while the micromass was grey to brown with dotted limpidity. A weakly to clearly developed stipple-speckled b-fabric was observed. The coarse material consisted of quartz and quartzite grains, while much less feldspar and mica was identified. Few ferricrete fine gravel occurred as well. Organic remnants were not identified. Pedofeatures consisted of few typical and many dendritic iron hydroxide nodules as well as diffuse impregnations with iron hydroxide. In the lower part, iron depletion pedofeatures were common. A peculiar feature were abundant thin brown to dark brown dusty clay coatings in pores, often well laminated and showing nicely preserved crescent shape (Figures 35–38). In the lower part these had a lighter colour and were locally intercalated with iron hydroxide coatings. The clay coatings did not show mechanical disruption.

Unit C deposits were covered in ts OV<sub>15/66-1</sub> and 66/2 (Figure 21). The sandy sediment was rich in silt grains (Figures 30 and 33) and showed a moderately high porosity consisting mainly of simple packing voids. Microstructure was coarse monic. Micromass was very rare, therefore, the c/frdp and b-fabric were not assessed. The coarse material mainly consisted of quartz and quartzite grains while much less feldspar and mica particles were observed. Few fresh plant roots were present as well. Pedofeatures were very rare comprising very few typical iron hydroxide nodules and very few thin dusty clay coatings.

Unit B was represented in ts OV<sub>15/66-1</sub>, 66-4 (Figure 19), 66-5 (Figure 22), 66-6 (Figure 18) and 66-7. The porosity was high to very high and most pores were simple packing voids, while very few burrows or vughs occurred as well. The microstructure was single grain (Figures 25

labor no.	sample	unit	U (ppm)	$\delta U$	Th (ppm)	$\delta Th$	K (%)	$\delta K$	grain size (?m)	depth (m)	$\delta$ depth
C-L3999	RAV-1	C	1,54	0,08	5,74	0,29	1,11	0,02	100–150	0,45	0,02
C-L4000	RAV-2	D	2,52	0,13	8,61	0,51	1,32	0,02	100–150	0,65	0,02
C-L4001	RAV-3	B,1	1,12	0,06	3,70	0,21	0,94	0,02	100–200	0,30	0,02
C-L4004	RAV-6	D	2,13	0,11	7,65	0,45	1,33	0,02	100–150	0,65	0,02

Table 4 Radioisotope concentrations and other variables for environmental dose rate calculation. A water content of  $10 \pm 10\%$  and an overburden density of  $1.6 \pm 0.16$  g cubic centimetres were assumed. Samples were located at an altitude of 98 m at  $50.824840^\circ N$ ,  $7.165679^\circ E$ . See Figure 6 for the exact position of the sampling.

and 28) and, in presence of illuvial clay, also chitonic/gefuric (Figures 31 and 34). These types also hold for the c-f rdp. Due to a very limited amount of micromass that was not consisting of illuvial clay, the b-fabric was not determined. The coarse material was dominated by quartz and quartzite grains and minor amounts of feldspar and mica. Pedofeatures were rare. They included very few to few typical iron hydroxide nodules finely dispersed over the groundmass. In thin sections from the lower part of Unit B in squares A1 and A3 many limpid or dusty finely laminated clay coatings occurred in pores and as grain coatings (Figures 31 and 34). The dark colour of the coatings showed inclusion of finely dispersed organic matter. The clay coatings were best expressed in ts OV15/66-6. The Unit B deposit exhibited in ts OV15/66-7 was peculiar. It showed very few signs of pedogenesis represented by very few small typical iron hydroxide nodules, very thin dusty clay coatings in pores and on grains as well as very few excrements. In contrast, excrements were more abundant in thin section OV15/66-4 from the uppermost part of Unit B.

The upper part of ts OV15/66-8 showed a sequence of thin sediment layers (Figure 17). The first one from the bottom to the top comprised one and a half centimetre thick dark brown loamy sands rich in amorphous organic matter and intensively bioturbated as indicated by high porosity and abundant excrements. This layer was overlain by loamy sand, about three centimetres thick, subdivided into layers with different concentrations of iron hydroxides or illuvial clay. The uppermost layer, two and a half centimetres thick, consisted of strongly compacted clay-rich loam with sand pockets.

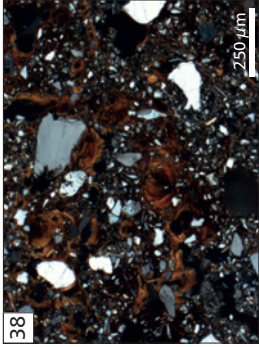
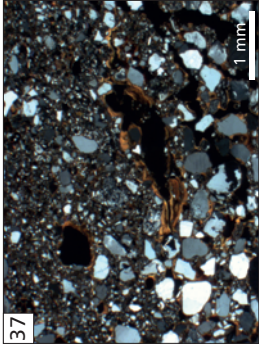
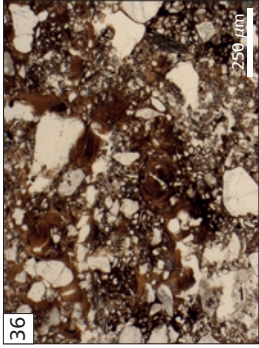
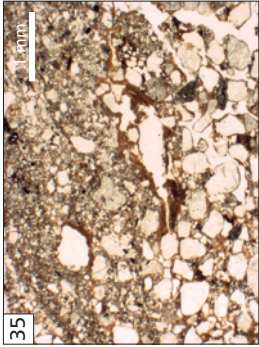
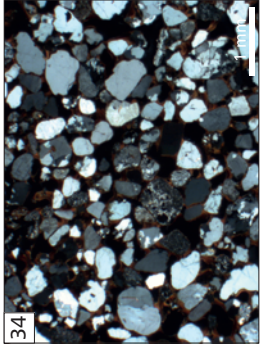
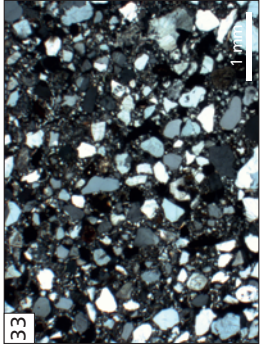
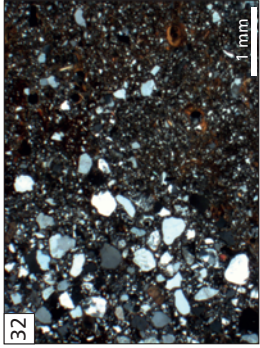
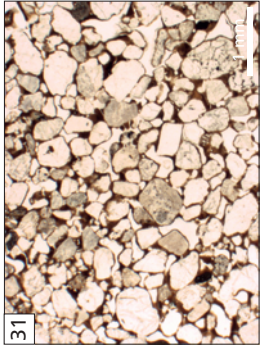
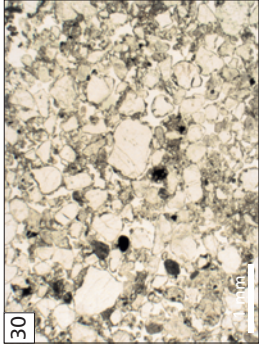
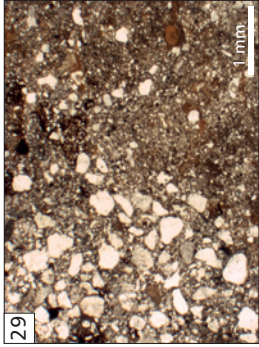
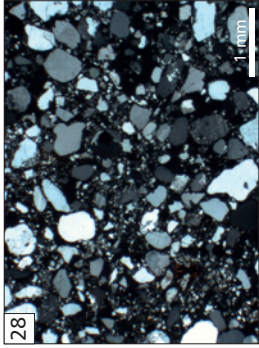
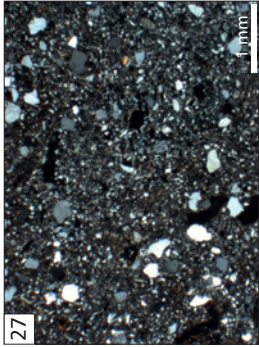
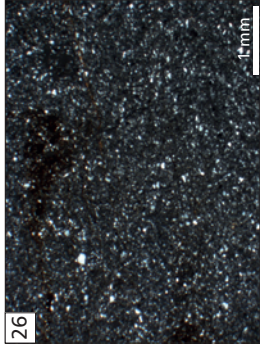
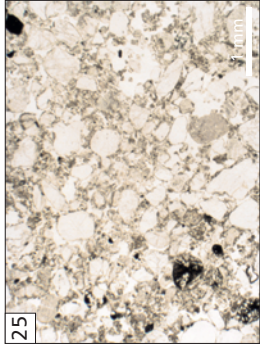
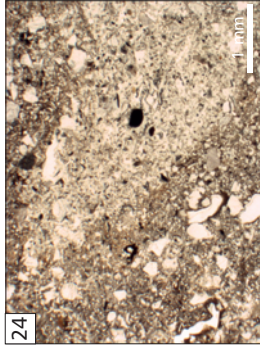
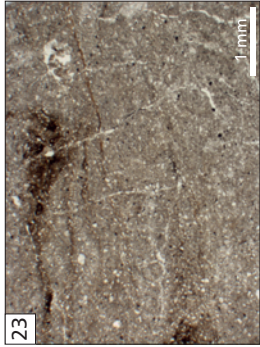
This sequence of microlayers represents a good example of anthropogenic sediments accumulated and compacted during or after road construction.

The granulometric characteristics of the different units are well represented by the micrographs captured under CPL displaying an increase in number of sand grains from Unit E (Figure 24) towards Unit D (Figure 27), Unit C (Figure 33) and finally Unit B (Figure 28).

*OSL-Dating (G. K.).* The luminescence properties of the Troisdorf-Ravensberg samples were favourable and a minimum of 32 aliquots was accepted for each sample. Overdispersion values ranged from 54 percent for sample RAV-3 to 26 percent for sample RAV-1, indicating that the samples may be affected by partial resetting (Table 3). In Figure 40 plots of the single  $D_e$ -values are shown<sup>39</sup>. As partial bleaching could potentially lead to age overestimation, equivalent dose values and ages were calculated using both the central age model and the minimum age model

<sup>39</sup> All plots in Figure 40 are drawn using the plot\_AbanicoPlot function, see M. Dietze / S. Kreutzer, plot\_AbanicoPlot(): Function to create an Abanico Plot. Function version 0.1.11. In: S. Kreutzer et al. (eds.), Luminescence:

Comprehensive Luminescence Dating Data Analysis. R package version 0.9.7. <https://CRAN.R-project.org/package=Luminescence>. The function is included in the R Luminescence package. Cf. the following note.



Opposite page: Figures 23–34 Micrographs showing various characteristics of the groundmass. (23) Massive, partly platy microstructure and fine-grained groundmass in silty deposits of Unit E (ts OV<sub>15/66-8</sub>). Note the dark brown iron hydroxide nodule in the upper part of the micrograph; (26) same as (23), but circular polarised light (CPL); (29 and 32) abrupt textural change in groundmass of Unit D (PPL and CPL, thin section OV<sub>15/66-2</sub>); (24 and 27) typical groundmass of Unit D (PPL, CPL, thin section OV<sub>15/66-3</sub>), note the wedge-shaped light coloured part to the right resulting from loss of iron hydroxides; (30 and 33) typical groundmass of Unit C showing a larger abundance of silt grains and fines (OV<sub>15/66-2</sub>, PPL and CPL) compared to Unit B; (25 and 28) sandy groundmass of Unit B with limited amounts of silt and micromass (OV<sub>15/66-4</sub>, PPL and CPL); (31 and 34) chito-gerfucic microstructure related to illuviation of clay in the lower part of Unit B (OV<sub>15/66-6</sub>, PPL, CPL). – Figures 35–38 Selected pedofeatures of unit D: (35 and 37) abrupt textural change and well-laminated clay coatings (OV<sub>15/66-6</sub>; PPL, CPL); (36 and 38) clay coatings and dark brown to black precipitates of iron hydroxides forming nodules (OV<sub>15/66-3</sub>; PPL and CPL).

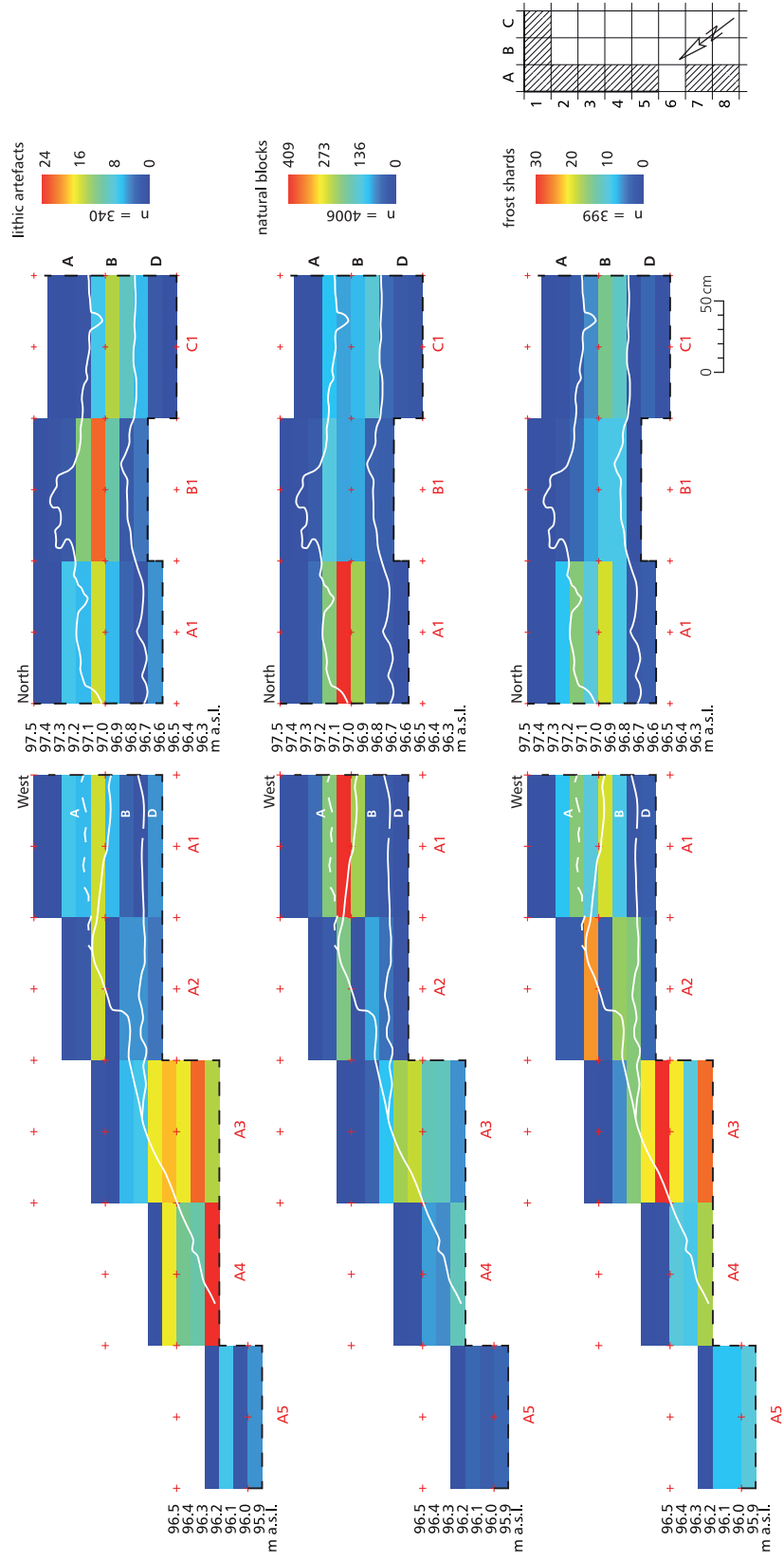


Figure 39 Vertical distribution of lithic artefacts, natural blocks and frost shards. Matrix plot compiled with PAST software package 3.18.

flake	346
debris	18
natural blocks	36
frost shard	2
pebble	1
blade	8
siret	4
indet.	3
<b>total</b>	<b>418</b>

Table 5 Compilation of blank types.

(Table 3). Using DRAC v.1.2, environmental dose rates were calculated<sup>40</sup> and are listed in Table 4. A water content of  $10 \pm 10$  percent and an overburden density of  $1,6 \pm 0,16$  gram centimetres<sup>-3</sup> were assumed.

*Vertical distribution of lithic artefacts (A.P.).* In the course of the excavations, Unit B was identified as the stratigraphic unit with the greatest number of lithic artefacts. This is to be quantified here by detailed analyses of the vertical distribution of the finds and thus verified. For this, the vertical distribution is investigated in order to separate areas with a high density from those that contain few or no finds. This analysis can be done by either plotting every single item or groups of them. Since the finds in Troisdorf-Ravensberg were not documented in their position individually, but assigned to artificial removals, the question can only be studied by

the analysis of the quantitative density per removal, which corresponds to a square cuboid of one by one metre and ten centimetres height. For the investigations in the two connected square rows there are available A1–C1 and A1–A5 340 artefacts, 4006 natural blocks and 399 frost shards with clear stratigraphic classifications.

The result of the distribution analysis shows two clearly separated areas for all three above mentioned find categories (Figure 39)<sup>41</sup>: four square meters on the plane (A2 and A1–C1) and three on the embankment of the road (A3–A5). While the finds on the plane concentrate on a more or less horizontal area of thirty to forty centimetres thickness, no comparable pattern can be seen in the embankment of the road area. Here the finds spread over a little more than seventy (A3) or forty centimetres (A4) with a vertical displacement of thirty to forty centimetres from the concentration on the plane area. In these two squares a special feature seems to have been recorded, the character of which has to be examined in more detail.

On the plane the highest density of lithic artefacts is located at an absolute height of 97,0–97,1 metres a.s.l. (A2, A1 and B1) respectively 97,1–97,2 metres a.s.l. (C1). From there the finds spread irregularly in both vertical directions over ten to twenty centimetres. This diffuse distribution over a thickness of thirty to forty centimetres with a clear centre can best be explained by post-sedimentary repositioning. A former prehistoric living horizon is not recognizable. This distribution corresponds mostly with the one of the stratigraphic Unit B, which during the excavation was considered the archaeological find horizon. But the study also shows that the finds are furthermore found in the other stratigraphic units.

The distribution of the natural blocks and the frost shards is almost identical to that of the lithic artefacts. Here, too, the centre lies in the range between 97,0 and 97,1 metres a.s.l. with a maximum vertical dispersion of thirty to forty centimetres.

The squares A3 and A4 on the embankment of the road show a completely different picture. Here the lithic artefacts, the natural blocks and the frost shards spread from the maximum excavation depth at 96,2 to 96,9 metres a.s.l. and thus end below the distribution range of the finds

	flint	quartz	t. qu.	slate	total
natural shard-edged block		1	4434		4435
natural round-edged block			21		21
frost shard			452		452
pebble	1	58	2		61
slab				5	5
total	1	59	4909	5	4974

Table 6 Compilation of natural product types. – (t. qu.) tertiary quartzite.

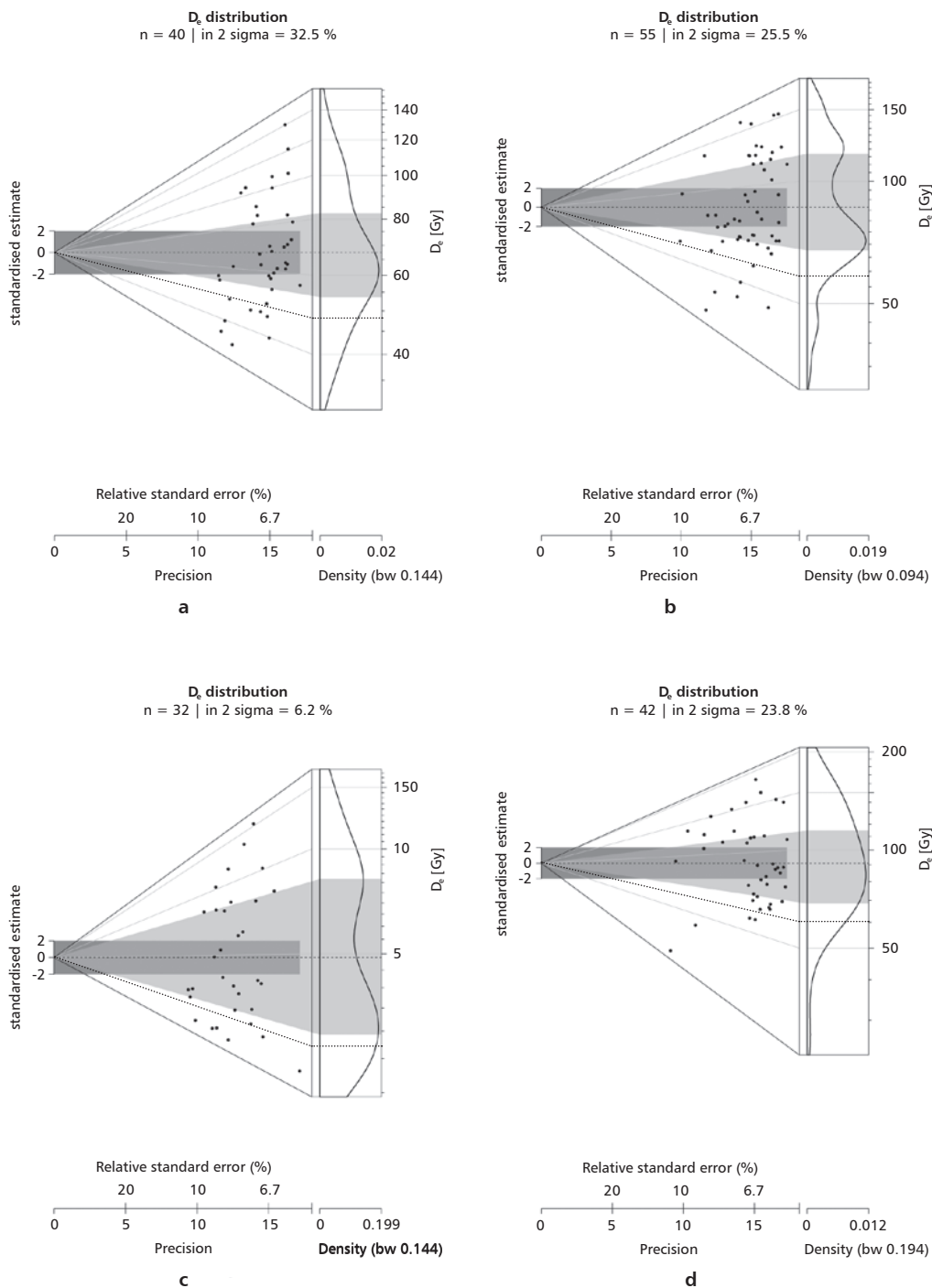


Figure 40 (a) Abanico plot of RAV-1. The red line shows the MAM-3  $D_e$  value. The dark shaded box the 2 sigma limit around the central value (dashed line) and the light shaded box the interquartile range. (b) Abanico plot of RAV-2. The red line shows the MAM-3  $D_e$  value. The dark shaded box the 2 sigma limit around the central value (dashed line) and the light shaded box the interquartile range. (c) Abanico plot of RAV-3. The red line shows the MAM-3  $D_e$  value. The dark shaded box the 2 sigma limit around the central value (dashed line) and the light shaded box the interquartile range. (d) Abanico plot of RAV-6. The red line shows the MAM-3  $D_e$  value. The dark shaded box the 2 sigma limit around the central value (dashed line) and the light shaded box the interquartile range.

on the plane. Probably the massive natural blocks found in A3 and A4 with edge lengths of more than half a metre are related to this unclear image. Their chaotic placement and the reduced space for sediments do not provide the condition for the formation of a horizontal distribution of finds.

*Anthropogenic selection of natural raw material pieces and the transformation of blanks (A. P.).* The raw material spectrum of the 5392 lithic artefacts and natural products is very homogeneous and clearly shows the anthropogenic procurement strategies with a focus on the local Ravensberger tertiary quartzite. All 418 lithic artefacts are made from this raw material. In addition, the compilation of blanks shows that the local tertiary quartzite was processed on the spot (Table 5). This is indicated by the high number of flakes and blades. The fact that debris was also found (eighteen pieces) can be explained by the assumption that there is no in-situ conservation or that sorting by post-sedimentary processes has taken place.

The raw material spectrum of the natural products on the one hand reflects the presence of the local tertiary quartzite (natural blocks and frost shards), on the other hand the immediate spatial proximity to the middle terrace of the Rhine (quartz pebbles and slate slabs) (Table 6). The round-edged block fragments are also made of local tertiary quartzite and testify to weathering processes, probably based on in-situ silica dissolution.

As described above, the lithic artefacts make up only a small part of the excavated assemblage. By far the largest part consists of natural products without any evidence of anthropogenic use. These natural blocks and frost shards make up about 92 percent ( $n=4974$ ) of the 5392 excavated finds. Due to the non-selective documentation and analysis of the above-mentioned natural products, it is feasible to investigate possible patterns in the anthropogenic selection of raw material pieces.

A first sample shows the negative selection of frost shards for further processing. They were only processed in two cases (0,4 percent of the frost shards)<sup>42</sup> (Figure 43). The 452 frost shards without processing marks have a weight of 1 to 3096 gram (mean 51,9 gram, std. error 7,9 gram, median 11 gram). The right-skewed distribution (skewness 13,3) testifies to the dominance of the light frost shards. The two processed frost shards weigh 1099 and 3283 gram and belong to the three heaviest pieces of the Troisdorf-Ravensberg assemblage. It can be stated that frost shards were not of interest for further processing and if they were, then from a weight of more than one kilo.

The interest in natural blocks was also very focused. Of the 4471 natural blocks, a total of thirty-six pieces were further processed (0,8 percent), 4435 were disregarded. The processed natural blocks were tested or configured to cores. The unprocessed natural blocks are relatively light. They weigh between 1 and 13.550 gram (mean 50,9 gram, std. error 5,9 gram, median 5 gram) and show a strong right skewness in the distribution (skewness 24,7). Thirty-five unprocessed natural blocks weigh more than one kilo (0,1 percent of natural blocks without processing).

Among the processed natural blocks, the configured cores dominate. The twenty-seven pieces weigh between 61 and 3525 gram (mean 951,1 gram, std. error 202,3 gram, median 526 gram) with

<sup>40</sup> J. A. Durcan / G. E. King / G. A. T. Duller, DRAC. Dose Rate and Age Calculator for trapped charge dating. *Quaternary Geochronology* 28, 2015, 54–61.

<sup>41</sup> On the PAST software package 3.18 see Ø. Hammer / D. A. T. Harper / P. D. Ryan, PAST. Paleontological Statistics software package for education and data analysis. *Palaeont. Electronica* 4, 1, 2001, 1–9.

<sup>42</sup> On the mechanical recording see A. Pastoors / G. C. Weniger, Graphical documentation of lithic artefacts:

traditional hand craft versus 3-D mechanical recording. In: R. Macchiarelli / G. C. Weniger (eds.), *Pleistocene databases: acquisition, storing, sharing*. *Wiss. Schr. Neanderthal Mus.* 4 (Mettmann 2011) 9–18. – On the software Artefact Viewer see D. Wickerth / A. Pastoors / D. M. Laurentius et al., *Artefact Viewer. A 3D tool for archaeologists*. In: University of Granada / Virtual Archaeology Spanish Society/Virtual Archaeology International Network (eds.), *Digital Heritage* (2015) 1–4.

	flake	debris	nat. bl.	frost sh.	pebble	blade	siret	indet.	total
borer	1								1
denticulate piece								1	1
edge retouched piece	1								1
bifacial backed knife								1	1
side scraper	1		1						2
hammer stone					1				1
tested piece			8	2					10
core	2		27					1	30
non-retouched	340	18				9	4		371
total	344	18	36	2	1	7	4	3	418

Table 7 Compilation of transformed blanks. – The bifacial backed knife is of the Klausennische-type.

a slight right oblique distribution (skewness 1,4). Seven of the cores weigh more than one kilo (25,9 percent of the cores).

In addition to the cores mentioned, there are eight tested pieces. They have a weight of 39 to 5500 gram (mean 1511,1 gram, std. error 596,5 gram, median 1165 gram) and a slightly right-angled distribution (skewness 2,3). Five of the tested pieces weigh over one kilo (62,5 percent of the tested pieces).

Finally, only one single natural raw material piece (42 gram) was processed directly into a formal tool (Figure 53 c).

Overall, it can be noted that the proportion of further processed frost shards and natural blocks is very low. The values are 0,4 percent of frost shards and 0,8 percent of natural blocks. If pieces from these two natural forms were selected for further processing, it were the heavy pieces weighing between one kilo and five and a half kilo (25,9 percent of the cores, 62,5 percent of the tested pieces and all the frost shards).

The variety of blanks shows an interesting pattern (Table 7). In addition to flakes, which dominate the overall assemblage with 344 pieces, natural blocks were integrated into the stone processing. Debris is very rare at a site where stones were probably worked on site. What is remarkable about this composition is the fact that the flakes were hardly processed any further. Only five of them are to be mentioned here: three were transformed into formal tools and two served as cores. With the exception of the few undetermined blanks, all other pieces have not been further processed. It is already apparent at this point of the investigation that the focus of stone processing in Troisdorf-Ravensberg was on the production of blanks, or cores.

The metric values of the lithic artefacts are distributed unequally. In length the pieces vary between 2 and 263 millimetres (mean 50 millimetres, std. error 2,05 millimetres, median 37 millimetres). The weight ranges from 1 to 5500 gram (mean 141,3 gram, std. error 24,2 gram, median 10 gram). Overall, the high maximum values of length and weight are noticeable. A total of fourteen lithic artefacts weigh over one kilo, over half a kilo there are twenty-seven pieces.

*Concepts of core configurations (A. P).* Altogether, the thirty cores and a number of blanks as technological markers from Troisdorf-Ravensberg provide a good basis for investigating the human technological behaviour applied here with its broad range of different lithic reduction strategies (Table 8). The figures 41–52 and 54 a and b represent examples of the identified concepts and methods and their stages of processing.

	flake	nat. bl.	indet.	total
recurrent centripetal		4		4
recurrent unidirectional		3		3
preferential		1		1
discoid		1		1
kombewa	2			2
opportunistic flake		13	1	14
opportunistic blade		5		5
total	2	27	1	30

Table 8 Compilation of lithic reduction strategies. – (nat. bl.) natural block.

Besides the surface recurrent methods (unidirectional and centripetal), the preferential discoidal method, the Kombewa method and most of all opportunistically reduced cores were observed. Of these the recurrent unidirectional and centripetal type are predominant in Troisdorf-Ravensberg (respectively three and four pieces each). One core of the preferential type, one discoid core, and two Kombewa cores complete the spectrum of core configuration. Opportunistically reduced cores (nineteen pieces) can be divided into blade (five pieces) and flake (fourteen pieces) subtype. The here reported spectrum comprises only a part of the known concepts and methods for lithic production<sup>43</sup>. As no conceptual blade or bladelet production is documented in Troisdorf-Ravensberg the lithic production systems are focused on flake production.

Initialisation of the raw material pieces: A condition for the successful core configuration is the selection of the adequate raw material pieces. Whether humans have taken a raw material piece into consideration becomes archaeologically visible only when transformations have been made. In concrete terms, parts of the raw material pieces would have to have been removed in order to test the quality and prepare them for further processing. There are ten artefacts representing this stage in the assemblage (eight natural blocks and two frost shards). The main characteristic of these pieces is the low number of negative flake scars visible on their surfaces, sometimes only one or two. The location of these scars on the pieces proves an opportunistic approach, because only naturally given configurations of angles and convexities served for knapping. Their surfaces provide no cortex (five pieces), cortex (one piece) or wind polish (four pieces).

With one exception, these pieces representing the initialisation stage are relatively voluminous and heavy. Their maximum lengths are between 158 and 263 millimetres. The pieces weigh between 557 and 5500 gram, with only two pieces weighing less than one kilo (mean 1647 gram, std. error 506 gram, median 1165 gram). The exception is one small piece with maximum length of 39 millimetres and weight of 39 gram.

It is to be assumed that flakes from the initialisation stage are also present, whereby the archaeological visibility seems difficult. For the investigations in this respect, flakes are considered which cannot be assigned to any of the subsequent stages in the operation sequences. There are 271 of them in the assemblage. Of these, nine pieces have a cortex proportion of over fifty percent. These flakes probably represent the initialisation stage with a large proportion of the former raw material piece surface. However, most of the flakes have less (twenty-six pieces) or no cortex at all (229 pieces) on their surfaces. For these pieces a reliable attribution is not possible. The nine flakes of the initialisation stage have maximum lengths of 22 to 50 millimetres (mean 39 millimetres, 42 millimetres median). Unfortunately, the small number does not allow a further search for possible features that suggest human behaviour patterns.

<sup>43</sup> Delagnes/Meignen, France (note 26).

Configuration of the cores: After the selection and initialisation of the adequate raw material pieces, the cores are configured according to the desired concepts. Blanks from this working stage are seen as evidences for all features of the core configuration: setting up the reductions surface as well as the striking platforms, preparing the lower core side and core flanks. Not all of them can be clearly identified in the flaking material. However, there are characteristic features of blanks that occur during certain working stages (Table 9). Short-width flakes with massive and triangular cross-sections change the angle between two surfaces, and long-width flakes with asymmetric triangular cross-sections process lateral convexity (*débordant*). Triangular blanks in outline, with the tip not in direct extension of the impact axis, provide lateral convexity, while maintaining the central mass of the surface to be processed. Another indicator for the presence of this stage of core configuration is the still high proportion of the initial raw material piece surface (cortex, wind polish, fissure etc.).

Unfortunately, blanks from the stage of core configuration cannot be precisely assigned to the core configuration systems documented in Troisdorf-Ravensberg because they would fit into all of them.

In the assemblage a total of forty-one blanks of the core configuration stage could be identified. These include three long-width flakes with asymmetric triangular cross-sections (Figure 42 a), four core-edge flakes and blades (Figure 42 b–d) and thirty-four short-width flakes with massive and triangular cross-section blanks for modifying the edge angle (Figure 42 e and f). The *débordant* flakes show different amounts of wind polish and cortex. On their striking platforms there is the cortex or parts of a large negative flake scar. The core-edge flakes and blades provide also cortex remains on their dorsal surfaces and their striking platforms document also little effort in preparation. The short-width flakes with massive and triangular cross-section have a relatively high proportion of wind polish or cortex. Fifteen pieces show more than fifty percent of initial raw material piece surface. As with the *débordant* flakes and the core-edge flakes and blades, the striking platforms are mainly flat or covered with cortex. The presence of *dièdre* and ridge-shaped types of striking platforms testify the change of the edge angle.

Exploitation of the configured cores: Based on the configuration of the cores, the exploitation of the corresponding volumes follows. To this exploitation stage that is conceptually most tangible can be assigned a total of fifty-two pieces, thirty cores and twenty-two flaking products. Among the cores, opportunistic methods including *Kombewa* dominate. Also important are recurrent, preferential and discoid methods, which could be identified among the cores as well as the flaking products.

The recurrent centripetal as well as unidirectional methods were observed in the assemblage from Troisdorf-Ravensberg, although its application appears heterogeneous.

The four cores configured according to the recurrent centripetal method show this diversity very well. Their lower surfaces serve as striking platform for the preparation of the reduction surface. The four pieces consist of plane fissure surface, natural pebble surface partly with single negative flake scar of the preparation or completely prepared surfaces. The distal as well as the lateral convexity of the reduction surface is ensured by centripetal end products, lateral preparation and the integration of natural surfaces. Coarse faceting, single negative flake scar or natural surface serve as striking platform (Figures 41 a and b as well as Figure 44). Of the four cores two fulfil the condition of almost complete intentional transformation of the core configuration components

	flake	blade	siret	total
long-width flakes	3			3
short-width flakes	33		1	34
core edge blank	2	2		4
total	38	2	1	41

Table 9 Characteristic blanks from the core configuration. – The long-width flakes have an asymmetric triangular cross-section (*débordant*), the short-width flakes have a massive and triangular cross-section.

Figures 41–56 For the mechanical recording a 3-D metrology system smartSCAN 3D-DUO from Breuckmann GmbH with 90 millimetres objective with a special resolution of 50  $\mu\text{m}$  was used running with software OPTOCAT 2009 Rt. The artefacts were rendered and lighted with the software Artefact Viewer in a uniform colour with up to 4 light sources that can be set up individually by specifying its brightness and positions. The scale bar corresponds always to ten centimetres.

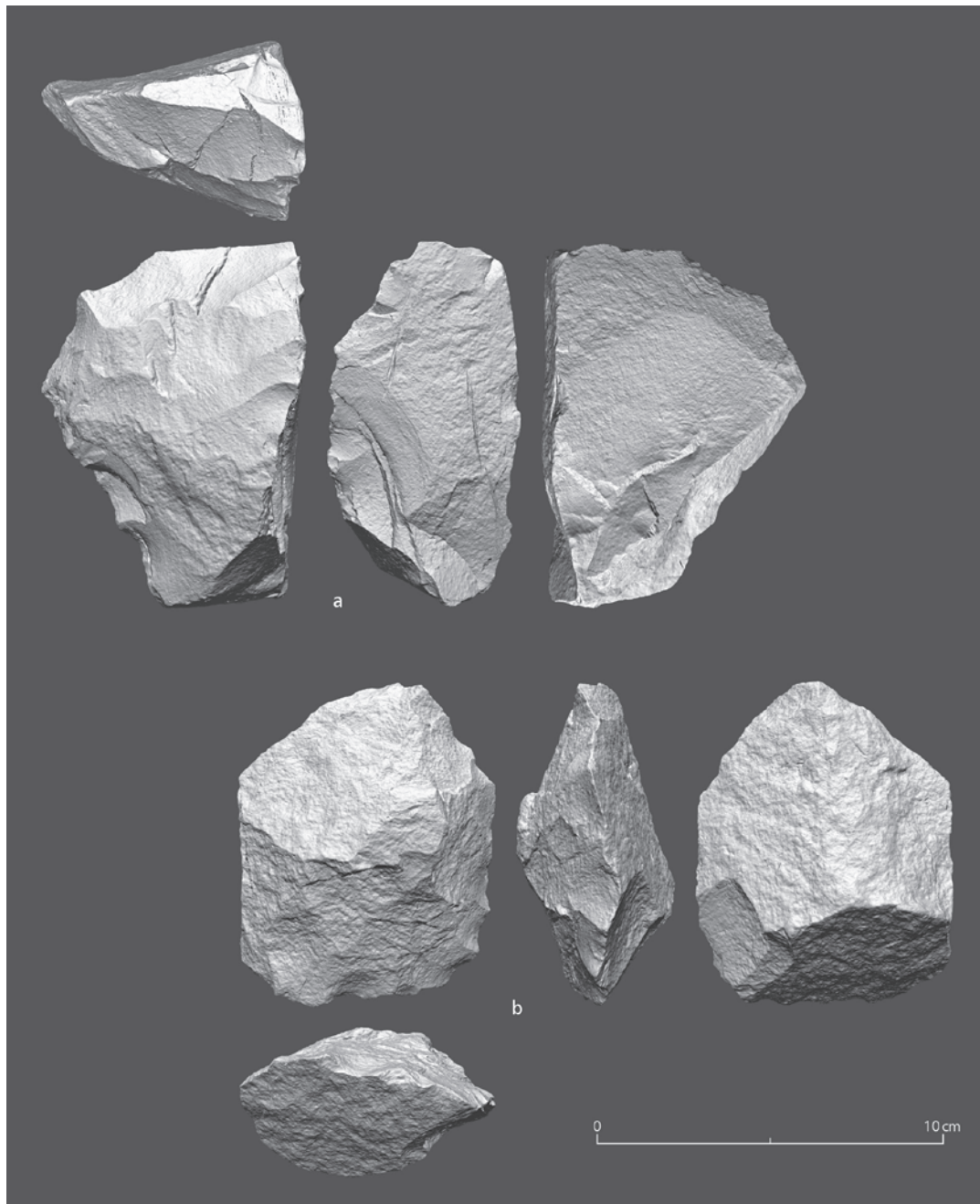
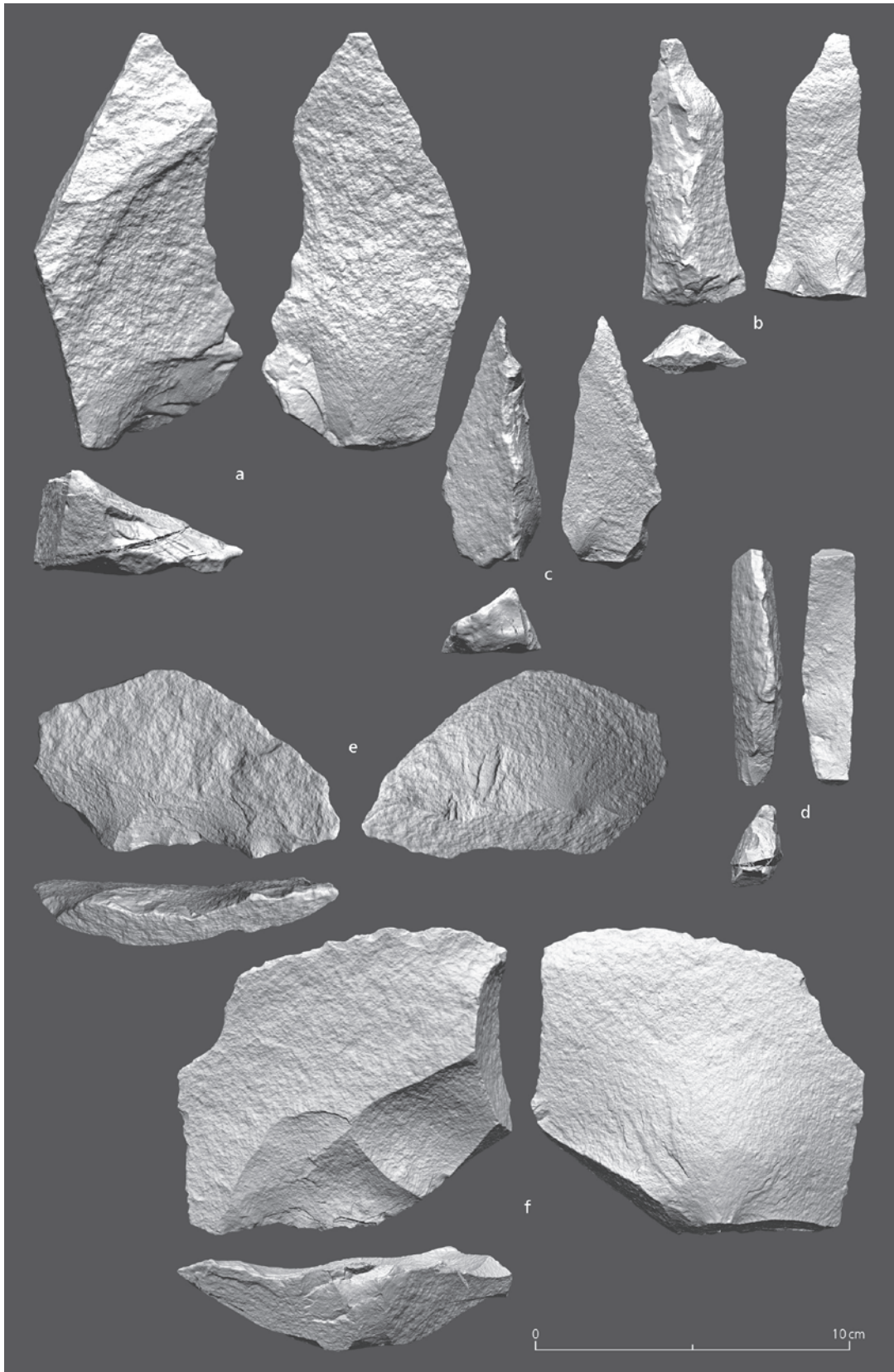


Figure 41 Cores configured according to the recurrent centripetal method.

Figure 42 (opposite page) (a) Long-width flakes with asymmetric triangular cross-sections; (b-d) core-edge flakes and blades; (e and f) short-width flakes with massive and triangular cross-section blanks for modifying the edge angle.



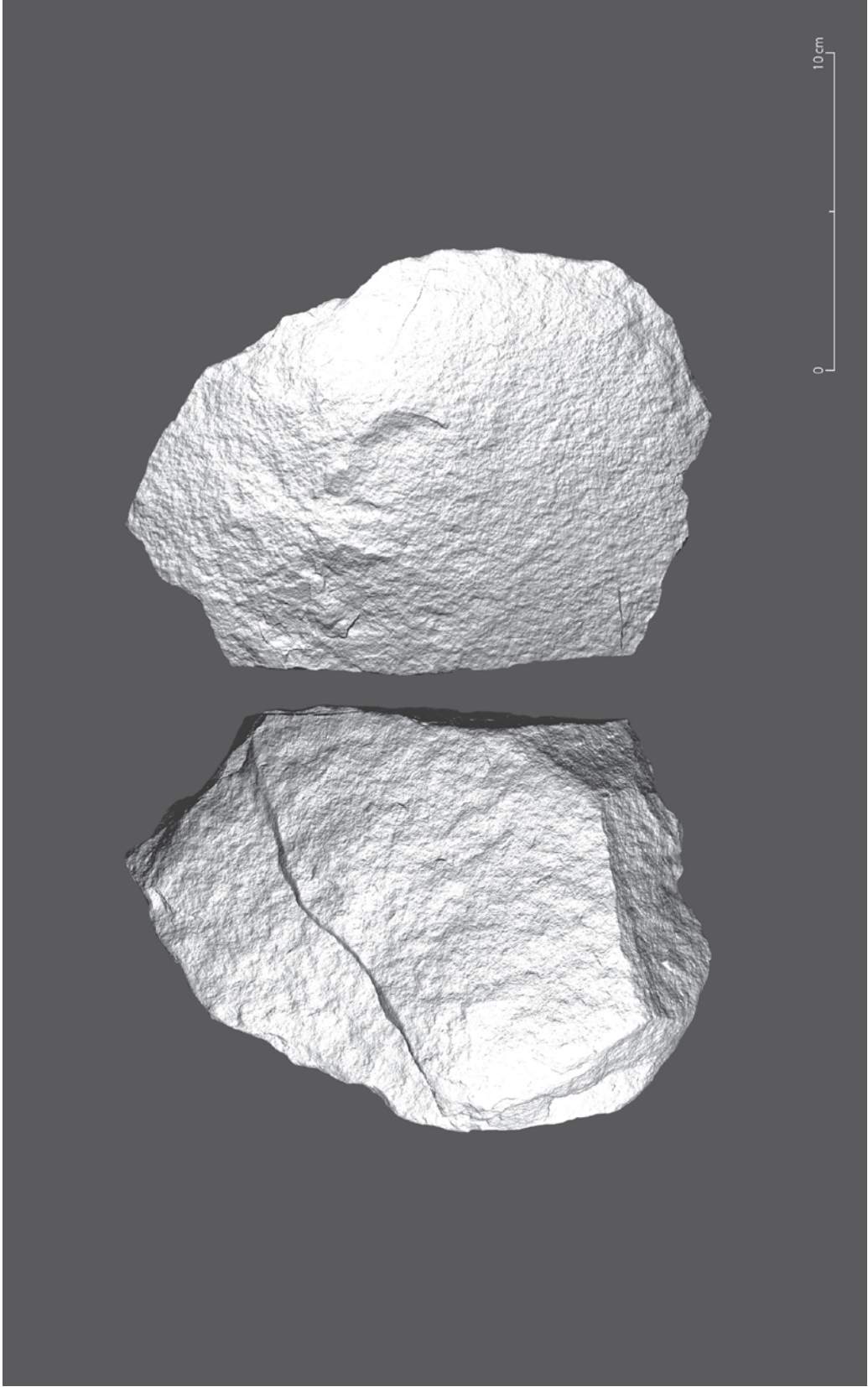


Figure 43 Frost shard.

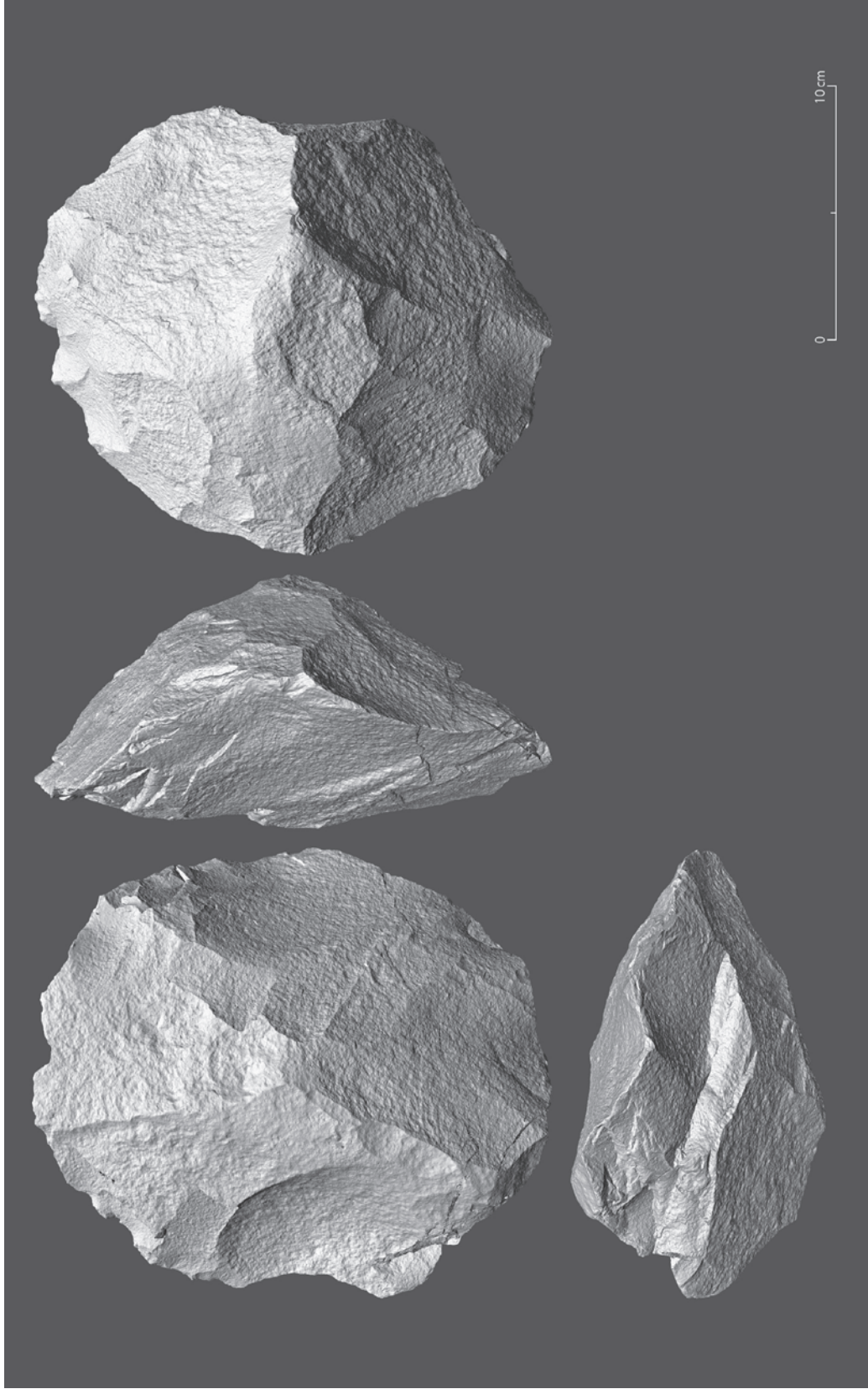


Figure 44 Core configured according to the recurrent centripetal method.

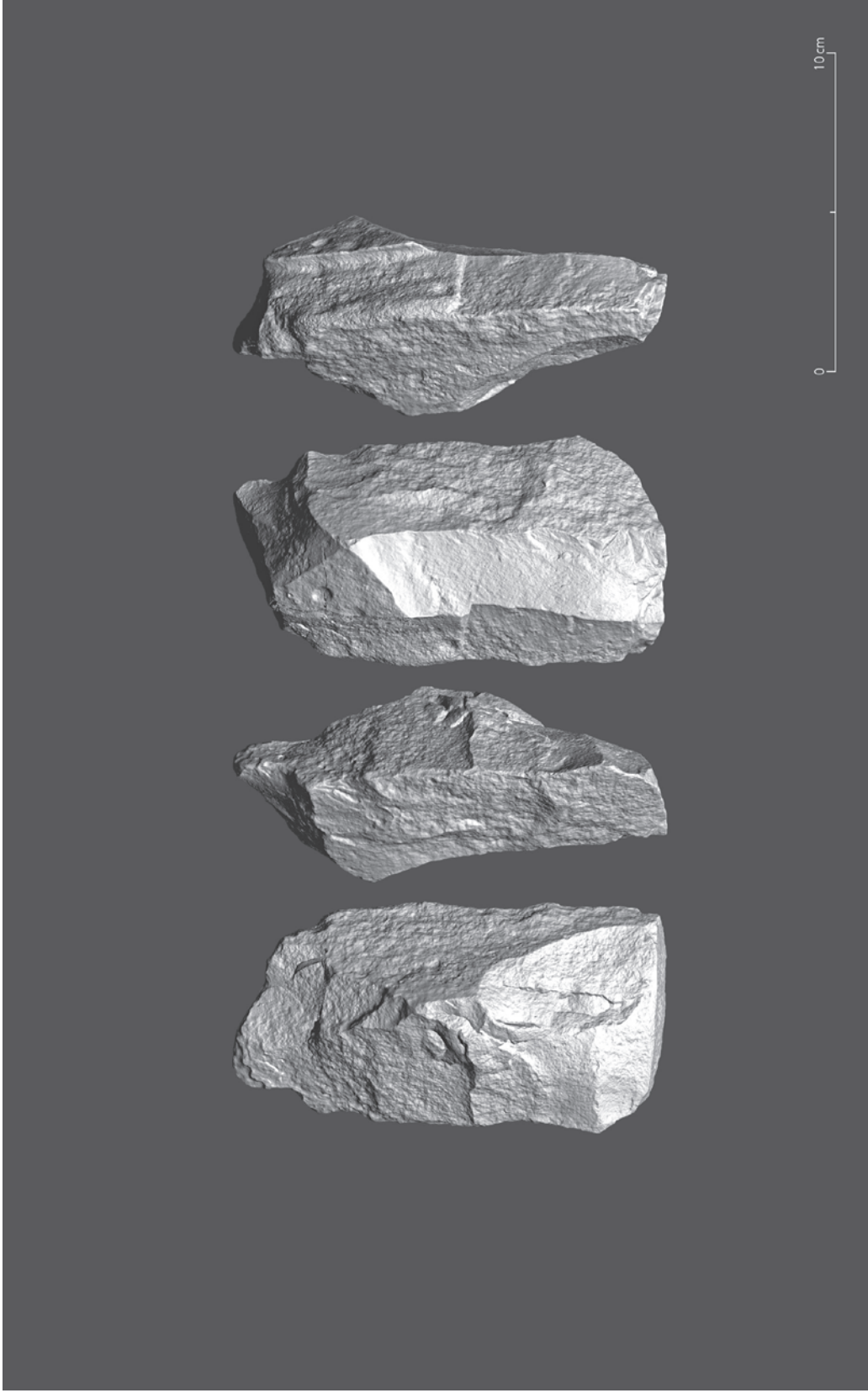


Figure 45 Core configured according to the recurrent unidirectional method.

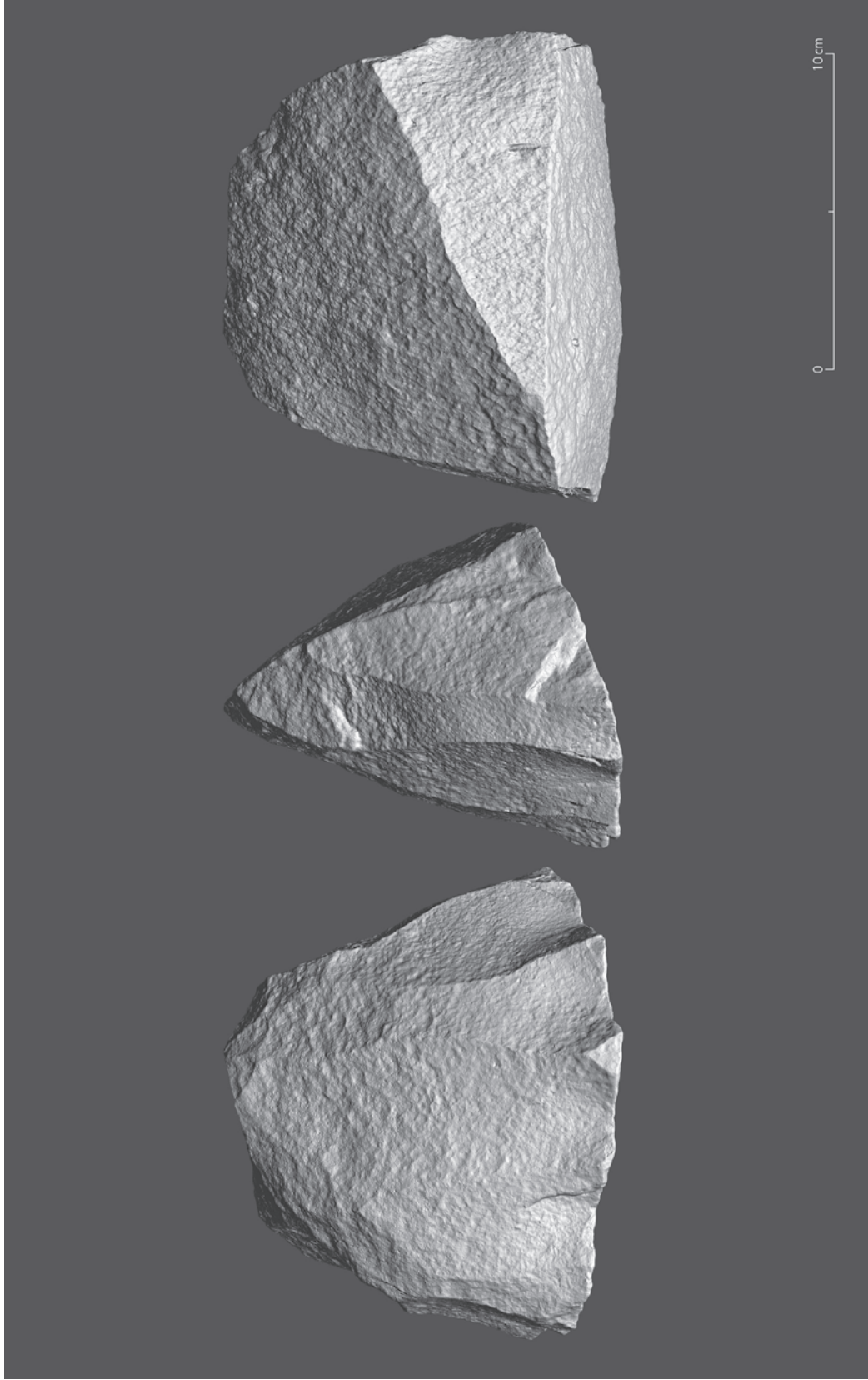


Figure 46 Core configured according to the recurrent unidirectional method.

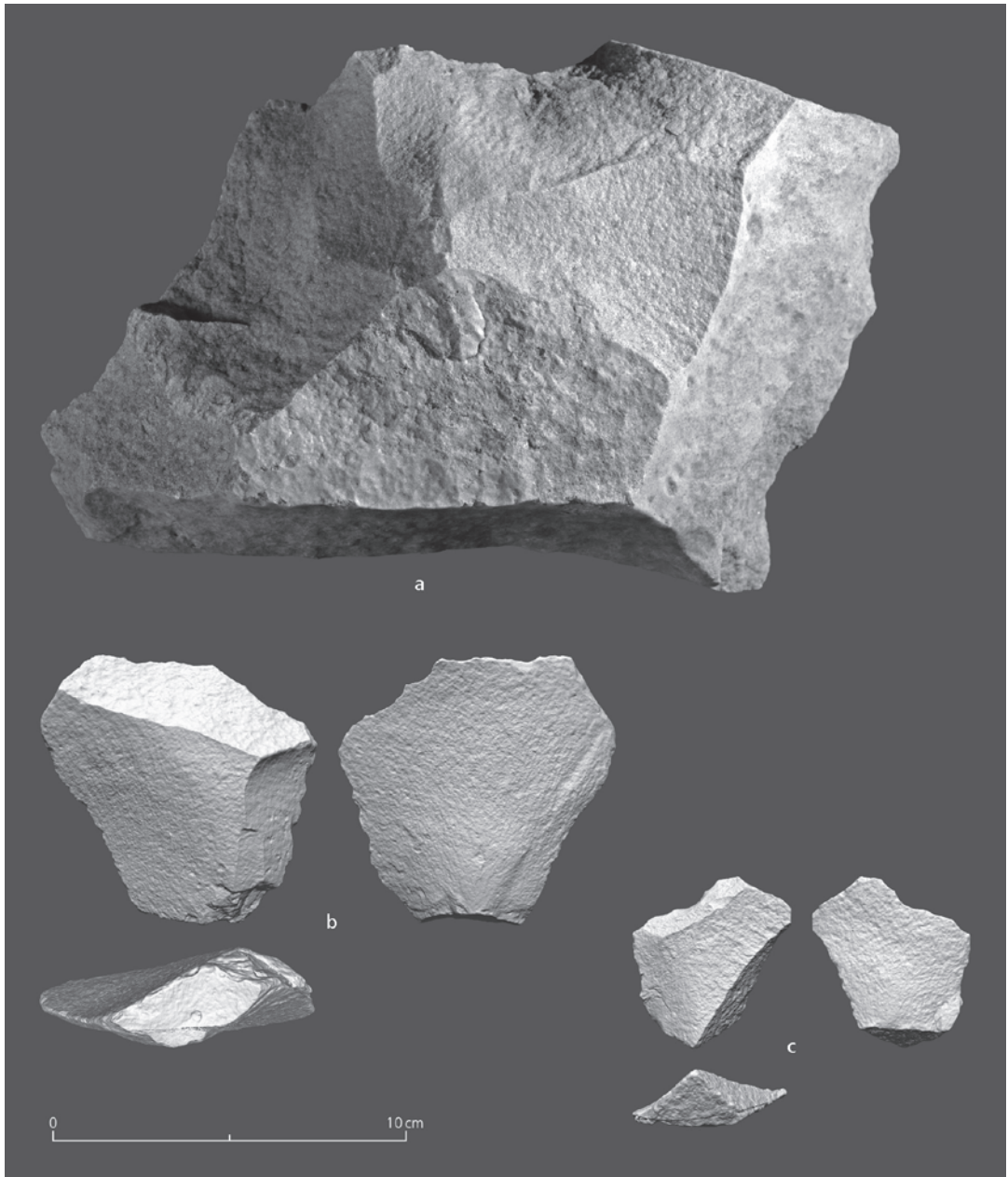
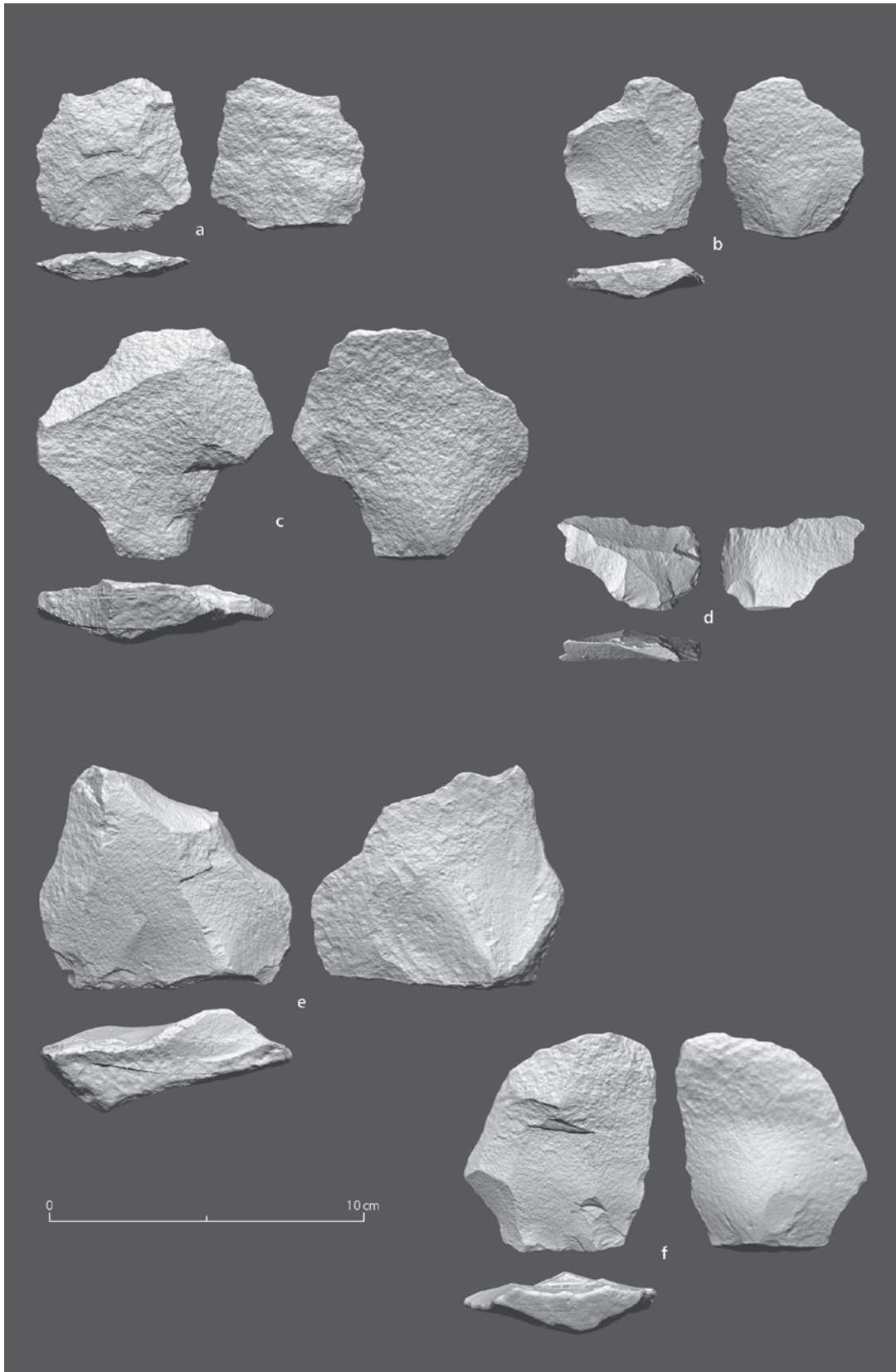


Figure 47 (a) Core configured according to the discoidal method (photo); (b and c) products of the exploitation stage according to the discoidal method.

Figure 48 (opposite page) (a–d) Products of the exploitation stage according to the recurrent centripetal method; (e) Core configured according to the recurrent unidirectional method; (f) product of the exploitation stage according to the recurrent unidirectional method.



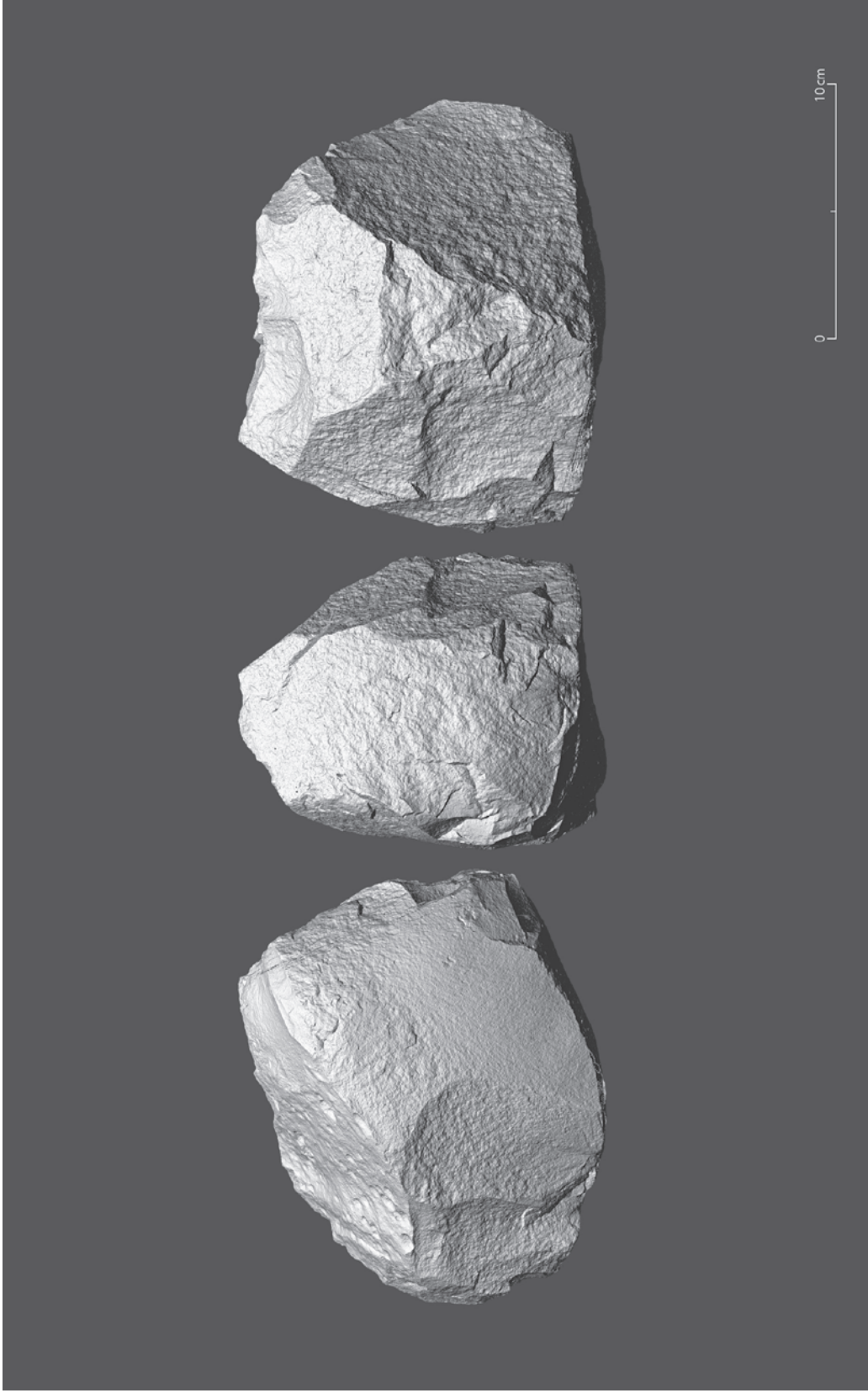


Figure 49 Opportunistic flake core.

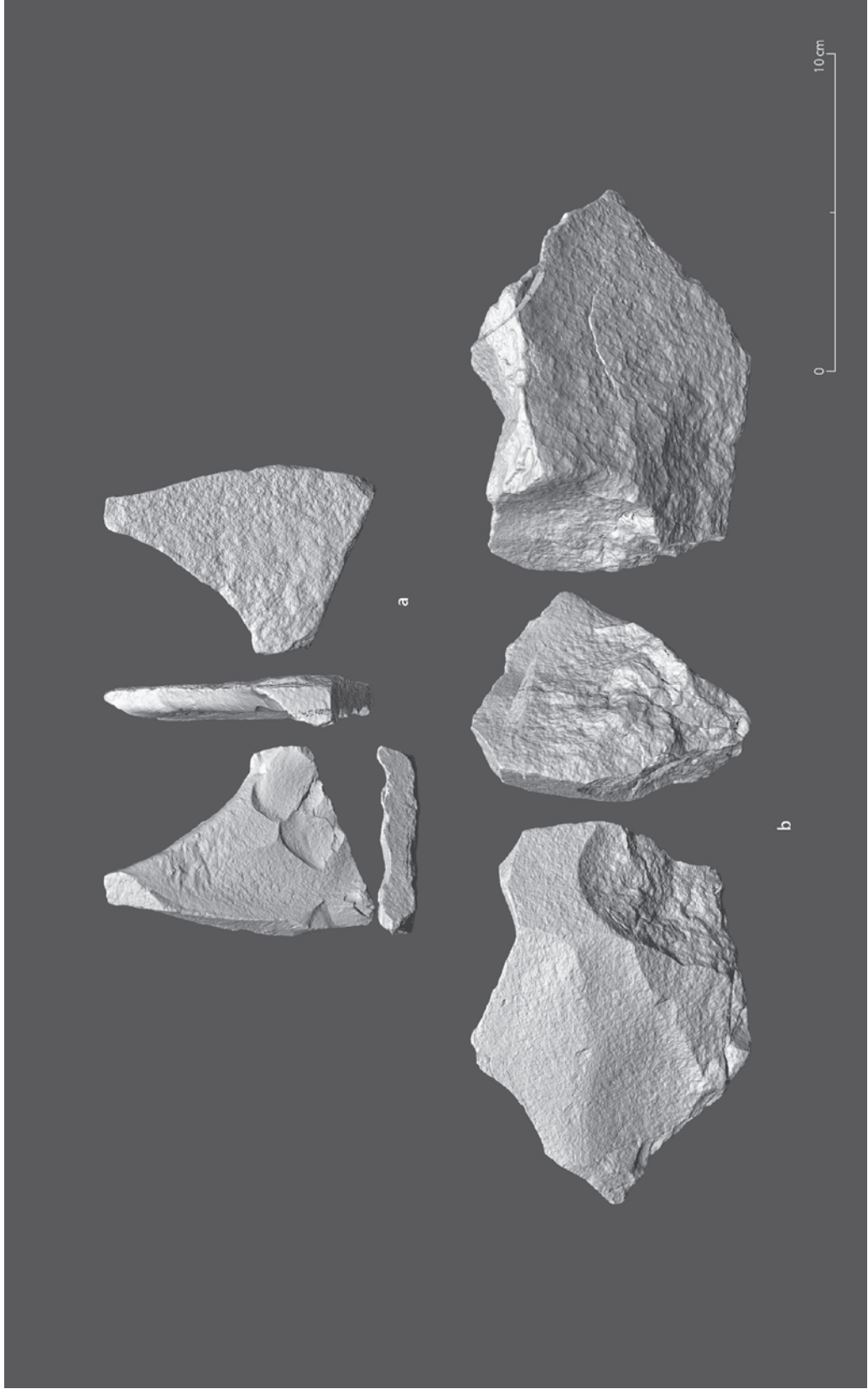


Figure 50 Opportunistic flake cores.

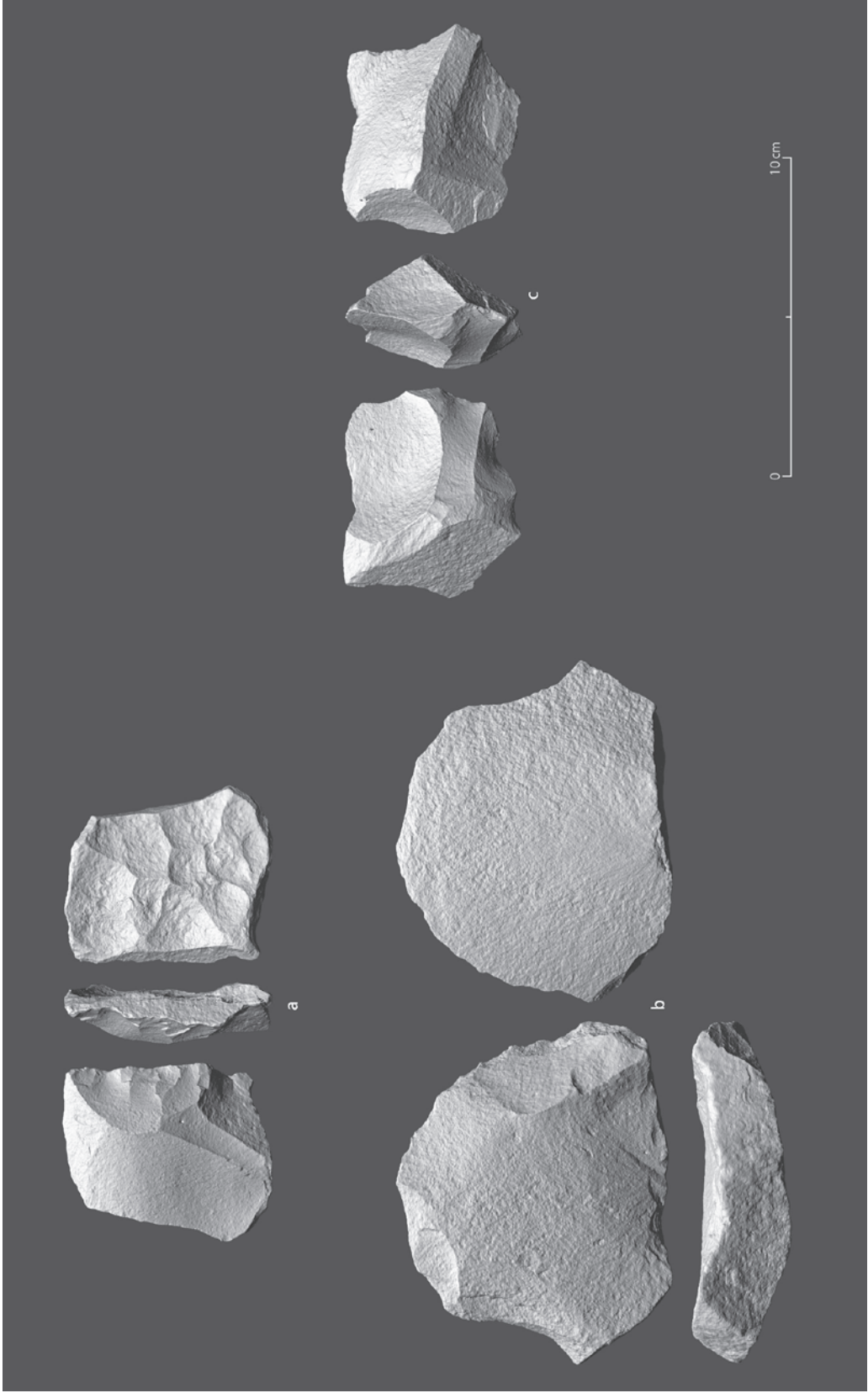


Figure 51 (a) Core configured according to the preferential method; (b) product of the exploitation stage according to the preferential method; (c) Kombewa core.

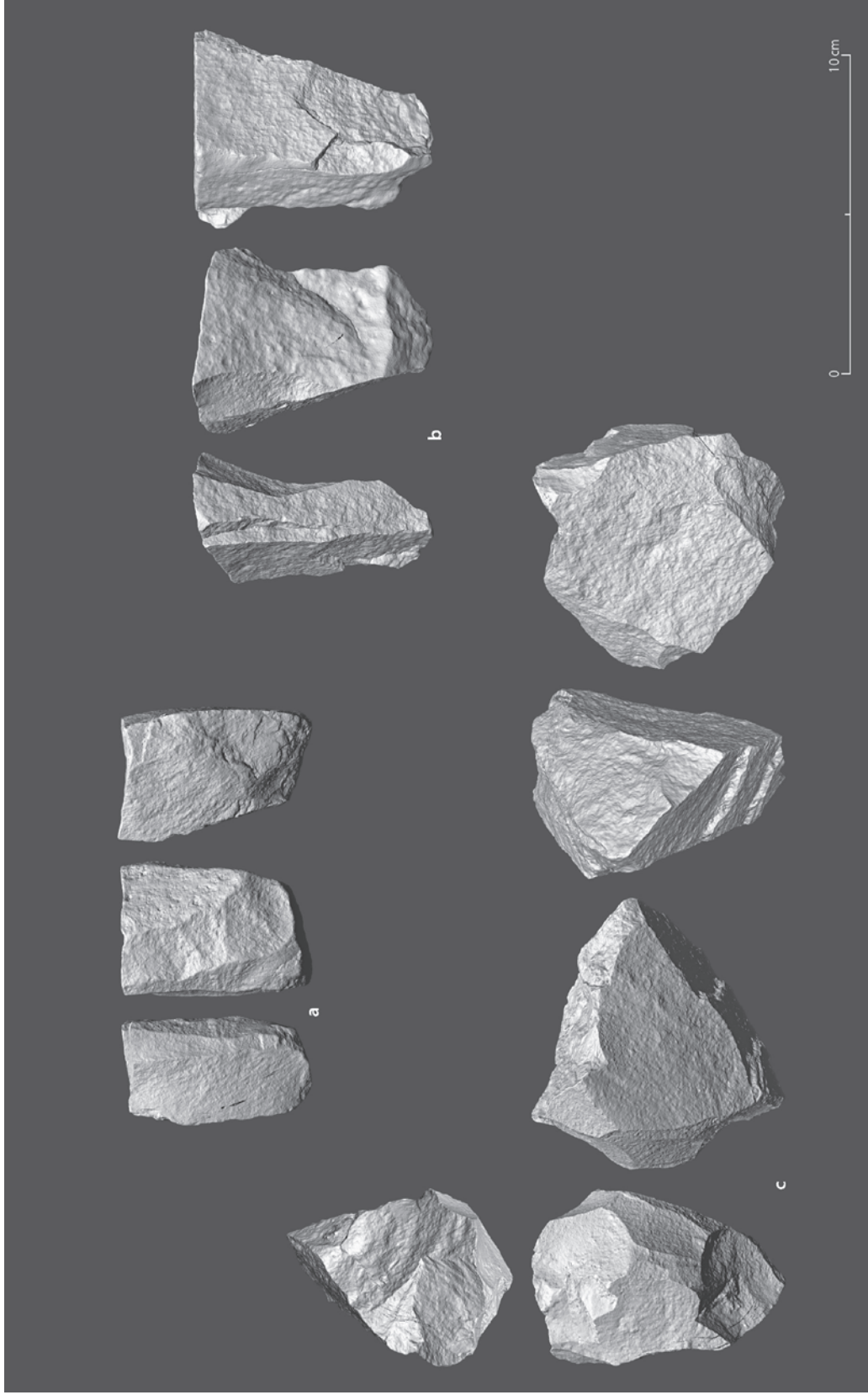


Figure 52 Opportunistic unidirectional blade cores.

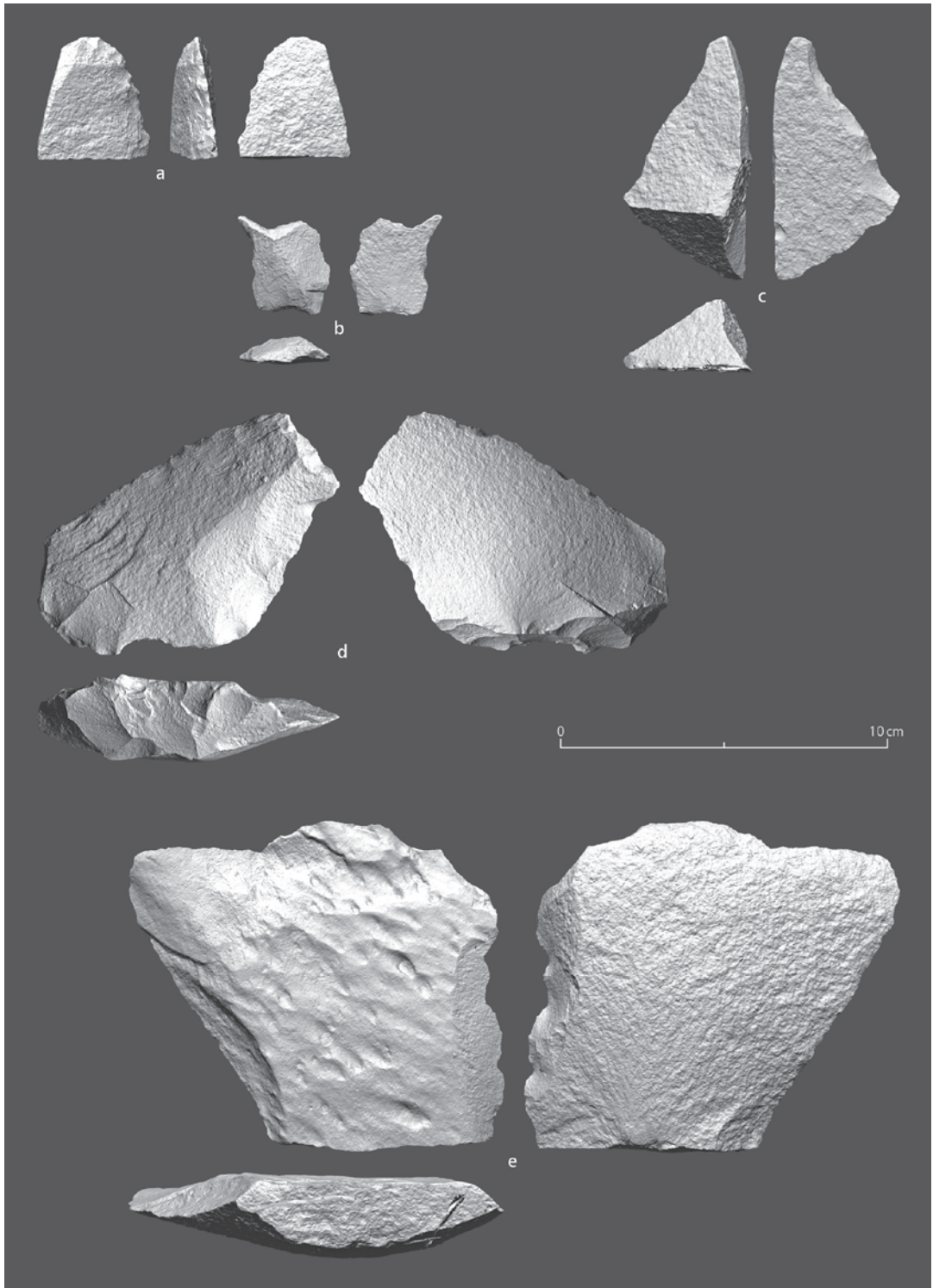


Figure 53 Formal tools (a) denticulate piece; (b) borer; (c and d) side scraper; (e) edge-retouched piece.

Figure 54 (opposite page) (a and b) Débordants flakes of the revision stage; (c) Bifacial backed knife (Klausen-nische-type).



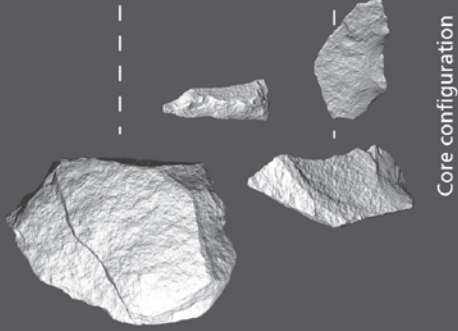


Figure 55 Pebble with scar fields at both ends.

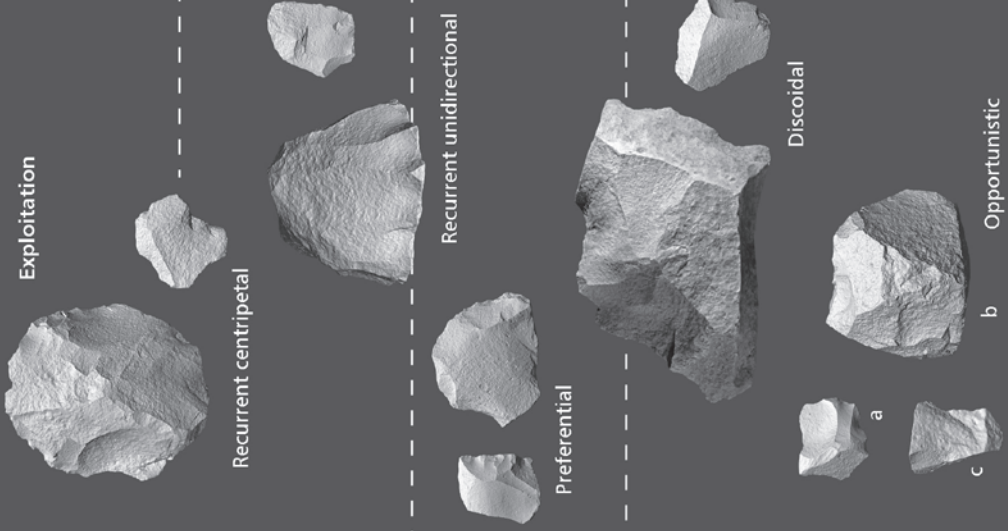
Figure 56 (opposite page) Tertiary quartzite extraction and processing in Troisdorf-Ravensberg.

Initialisation

Selection of raw piece  
block/forst shard 1-5.5 kg  
quartzite MA, MQC variety



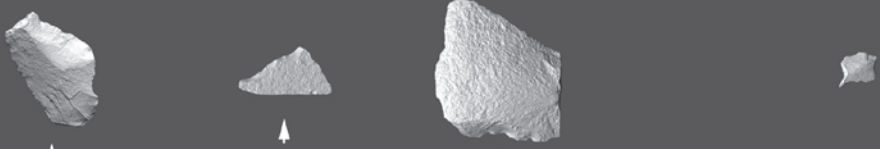
Exploitation



Revision



Formatting of tool types



(Figures 41 b and 44) and can thus be described as Levallois cores. Fifteen flakes are identified as products of the exploitation stage according to the recurrent centripetal method (Figure 48 a–d), whereas only a single one was transformed into a formal tool, a side scraper (Figure 53 d).

Three cores attest an exploitation following the recurrent unidirectional method (Figures 45, 46 and 48 e). The lower surfaces of the cores are formed by plane fissure surface, single negative flake scar or secondary reduction surface. The distal as well as the lateral convexity was ensured by distal and lateral preparation, whereby natural surfaces were partially integrated into the design of the lateral convexity. Single large negative flake scars or natural surfaces served as striking platforms. Two of the three cores can be described as Levallois cores (Figures 46 and 48 e). In terms of flaking products, the exploitation stage of the recurrent centripetal method is not well documented, only by two flakes (Figure 48 f).

In the Troisdorf-Ravensberg assemblage there are only two artefacts indicating the application of the preferential method, a core (Figure 51 a) and an end product (Figure 51 b). Concerning the core, its lower surface is covered by natural surfaces. Distal convexity is realised by negative flake scars of arc-shaped end products, lateral convexity by lateral preparation. The striking platform shows a rough preparation. This low preparation effort of the striking platform is also proven by the only end product of this series.

Discoïdal cores are characterised by the presence of two opposing reduction surfaces. Unifacial discoïdal cores, as described by Jean-Pierre Duran and Narcís Soler at the site of Arbreda<sup>44</sup>, have been classified here as recurrent centripetal cores, because of the clear differentiation between reduction surface and lower surface of the cores. Within Troisdorf-Ravensberg only one core representing the discoïdal method is documented (Figure 47 a). The distal as well as the lateral convexities were ensured by centripetal end products. No big effort was made to roughly prepare the striking platforms. Among the flaked blanks, there were only four pieces corresponding to the discoïdal method (Figure 47 b and c). A characteristic of these four pieces is the height of the striking platform in relation to the relatively short length of the flake.

In the assemblage of Troisdorf-Ravensberg, the core configuration following the methods described so far was notable for the overall low effort put into the layout. This was expressed on the one hand by the integration of natural surfaces and on the other hand by the targeted preparation of the necessary convexities. The following opportunistic cores underline this effective handling of the local tertiary quartzite.

The two Kombewa cores (Figure 51 c) do not show any exceptional characteristics. The ventral surface of a flake served as the reduction surface. All necessary convexities are thus given by the convexity of the ventral surface. Little or no effort was put into the preparation of the striking platforms. Corresponding Kombewa flakes were not found in the assemblage of Troisdorf-Ravensberg.

The variability of the configuration of the specific components of a core – lower surface, reduction surface and striking platform – is very large for the fourteen pieces following the opportunistic flake method from Troisdorf-Ravensberg. Plane fissure surfaces, single negative flake scars, natural cortex and also rough preparations are the most frequent characteristics (Figures 49 as well as 50 a and b). This reduction strategy produces flakes without specific characteristics.

While the opportunistic flake method is directed towards flakes without special features, the cores of the opportunistic blade method are intended to produce elongated blanks. All five cores of this type were configured unidirectional (Figure 52 a–c). In the course of the present analysis even very early stages of the core reduction were included in our counting. Most parts of all cores are covered with natural flat surfaces or negative flake scars resulting from previous reduction stages of unknown type. The back of the cores remains unprepared. Only two cores show a rough preparation of the striking platform, including single negative flake scars. The distal and

lateral convexities of the reduction surface were ensured by natural, unmodified surfaces with convergent shoulders. In one case, the distal convexity was also realised by preparation from the lateral part of the core.

Revision of the exploited cores: With the less elaborate configuration and exploitation of the cores it is difficult to find indications for their revision. Rare pieces prove that this stage of the core reduction also took place on site, a method-exact assignment must be avoided, however, due to the missing characteristics. Four pieces – two débordant flakes and two core edge blanks – are not sufficiently significant (Figure 54 a and b).

Another reason for the lack of indications for the revision of the exploited cores is the prior discard of the cores. Henning Hundsdörfer has studied the configuration of twenty-four cores with the working stage analysis<sup>45</sup>. He was able to delimit 543 single areas on the examined surfaces. Of these, 87 are natural fissures and fractures and 456 are negative flake scars. For 266 of the 456 negative flake scars, the terminal end is completely preserved, so that a sufficiently large data basis for the assessment of possible impact accidents is given. Of the 266 negative flake scars with a preserved terminal end, 112 end flat (42,1 percent) and 154 end broken (57,9 percent). It is interesting to observe that these broken ends (hinge) tend to be at the end of the processing of the core. If one considers a hinge as an unintentional interruption of the impact impulse when a flake was taken off, this could be described as a knapping accident and may be regarded as cause for the discard of the respective pieces.

Of a total of seventy-six negative flake scars that end in a hinge and of which the exact chronological position within the reduction sequence can be determined at the same time, ten lie within the first half (7,6 percent) and sixty-six within the second half (86,8 percent) of the reduction sequence with a maximum of twenty-seven negative flake scars in the last stage (35,5 percent) of the reduction sequence.

Tool manufacturing: Tool types are mostly not standardized in the Middle Palaeolithic<sup>46</sup>. In principle, the more specific the formal tool is, the more suitable the tool type is for chrono-cultural modelling. Six formal tools were found in Troisdorf-Ravensberg: one edge-retouched piece (Figure 53 e), a borer (Figure 53 b), a bifacial backed knife (Klausennische-type) (Figure 54 c), a denticulate piece (Figure 53 a) and two side scrapers (Figure 53 c and d). Of these only the bifacial backed knife is of specific importance for the chrono-cultural discussion.

The number of tool types is too small to search for possible patterns in their production. Nevertheless, they are presented here with the essential characteristics. First, the pieces were found in all areas of the excavation (plane, embankment of the road and surface find). Their maximum length ranges from 38 to 132 millimetres, their weight from 7 to 322 gram. Roughly speaking, two groups of tool types can be distinguished on this basis: smaller (borer, denticulate piece and side scraper) and larger pieces (edge retouched piece, bifacial backed knife and again side scraper). With the exception of the edge retouched piece, all are completely free of cortex. This implies that pieces have been selected for manufacturing, which tend to come from the end of the reduction process. For three pieces, flakes served as the initial blank, in one case natural block. For two pieces the blank is unclear.

The bifacial backed knife is the only piece where not only the edges, but also the surface has been transformed. For this purpose flat and slightly convex surfaces were created by respective knapping techniques. The relatively flat lower surface is covered by large negative flake scars,

<sup>44</sup> J.-P. Duran / N. Soler, Variabilité des modalités de débitage et des productions lithiques dans les industries moustériennes de la grotte de l'Abreda, secteur alpha (Serinyà, Espagne). Bull. Soc. Préhist. Française 103, 2006, 241–262.

<sup>45</sup> H. Hundsdörfer, Die Kerne der mittelpaläolithischen Steinbearbeitungswerkstatt Troisdorf-Ravensberg, Rheinland (M.A.-thesis Cologne 2017).

<sup>46</sup> Richter, Altsteinzeit.

which are to be regarded as remnants of the original piece. A fracture serves as the back. The working edge bends in the upper third towards the tip and this corresponds to the bifacial backed knife of the Klausennische-type.

Finding evidence for the manufacturing of tools in Troisdorf-Ravensberg is a matter of luck, given the small area excavated. This can be achieved by identifying object-related fabrication waste (debris from retouching and flakes from the plane and convex surface shaping). Due to the lack of bifacial-related production waste, it can be assumed that the bifacial backed knife of the Klausennische-type was not produced in the studied area.

Hammer stone: Due to the documented intensive activities of configuration and exploitation of cores, it seems obvious that percussion instruments are also present in the Troisdorf-Ravensberg assemblage. Nevertheless, of the excavated pebbles, only one piece is in question (Figure 55), since it has scar fields at both ends, which could result from anthropogenic impacts. However,

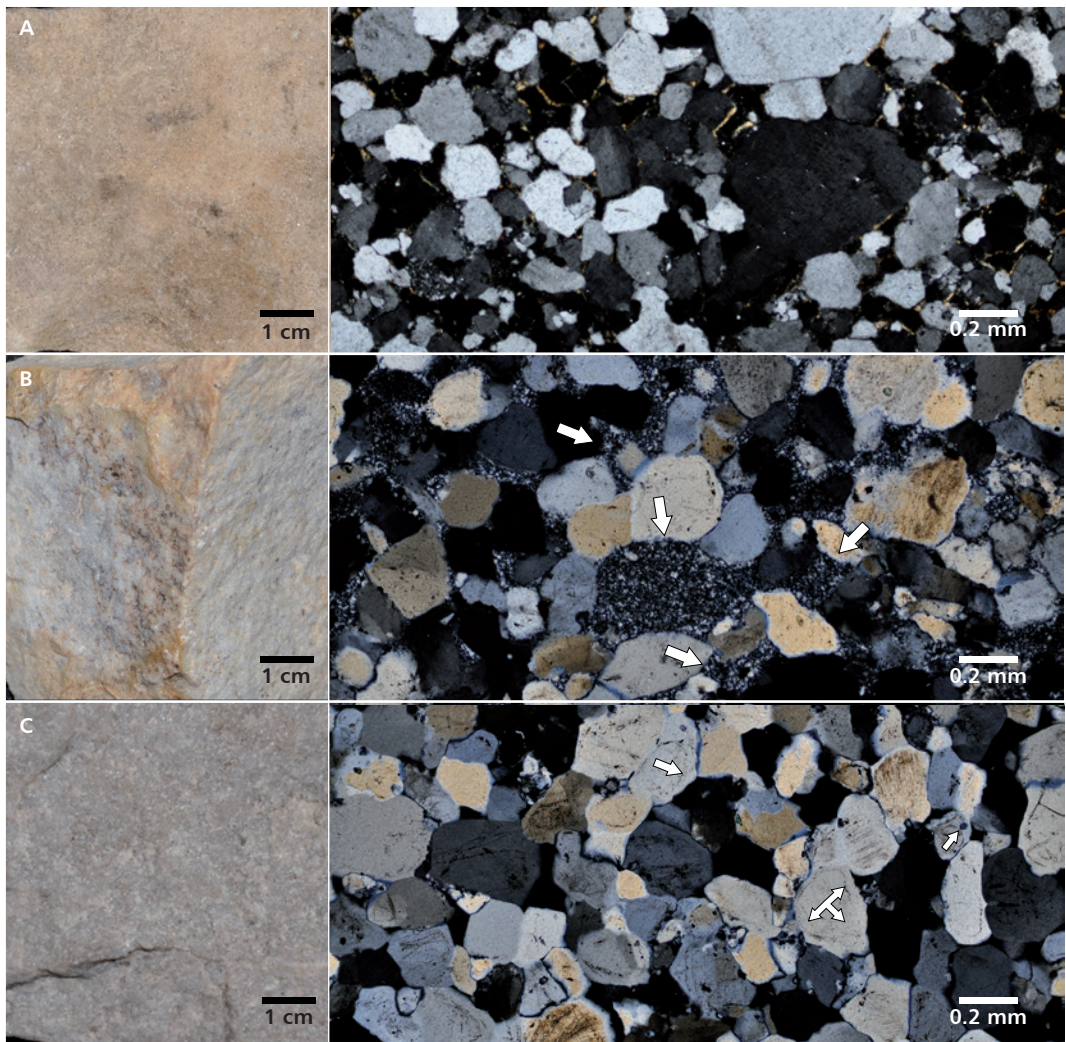


Figure 57 On the left part, pictures from surfaces of quartzites. On the right, microscopic pictures of thin section surfaces with cross polarised light at 100x magnification. (a) Picture of a MA\_CM variety. (b) Picture of a MA\_MQC variety. (c) Picture of an OO type.

it cannot be ruled out that they are also of natural origin. The piece is 102 millimetres long, 54 millimetres wide, 42 millimetres thick and weighs 338 gram.

*Petrographic characterisation of quartzites (A. Pr.).* The petrographic characterisation reveals the presence of two different petrogenetic types: The clastic and cemented quartz-arenite (MA) and the syntaxially overgrown orthoquartzite (OO type). Based on the presence of cement and its features, there are two different varieties belonging to the MA type.

Thin section samples characterised as MA type with clayey matrix (hereinafter MA\_CM) has an absence or residual presence of microcrystalline quartz but presence of clayey matrix (Figure 57a). The texture is clastic and cemented and the packing varies from complete tangential to clearly tangential. The characterisation of quartz grain features reveals the massive presence of clastic quartz grains and quartz grains with syntaxial overgrowth, while concave-convex quartz grain boundaries are limited to small complete packing zones. Grain size distribution ranges from very fine silt to coarse sand<sup>47</sup>. Regarding the mineral characterisation of the samples, the type of matrix is clayey. In the cases where cement is present, it is composed by microcrystalline quartz (in negligible proportions). There is presence of iron oxides among non-quartz minerals, probably related with the presence of clayey matrix.

MA type with microcrystalline quartz cement (hereinafter MA\_MQC) has no clayey matrix and is well characterised by its microcrystalline quartz cement in between quartz grains (Figure 57b). The texture of all these samples is clastic with matrix or cement, while packing varies from isolated to tangential categories. Most of the quartz grains are clastic ones, occasionally surrounded by syntaxial overgrowth. In some areas of the samples it is possible to recognise concave-convex quartz grain limits. The grain characterisation reveals similar parameters to those appreciated on the previous variety of MA type, a heterogeneous distribution between very fine silt and coarse sand categories, though the main grain framework is around fine sand. Regarding the composition of the cement, it is massively formed of microcrystalline quartz. Its presence ranges between five and twenty percent of the sample surface and it tends to surround quartz grains. In the cases where packing is less compact, the quantity of cement is higher. Regarding the identification of non-quartz minerals, iron oxides are frequent, followed by zircons and clays. Iron oxides appear as small crystals inside microcrystalline quartz, too. Mica, pyrite, chlorite, and rutile are present in some samples.

The last analysed petrogenetic type is the OO one (Figure 57c). The characterisation of the texture is clastic grained. Packing reveals that all the samples are within the complete category, though small porosity could be observed on some parts of them. The characterisation of grain features points at the coexistence of clastic grains with others with undulatory extinction. Most of the grains exhibit syntaxial overgrowths that generate concave-convex quartz grain limits. The size characterisation of quartz grains in these samples shows parameters similar to those observed in the former type and varieties. There is a small portion of siliceous matrix in some samples, and a residual proportion of microcrystalline quartz cement in others. The non-quartz mineral characterisation points at the presence of iron oxides, rutile, clay, and pyrite.

Concerning physical properties, the three types have similar quartz grain size, with a main distribution between the very fine sand and the fine sand categories. Nevertheless, the presence of smaller and clearly bigger quartz grains creates non-homogeneous surfaces that hamper knapping activities (Figure 58). The previous compactness degree of the grain framework for the two

<sup>47</sup> C. K. Wentworth, A scale of grade and class terms for clastic sediments. *Journal Geology* 30, 5, 1922, 377–392.

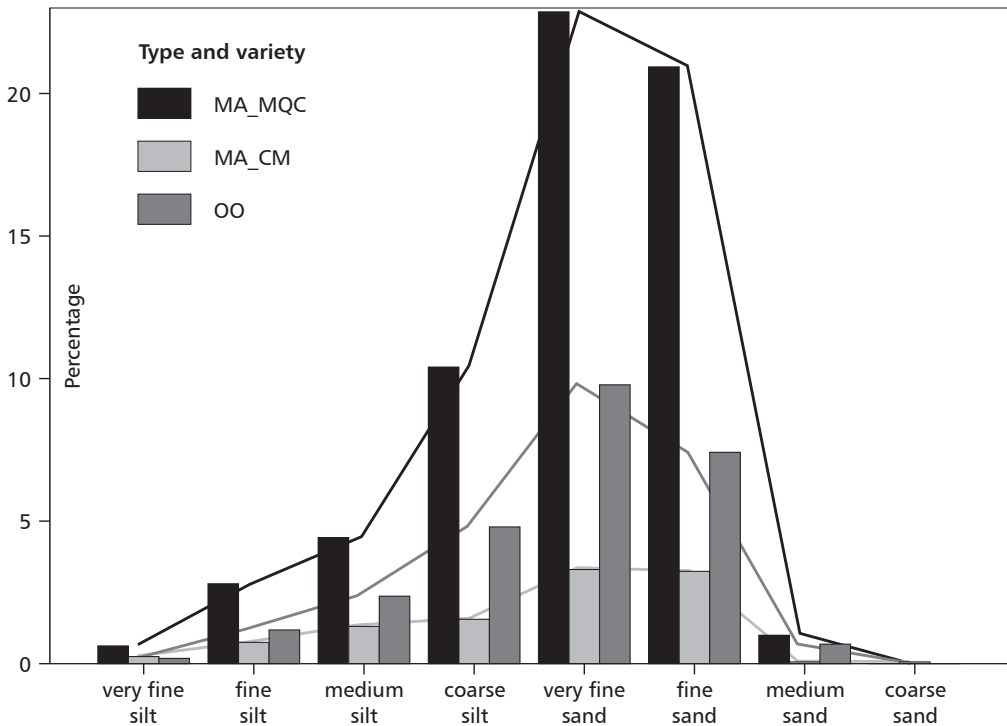


Figure 58 Bar-chart representing the size of quartz grains grouped by Udden-Wentworth categories and type and variety of quartzite. Quantity of grains is expressed as percentage. The total of quartz grains analysed is 1605 and the differences in quantity of grains between types and varieties are the consequence of the quantity of thin section samples belonging to each type. The proportion is similar in all three categories, as seen by interpolation lines.

varieties of MA type also creates non-homogeneous surfaces. However, the major presence of microcrystalline cement in the MA\_MQC variety creates homogeneous and compact rocks that prevent the creation of pores and grain irregularities, easing knapping activities. In addition, microcrystalline quartz also creates sharp edges in flaking products. The compactness degree of the OO type prevents the porosity that hinders knapping activities, but it does not prevent the irregularities generated by the difference in size of quartz grains. Only when microcrystalline cement fills in the small spaces between quartz grains, the OO type, more homogeneous, becomes an optimal knapping product.

The analysis performed in the site of Troisdorf-Ravensberg concludes that the properties of the MA\_MQC variety make it optimal for knapping and use. Therefore, its massive exploitation could be the main reason for human activity in this site. We propose that use and acquisition of OO type would be secondary and derived from the main product, the MA\_MQC type. The MA\_CM variety could not be used for knapping due to its friable properties and was probably considered a waste product.

Further analyses such as geo-chemical ones and the characterisation of the geological stratum, also the characterisation of the complete assemblage using non-destructive methods and the understanding of rock fragments with different facies could better explain not only the features of these quartzites, but also the capture, management and mobility mechanism employed by humans taking advantage of this resource.

## Discussion

*Site formation and chronostratigraphy (M. K.).* Several sharp contacts between different sediment units indicate the presence of major stratigraphic gaps. The base of the sequence, Unit E, consists of silty to sandy sediments of the Oligocene and Miocene ›Köln-Schichten‹. The high degree of compaction and the fact that quartzite boulders and blocks are intermixed suggest that the uppermost part of Unit E has been reworked by gelifluction.

The deposits of Unit E are disconformably covered by silt and sand rich loams of Unit D, which represent a heterogeneous mixture of different sediment microfacies. Microlayers and lenses of coarse sediment occur directly adjacent to or above those with fine grains. These granulometric heterogeneities result from transport by gelifluction or cryoturbation processes related to seasonal frost.

Sediments of Unit C are rich in silt if compared with the overlying sands of Unit B. However, Unit C appears to be restricted to square A<sub>3</sub>, where the concentration of boulders may have promoted their preservation.

The high silt contents in units D and C may have originated from the underlying silty Oligocene and Miocene deposits intermixed during gelifluctional transport. Alternatively, aeolian inputs of silt could have been a major pathway. Loess deposits are widespread in the southern Lower Rhine Embayment<sup>48</sup> and occur close to the site (Figure 2) testifying to Last Glacial dust dynamics. Gelifluction and cryoturbation were common processes under periglacial climatic conditions of the Last Glacial<sup>49</sup> and on slopes, cover beds are widespread, as in other subdued mountain areas of Central Europe. Cover beds are distinguished in an intermediate layer, the so-called ›Mittellage‹, and an upper layer (›Hauptlage‹), which both host considerable amounts of aeolian dust, while the base layer (›Basislage‹) does not<sup>50</sup>. While there is dispute about stratigraphic subdivision and regional correlation of these cover beds, it is often postulated that the ›Mittellage‹ and ›Hauptlage‹ accumulated during the Last Glacial Maximum (LGM) and the Younger Dryas, respectively. In this study, the luminescence method gave deposition ages for sediments of units D and C ranging from about 41.900 to 30.600 years ago as calculated using the Central Age Model and 28.500 to 20.600 years ago for the Minimum Age Model, if error margins are considered. This suggests that the corresponding gelifluctional layers accumulated shortly after Neanderthal occupation in Central Europe<sup>51</sup>. A widespread stratigraphic feature of loess sequences in the Lower Rhine embayment is the so-called Eben-disconformity reflecting a phase of solifluctional erosion

<sup>48</sup> N. Henze, Kennzeichnung des Oberwürmlösses der Niederrheinischen Bucht. Kölner Forum für Geologie und Paläontologie (Diss. Cologne 1998); D. Haase et al., Loess in Europe. Its spatial distribution based on a European Loess Map, scale 1:2500000 Quaternary Science. Reviews 26, 9–10, 2007, 1301–1312; F. Lehmkuhl et al., Loess-paleosol sequences at the northern European loess belt in Germany. Distribution, geomorphology and stratigraphy. Quaternary Science. Reviews 153, 2016, 11–30; J. Zens et al., OSL chronologies of paleoenvironmental dynamics recorded by loess-paleosol sequences from Europe. Case studies from the Rhine-Meuse area and the Neckar Basin. Palaeogeogr., Palaeoclimatol., Palaeoecol. 509, 2018, 105–125.

<sup>49</sup> K. Kaiser, Wirkungen des pleistozänen Bodenfrostes in den Sedimenten der Niederrheinischen Bucht. Ein Beitrag zur Kenntnis der Periglazialerscheinungen der

Rheinlande. E&G Quaternary Science. Journal 9, 1, 1958, 110–129; O. Fränze, Geomorphologie der Umgebung von Bonn. Erläuterungen zum Blatt NW der geomorphologischen Detailkarte 1:25000. Arbeiten Rhein. Landeskd. 29, 1969, 1–58; J. Grunert, Geomorphologische Entwicklung des Bonner Raumes. Arbeiten Rhein. Landeskd. 58, 1988, 165–180.

<sup>50</sup> D. Sauer / P. Felix-Henningsen, Saprolite, soils, and sediments in the Rhenish Massif as records of climate and landscape history. Quaternary International. 156/157, 2006, 4–12; A. Kleber / B. Terhorst (Eds.), Mid-Latitude Slope Deposits (Cover Beds) (Oxford 2013); F. Yang / V. Karius / D. Sauer, Quantification of loess proportions in Pleistocene periglacial slope deposits and Holocene colluvium using grain-size data by laser diffractometry. Journal Plant Nutrition and Soil Science. 2020, 1–5.

<sup>51</sup> Richter, Altsteinzeit.

and cryoturbation at the land surface, which have taken place during the LGM and shortly after deposition of the Eltville Tephra dated to about 24.000 years ago<sup>52</sup>. It appears likely that this stage of reworking also had an impact on the sequence in Troisdorf, however, a temporal correlation remains difficult due to lack in stratigraphic and geochronometric resolution.

The sandy and more homogeneous deposits of Unit B accumulated by gelisolifluctional transport of sand rich materials as indicated by dispersed coarse materials ranging in size from small fine gravel to coarse large boulders. This reworking occurred after about 20.000 years ago and probably correlates with intense geomorphodynamic activity during the Younger Dryas when solifluctional transport along slopes was last active before the landscape became vegetated and stabilized during the Holocene. Our dating result yielded for the uppermost part of Unit B, however, shows that the last exposure to sunlight before final deposition took place during the Late Holocene at around 3500 to 2700 years or 2000 to 1500 years ago as calculated using CAM or MAM, respectively. This young age and the high overdispersion value of 54 percent for this sample (Table 3) suggests disturbance of the uppermost layers of Unit B in comparatively recent times possibly related with human occupation during the Bronze age or later, which is quite possible, as in the vicinity several Iron age burial mounds and a rampart are known. Not in contradiction to this observation, the main part of the sediments of Unit B could well correlate with a gelisolifluctional layer of the Younger Dryas, which would then allow to correlate this sand rich unit with the »Hauptlage«. However, the thin section study did not provide any evidence for the presence of tephra particles from the Laacher See volcanoes, which is a widespread feature used to identify the »Hauptlage«.

In Unit B most lithic artefacts were found. They are concentrated at an absolute height of 97,0–97,1 metres a. s.l. (A2, A1 and B1) respectively 97,1–97,2 metres a. s.l. (C1) and scatter in vertical direction over ten to twenty centimetres. This observation can best be interpreted by post-sedimentary repositioning. Similar to the distribution of lithic artefacts is the distribution of natural blocks and frost shards, whose centre lies in the range between 97,0–97,1 metres a. s.l. with a maximum vertical dispersion of thirty to forty centimetres. The presence of Middle Palaeolithic lithic artefacts in Unit B suggests that a pre-existing find concentration outside the excavation area was embedded in the sandy homogeneous sediments and was relocated to its present position by gelisolifluctional transport. While the moment of the last deposition can be discussed, the date of the embedding of the finds cannot be determined. It is highly unlikely that the finds originate from the penultimate or older glaciations and have been preserved during several phases of periglacial slope mobilisation with erosion of cover beds from previous glacial stages. At Troisdorf-Ravensberg, the lowermost cover bed preserved is only about 41.000 years old.

Sediments of Unit D show a strong imprint of pedogenesis including accumulation of illuvial clay and redoximorphic mottling. These features do not show signs of mechanical disturbance, hence relate to formation of the modern soil. The lower part of Unit B, as observed in profile A1, shows clear signs of clay illuviation as well and can be denominated as Bt horizon. Towards the top, Unit B is very poor in clay and can be understood as E horizon of a modern Luvisol. Mobilization of organic matter down to the lower parts of Unit B as indicated by dark coloured clay coatings strongly suggests that an initial process of podzolisation took place as well. The good preservation of this sequence makes it highly unlikely that the stratigraphic sequence of Unit B to D in squares A1 to A3 has been affected by recent disturbance.

In contrast, the uppermost part of the sequence, i. e. different materials of Unit A, constitutes subrecent deposits possibly related to Late Holocene occupation and finally to road construction along the Mauspfad. Deposition occurred after about 3100 years according to the luminescence dating results for the uppermost layer of Unit B.

Table 10 Comparison of the number of finds between the two excavations in 1967 and 2015. – (roof bricks ...) roof bricks, glass, ceramics, porcelain and slag

	1967		2015		total
tertiary quartzite artefact	550	58,3%	418	7,6%	968
roof bricks ...	251	26,6%	130	2,4%	381
nature product	143	15,1%	4974	90,1%	5117
total	944	100%	5522	100%	6466

*Quartzite extraction and processing in Troisdorf-Ravensberg (A. P.).* The habitus of these quartzites usually has the form of amorphous blocks, which can measure up to several meters. In addition, the tertiary quartzite is also available in the form of frost shards. The edges of the raw pieces are sharp and weathered. The overall shape of the pieces is unpredictable and the initial exploitation of the tertiary quartzite requires little or no effort. Due to the amorphous, undefined habitus of the quartzites, the choice of reduction strategies and thus the configuration of the cores are without restrictions (Figure 56).

The petrographic characterisation of the quartzites of Troisdorf-Ravensberg has shown that three types or varieties with different knapping properties are hidden behind the term ›quartzite‹. The clastic and cemented quartz-arenite with microcrystalline quartz cement samples (MA\_MQC) shows the best physical knapping properties. The other two, syntaxially overgrown orthoquartzite (OO type) as well as clastic and cemented quartz-arenite with clayey matrix (MA\_CM), are less suitable. First observations suggest that prehistoric humans for further processing have deliberately selected the MA\_MQC variety.

It seems that not only the quality of the tertiary quartzite has had an influence on the positive or negative selection, but also the weight or the dimensions of the raw piece. From the rich assortment of 452 frost shards and 4471 natural blocks, especially those pieces with a weight of at least one up to five and a half kilos were selected. The two frost shards and more than sixty percent of the natural blocks (36 of 4471) testify to this. These large pieces were knapped. The lighter, smaller pieces show hardly any traces of further processing. From the described selection of raw pieces on, all subsequent stages of the operational processes are documented in Troisdorf-Ravensberg. A few pieces of the core preparation testify to the initialisation. Cores and their target products, configured in different ways, demonstrate exploitation. There are recurrent centripetal and unidirectional, preferential, discoidal and three opportunistic methods (Kombewa, flake and blade). Especially striking is the lack of fine skill within the concrete implementation of the respective reduction strategy. Even though natural surfaces were often integrated into the configuration of the cores, the complete implementation of the necessary convexities can be observed in single cases. This can be seen as evidence for the Levallois method. There is little concrete evidence for the revision of the cores. This may indicate that on the one hand there was no need for a revision of the cores, on the other hand the cores were discarded early. Twenty-four cores examined with the working stage analysis show that almost ninety percent of the hinges detected on the surfaces of the examined pieces are at the end of the work process<sup>53</sup>. This indicates that impact accidents were not rectified.

The small number of six formal tools in the Troisdorf-Ravensberg assemblage alone is indicative of the low importance given to this artefact class by prehistoric humans. This is confirmed by the unsystematic selection of the later formatted blanks. A recurrent centripetal flake, a preparation flake and a natural block were retouched. For the three other objects a more exact allocation is not possible. For the chrono-cultural attribution of the Troisdorf-Ravensberg as-

<sup>52</sup> J. Zens et al., The Eltville Tephra (Western Europe) age revised. Integrating stratigraphic and dating information from different Last Glacial loess localities. *Palaeo-*

*ogeogr., Palaeoclimatol., Palaeoecol.* 466, 2017, 240–251.

<sup>53</sup> Hundsdörfer, Ravensberg (note 45).

semblage the presence of a bifacial backed knife (Klausennische-type) is of great importance. Due to the lack of bifacial-related fabrication waste, it can be assumed that the piece was not produced in the studied area.

Even though the composition of finds of the 1967 excavation does not correspond in detail to those of the 2015 excavation, a number of comparable aspects can be found between them (Table 10). This was to be expected, since the investigations on the position of the 1967 excavation have shown that it must have been in the immediate vicinity of the 2015 excavation.

Little is known about the vertical distribution of finds from the 1967 excavations. The combination of the information given by Schwabedissen<sup>54</sup> and Fiedler and Veil<sup>55</sup> in this respect suggests that the conditions were comparable, if not identical compared with the 2015 excavation. According to both authors, the lithic artefacts can be found from the present surface to the loamy sand at a depth of one metre. Schwabedissen states that the finds originate from brown sand that was documented at a depth of ten and eighty centimetres<sup>56</sup>. He adds: »in the upper part an approximately horizontal position of quartzites, find layer«.

In both assemblages tertiary quartzite is the only raw material used for the production and processing of lithic artefacts.

When comparing the quantities of finds, the big difference between the proportions of natural products is striking. While they have by far the highest proportion in the 2015 excavation, they are the smallest group of finds in the 1967 excavation. As already described in the context of the research history, the finds were selectively recorded on site during the 1967 excavation. It can be assumed that a large part of the natural products was discarded undocumented.

Modern flakes were identified only in the 1967 excavation. These are flakes »probably detached using steel hammer«<sup>57</sup>. According to investigations by Klaus Dettmann, Ravensberg quartzite was used for house and road construction in the Middle Ages and modern times<sup>58</sup>. The corresponding quarries were located in the south of the prehistoric site beyond the Mauspfad. The remains of this work can still be seen today. In this respect, the modern flakes found in the course of the 1967 excavation could originate from the trimming of cubes. This type of flakes is missing in the assemblage of the 2015 excavation. Furthermore, the very good state of preservation of the finds of the 2015 excavation did not seem to make it plausible to separate the quartzite artefacts between »modern« and »prehistoric«.

Both assemblages contain the same forms of natural products: natural blocks (with sharp and round edges) and frost shards. Quartzites with traces of heating are difficult to associate with anthropogenic activities in the absence of evident structures. The possibilities of contact with natural fire are far too great. Thus, the two pieces from the 1967 excavation are not regarded as evidence of anthropogenic fires<sup>59</sup>.

Due to the selective documentation in the course of the 1967 excavation, investigations into the selection of natural products are not possible.

The proportion of tested pieces in the assemblage of the 1967 excavation (14 percent) is significantly higher than in the assemblage of the 2015 excavation (2,4 percent). This striking difference cannot be explained by different methods in selection, identification or documentation. This may reflect a spatial differentiation of prehistoric activities.

<sup>54</sup> Schwabedissen, Quarzit-Fundplätze, 103.

<sup>55</sup> Fiedler/Veil, Ravensberg 378.

<sup>56</sup> Schwabedissen, Quarzit-Fundplätze, 103.

<sup>57</sup> Fiedler/Veil, Ravensberg 382.

<sup>58</sup> K. Dettmann, Quarzit, ein besonderes Troisdorfer Gestein. Troisdorfer Jahresh. 45, 2015, 53–62.

<sup>59</sup> Fiedler/Veil, Ravensberg 380.

<sup>60</sup> Fiedler/Veil, Ravensberg 391.

<sup>61</sup> Fiedler/Veil, Ravensberg 389, also concerning the following.

<sup>62</sup> Fiedler/Veil, Ravensberg 393–397.

<sup>63</sup> Fiedler/Veil, Ravensberg 389; 393 s. 396 s.

<sup>64</sup> Fiedler/Veil, Ravensberg 394.

<sup>65</sup> Fiedler/Veil, Ravensberg 382.

It is very difficult to compare the results of the analysis of the 1967 and the 2015 excavations concerning the core configuration. There are about fifty years between the two studies and they testify the development of research in this field. Whereas in the nineteen-seventies the approach was purely morphological, today the address follows conceptual aspects of the core configuration, with the morphology of the pieces receding into the background. Nevertheless, the published drawings and detailed descriptions allow comparisons of the pieces from the 1967 excavation.

In total, the assemblage of the 1967 excavation comprises sixty-four cores. These include thirty-one opportunistic reduced cores<sup>60</sup>, twenty-four cores configured according to the recurrent method and also the preferential method<sup>61</sup>. In Fiedler and Veil, the cores of the surface concept are described as prepared cores with and without a fixed striking platform. Among the cores of the recurrent method are those which were reduced centripetal<sup>62</sup>, uni-<sup>63</sup> and bidirectional<sup>64</sup>. In addition, Fiedler and Veil mention four non-prepared globular cores and five blade cores<sup>65</sup>. From today's point of view, the globular cores can be described as discoidal cores. Three of the blade cores shown were configured according to the volumetric concept<sup>66</sup>. The fourth core shown<sup>67</sup> appears to be a core configured according to the recurrent bidirectional method. Fiedler and Veil see the blade cores in an Upper Palaeolithic context<sup>68</sup>, without the assemblage of the 1967 excavation giving any indication of the presence of Upper Palaeolithic finds. This black-and-white thinking can certainly be attributed to the state of research in the nineteen-seventies. According to the current state of research, the described blade cores of the volumetric concept can be found just as well in the Middle and Upper Palaeolithic context<sup>69</sup>.

It becomes apparent that the core configuration in the two assemblages is almost identical. In the assemblage of the 2015 excavation bidirectional and volumetric reduced cores are missing. On the other hand, Kombewa-cores are missing in the 1967 excavation.

Blanks of the exploitation stage are very rare in the assemblage of 1967. According to the terminology used by Fiedler and Veil, there are seven Levallois blanks<sup>70</sup>, which today are called end products of the preferential method.

The blades mentioned<sup>71</sup> are final products of the uni- and bipolar recurrent method as are the dorsal patterns of the negatives and especially the straight course of the ventral side in longitudinal section. This reflects the gesture used in the course of the impact, which is primarily associated with the surface concept. End products of the other reduction methods are not mentioned.

Overall, the small number of final products corresponds to the observations of the assemblage of the 2015 excavation.

Different tool types are also documented in the assemblage of the 1967 excavation. Fiedler and Veil (excavation and surface finds known until 1974) count three hand axes<sup>72</sup>, a Faustkeilblatt<sup>73</sup>, three cleavers<sup>74</sup>, a bifacial backed knife of the Klausennische-type<sup>75</sup>, one leaf-shaped scraper with back<sup>76</sup>, six side scrapers<sup>77</sup>, three end scrapers, one burin<sup>78</sup> and a few partially retouched pieces. To what extent the different tools were produced on site is difficult to judge. Concerning the bifacial tool types, there is none among the flakes that can be attributed to their production. For the other tool types, a statement is more difficult to make due to the selective documentation in the course of the 1967 excavation.

<sup>66</sup> Fiedler/Veil, Ravensberg 389.

<sup>67</sup> Fiedler/Veil, Ravensberg 389.

<sup>68</sup> Fiedler/Veil, Ravensberg 382.

<sup>69</sup> Pastoors/Tafelmaier, Balver Höhle (note 28).

<sup>70</sup> Fiedler/Veil, Ravensberg 383.

<sup>71</sup> Fiedler/Veil, Ravensberg 384.

<sup>72</sup> Fiedler/Veil, Ravensberg 402.

<sup>73</sup> Fiedler/Veil, Ravensberg 401.

<sup>74</sup> Fiedler/Veil, Ravensberg 400s.

<sup>75</sup> Fiedler/Veil, Ravensberg 402.

<sup>76</sup> Fiedler/Veil, Ravensberg 403.

<sup>77</sup> Fiedler/Veil, Ravensberg 403s.

<sup>78</sup> Fiedler/Veil, Ravensberg 404.

Even though the number of formal tools in the assemblage of the 2015 excavation is considerably smaller with only six pieces, the spectrum of documented tool types offers certain parallels. In both assemblages, in addition to side scrapers and edge-retouched pieces, there are bifacial backed knives of the Klausennische-type, which confirms that the two assemblages are comparable.

These similarities extend to the question of the production of bifacial tool types in the studied areas. Due to the lack of bifacial-related fabrication waste in both assemblages it seems unlikely that they were produced here. The repeated occurrence of bifacial tool types made from the local tertiary quartzite argues in favour of their production at a hitherto unknown location at or near Troisdorf-Ravensberg. However, it should be noted that these bifacial tools are single pieces and not produced in series.

Fiedler and Veil counted six hammer stones<sup>79</sup>. In the assemblage of the 2015 excavation, only one find can be considered as a hammer stone.

*Chrono-cultural attribution of the Troisdorf-Ravensberg assemblage (A. P.).* The chrono-cultural attribution of the finds from Troisdorf-Ravensberg requires the inclusion of the current discussions about the adequate methodological approach. The qualitative-typological tradition of Central European research on the classification of the Middle Palaeolithic is based above all on the work of Bosinski, according to whom a chrono-cultural classification depends on the presence or absence of single key-types<sup>80</sup>. Recent studies on this topic take a critical view of the important role of the key-types, because they do not represent a final state, but rather snapshots of a dynamic process in tool history, characterized by rejuvenation, reparation, redesigning and recycling<sup>81</sup>.

Besides these central developments in research, the hand axe as a key-type is of great importance, especially for the classification of the finds from Troisdorf-Ravensberg. Schwabedissen, but also Fiedler and Veil see in the presence of hand axes together with Levallois products indications for a possible classification of the site Troisdorf-Ravensberg into the Jungacheuléen<sup>82</sup>, which corresponds to the beginning of MIS 8 in the early Middle Palaeolithic<sup>83</sup>. However, at the latest with the re-evaluation of the finds from Salzgitter-Lebenstedt (Lower Saxony) it has been shown that hand axes together with Levallois products also occur in the late Middle Palaeolithic during the interpleniglacial (MIS 3)<sup>84</sup>.

Among the few formal tools of the Troisdorf-Ravensberg assemblage, only the two backed bifacial knives (Klausennische-type), which are assigned to the Micoquian, are of importance for the qualitative classification to be carried out here<sup>85</sup>. According to Bosinski, the Micoquian is mainly associated with MIS 5a (Odderade), but also after the MIS 4 it may occur<sup>86</sup>. Richter sees the duration of the Micoquian differently. According to him it begins around the MIS 4 (70.000–60.000 years BP) and ends around 40.000 years BP during the interpleniglacial (MIS 3)<sup>87</sup>. In this context and due to its regional relevance, it has to be mentioned that Thissen developed his own point of view about the Micoquian<sup>88</sup>. Since his ideas run against the general-

<sup>79</sup> Fiedler/Veil, Ravensberg 380.

<sup>80</sup> G. Bosinski, Eine mittelpaläolithische Formengruppe und das Problem ihrer chronologischen Einordnung. *Eiszeitalter u. Gegenwart* 14, 1963, 124–140; Bosinski, *Funde* (note 34).

<sup>81</sup> O. Jöris, Der spätmittelpaläolithische Fundplatz Buhlen (Grabungen 1966–69). *Stratigraphie, Steinartefakte und Fauna des Oberen Fundplatzes* (Bonn 2001); Richter, *Sesselfelsgrötte III*.

<sup>82</sup> Schwabedissen, *Quarzit-Fundplätze*; Fiedler/Veil, Ravensberg.

<sup>83</sup> Bosinski, *Paläolithikum II*.

<sup>84</sup> Pastoors, Salzgitter-Lebenstedt (note 31).

<sup>85</sup> G. Bosinski / K. Brunnacker, *Bonner Jahrb.* 169, 1969, 29–43.

<sup>86</sup> Bosinski, *Rhein 170*; O. Jöris, Zur chronostratigraphischen Stellung der spätmittelpaläolithischen Keilmessergruppen. *Der Versuch einer kulturgeographischen Abgrenzung einer mittelpaläolithischen Formengruppe in ihrem europäischen Kontext.* *Ber. RGK* 84, 2004, 49–153.

<sup>87</sup> Richter, *Altsteinzeit 133 s.*; Richter, *Sesselfelsgrötte III*.

ly accepted view and are, moreover, misleading, reference will only be made here to the detailed critique on this<sup>89</sup>.

The Troisdorf-Ravensberg site cannot contribute to the discussion of the duration of the Micoquian. On the one hand, the results of the new excavation are not sufficient for this purpose. On the other hand, the lithic artefacts can be correlated very well with the Mousterian with Micoquian-Option-B (the younger phase of the M.M.O. or Keilmessergruppe<sup>90</sup>), since in addition to the presence of bifacial tools with plano-convex cross section, a Levallois blank production was proven. According to Richter, this phase falls in a period between approximately 50.000 and 40.000 BP<sup>91</sup>. The older phase of the Micoquian, the M.M.O.-A, is characterized among others by the presence of Quina or discoid blank production. While the discoid method could be detected in the Troisdorf-Ravensberg assemblage, clear evidence of the Quina concept is missing so far.

In the past, Middle Palaeolithic quartzite extraction sites were mainly assigned to the early Middle Palaeolithic at the beginning of MIS 8<sup>92</sup>, even though mostly there was no possibility of stratigraphic investigations on site<sup>93</sup>. Decisive for this are the considerations that at all of these sites the Levallois blank production has been proven and at the same time a raw material deposit suitable for the specific technical implementation is available<sup>94</sup>. According to Bosinski the application of the Levallois technique is »quite a waste of raw material«<sup>95</sup>. This assessment is not valid without further specification, as there are various analytical applications in the estimation of lithic production systems efficiency<sup>96</sup>. Wasting implies the uneconomical use of resources and their measurement requires methodological positioning. Nevertheless, it seems difficult to consider Levallois technique per se a waste of material. However, since the Levallois flake production is an essential feature of the entire Middle Palaeolithic, Bosinski concludes that these quartzite extraction sites were frequented over a long period of time (over the entire Middle Palaeolithic)<sup>97</sup>.

Richter has already assigned two Middle Palaeolithic quartzite extraction sites (Reutersruh and Rörshain) to the late Middle Palaeolithic (M.M.O.)<sup>98</sup>. Possibly Ratingen is to be seen in this context as well. The combination of the two components, bifacial tools and Quina-, discoidal or Levallois blank production, has been proven at all cited sites except Battenberg and therefore speaks for the assignment to one of the phases of the M.M.O. Which one, according to the current state of research, cannot be reliably determined.

The attempt of a chrono-cultural classification of the Troisdorf-Ravensberg site has shown that it is worthwhile to reject the idea of a causal relationship between the Levallois flake production and large raw material deposits. Rather, it has been observed that at such sites the diversity of lithic reduction strategies and, consequently, the diversity of core configurations is very large.

*Quartzite extraction sites – a uniform special task site? (A. P.)* Troisdorf-Ravensberg appears to be a quartzite extraction site with a well-defined technological behaviour. About two hundred

<sup>88</sup> J.P. Thissen, Die paläolithischen Freilandstationen von Rheindahlen im Löss zwischen Maas und Niederrhein. Rhein. Ausgr. 59 (Mainz 2007).

<sup>89</sup> M. Bolus, Review: Jürgen Thissen, Die paläolithischen Freilandstationen von Rheindahlen im Löss zwischen Maas und Niederrhein. Mitt. Ges. Urgesch. 16, 2007, 133–147.

<sup>90</sup> For the definition of the term see Richter, Sesselfels-grotte III; Jöris, Keilmessergruppen (note 86).

<sup>91</sup> Richter, Altsteinzeit.

<sup>92</sup> Bosinski, Paläolithikum II.

<sup>93</sup> Bosinski, Rhein 106.

<sup>94</sup> Bosinski, Paläolithikum II.

<sup>95</sup> Bosinski, Paläolithikum II.

<sup>96</sup> See A. Pastoors / Y. Tafelmaier / G. C. Weniger, Quantification of late Pleistocene core configurations: Application of the Working Stage Analysis as estimation method for technological behavioural efficiency. Quartär 62, 2015, 63–84; Vaquero/Romagnoli, Assemblages.

<sup>97</sup> Bosinski, Rhein 101.

<sup>98</sup> J. Richter, Leave at the height of the party. A critical review of the Middle Paleolithic in Western Central Europe from its beginnings to its rapid decline. Quaternary Internat. 2016; Richter, Altsteinzeit.

kilometres in the east and south from Troisdorf-Ravensberg there are some Middle Palaeolithic sites where, as at Troisdorf-Ravensberg, the initialisation of quartzite was carried out directly at the site of the primary deposit (mainly Reutersruh, Rörshain, Lenderscheid-Voßberg and Battenberg) (Figure 59). Two sites of similar character in North Rhine-Westphalia (Ratingen and Liedberg) are mentioned repeatedly in the discussion<sup>99</sup>, but their comparability must be viewed critically. The question arises whether the technological behaviour at the sites mentioned above is comparable to that of Troisdorf-Ravensberg and whether thus a uniform site type emerges, or whether differences in the find material make a conceptual specification necessary.

The Reutersruh is a hilltop area on the edge of the Schwalmthal near Ziegenhain. Archaeological finds of local quartzite were mainly gathered by surface assemblage, but also by excavations<sup>100</sup>. A total of 1584 cores (surface methods in various stages of processing and discoidal cores), 3726 classifiable flakes and 625 formal tools (bifacial tools – including unfinished hand axes, side scrapers and end scrapers) are documented. Bosinski understands unfinished hand axes as »coarse and often only partially trimmed pieces with irregular edges«<sup>101</sup>. »The desired final shape is not always recognizable. There are transitions to the finished hand axes, all the more so as these are often only roughly worked«. The authors regard the Reutersruh assemblage as an exploitation site of the locally occurring quartzite.

In the immediate vicinity of the Reutersruh site, the Rörshain site is located in a sand pit not far from the village of Rörshain in the central Hessian highlands<sup>102</sup>. Intensive collection activities and several excavations up to 1974 led to a very rich assemblage of lithic artefacts. Unfortunately, only small parts of the finds have been examined, so that nothing can be said about the lithic reduction strategies. According to Bosinski, Rörshain is one of the richest locations of Central European Palaeolithic sites<sup>103</sup>. Up to one thousand artefacts originate from one square metre. The reason for this quantity is the quartzite found in large natural blocks, which was used as raw material for the artefact production. The site largely has the character of a workshop, with an immense flake material and many cores contrasting with a small percentage of formal tools<sup>104</sup>. Among the formal tools, the leaf points are particularly striking. According to Stefan Graßkamp, these were produced up to the final working stages using a standardised process, which is independent of the cross-section, outline or size of the respective leaf point<sup>105</sup>. The extent to which the natural conditions of the raw material piece had an influence on the production of leaf points on site can only be assumed. In any case, it is interesting to note that, unlike Reutersruh, quartzite in Rörshain is not found in block-like formations, but in large slab-shaped, round or oval plates. These slabs have a thickness of twenty to forty centimetres and a diameter of up to two metres<sup>106</sup>.

Near Frielendorf in the Schwalm-Eder district of northern Hesse, Lenderscheid-Voßberg is another quartzite resource that was used in the Middle Palaeolithic for the provision of raw materials<sup>107</sup>. In the literature, the site is also known as Lenderscheid. According to Heribert Heidenreich, the special feature of the site lies less in the often-mentioned formal tools, but rather in the fact that numerous quartzite sites are situated around the Voßberg<sup>108</sup>. The large amount of lithic artefacts in the Lenderscheid-Voßberg assemblage has so far been an obstacle for further

<sup>99</sup> Schmitz, Neandertal; Thissen/Pieper/Musshoff, Liedberg.

<sup>100</sup> Luttrupp/Bosinski, Reutersruh.

<sup>101</sup> Luttrupp/Bosinski, Reutersruh 69.

<sup>102</sup> Bosinski, Rörshain; Luttrupp/Bosinski, Rörshain (note 1).

<sup>103</sup> Bosinski, Rörshain.

<sup>104</sup> Bosinski, Rörshain 27 f.

<sup>105</sup> S. Graßkamp, Die mittelpaläolithischen Blattspitzen von Rörshain (Schwalmthal, Hessen), Grabung 1965 (M.A.-thesis, Cologne 2001) 118.

<sup>106</sup> Ibid. 22.

<sup>107</sup> Heidenreich, Lenderscheid.

<sup>108</sup> Heidenreich, Lenderscheid 6.

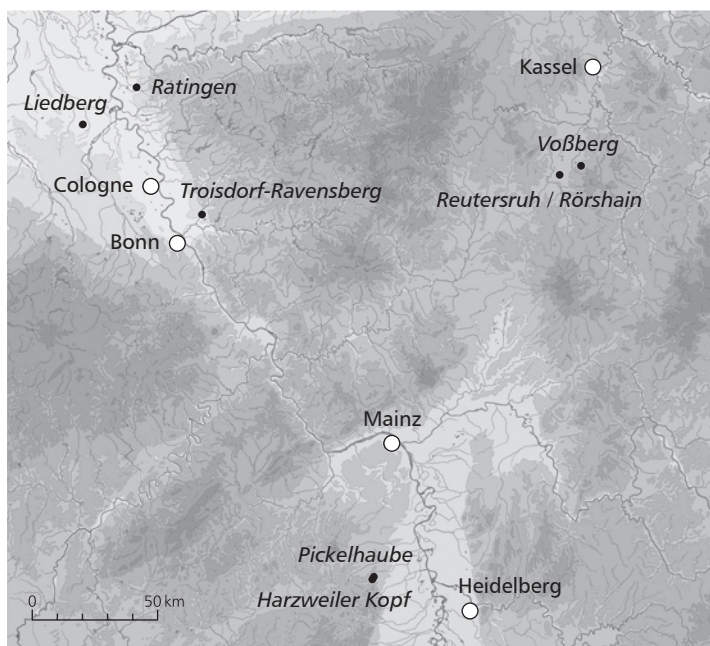
<sup>109</sup> U. Wohnhaas, Kerne der mittelpaläolithischen Steinbearbeitungswerkstatt Battenberg, Gem. Grünstadt (Pfalz) (M.A.-thesis Cologne 2001).

<sup>110</sup> Ibid. 55.

<sup>111</sup> Schmitz, Neandertal.

<sup>112</sup> Schmitz, Neandertal.

Figure 59 Location of Middle Palaeolithic quartzite extraction sites (*italics*) mentioned in the text. Pickelhaube und Harzweiler Kopf belong to the Battenberg region.



research. For example, the lithic reduction strategies are considered largely unexplored. The reason for the large amount of artefacts lies in the exceptionally good quality of the quartzite, whose knapping properties are comparable to that of flint stone. Lenderscheid-Voßberg's raw materials include fine-grained, light-coloured quartzite, which is occasionally interspersed with brownish or whitish stripes.

Near the village of Battenberg in southeastern Rhineland-Palatinate the two Middle Palaeolithic sites Pickelhaube and Harzweiler Kopf are situated, containing an unknown number of artefacts of unspecified dating made from local quartzite. Ulrike Wohnhaas has studied the configuration of the cores in her master thesis<sup>109</sup>. For this purpose she examined thirty-eight cores with the working stage analysis. She was able to identify five different reduction strategies. These include the surface recurrent centripetal, unidirectional and unidirectional convergent as well as the surface preferential and the discoidal method<sup>110</sup>. As this is only the result of a small number of samples, more can certainly be found in the assemblage. For the comparison with the assemblage of the Troisdorf-Ravensberg, the results of the technological investigations by Wohnhaas are particularly interesting. Of 549 negative flake scars on the 38 examined cores the respective terminal ends are preserved, of which 328 are flat (59,7 percent) and 221 end as hinge (40,3 percent). Of the negative flake scars ending as hinge, 212 showed the chronological position within the reduction sequence. Of these, 28 fall into the first half of the reduction sequence (13,2 percent) and 184 into the second (86,8 percent) with a maximum of 94 negative flake scars at the end of the reduction sequence (44,3 percent). Therefore, a possible cause for the discard of the cores was the hinge.

In the west of Ratingen, the Rhine has transported and washed out large natural blocks and slabs of quartzite, which were then used specifically for the manufacture of tools. While the formal tools were taken for future usage, wastes as well as damaged and broken tools were left behind in Ratingen<sup>111</sup>. The site within a gravel quarry, about six kilometres north of Düsseldorf, is difficult to assess for source criticism. A total of 458 lithic artefacts made of local quartzite (among them bifacial tools with plano-convex as well as biconvex cross section, cores and blanks) originate from a find area of more than 350.000 square metres from a seven metres thick sediment package which is assigned to the Niederterrasse of the Rhine<sup>112</sup>. This

lithic reduction strategies		TRO	RAT	REU	RÖR	LEN	BAT	
surface (incl. Levallois)	recurrent	centripetal	x	x	x	n.p.	x	x
		unidirectional	x	x	x		x	x
		bidirectional		x	x			
	preferential	unidirectional	x	x	x		x	x
		convergent						x
volume		discoidal	x	x	x		x	
		blade			x			
opportunistic		Kombewa	x					
		flake	x		x			x
		blade	x				x	
systematic production of bifacial tools			x	x	x	x		

Table 11. Lithic reduction strategies and systematic production of bifacial formal tools on site at the discussed quartzite extraction sites (n.p. – not published).

corresponds to a find density of one find per five thousand cubic meters of sediment. Due to the very roughly documented earthmoving work, the exact circumstances of the finds are unclear. Pieces larger than twenty centimetres were sorted out and those smaller than three centimetres fell through the sieve grid. All in all, it can be assumed that the exploitation of the locally occurring quartzite took place in Ratingen, but the assemblage of the lithic artefacts of Ratingen is difficult to assess for the reasons mentioned. It is possible that detailed technological research can provide arguments for the reconstruction of the function or functions of the site or sites.

The quartzite hilltop of Liedberg, south of Korschenbroich near Mönchengladbach, was partially formed from diagenetically hardened Miocene sea sands. Its top at 77 metres above sea level overlooks the surrounding countryside, characterised by the river meadows of Niers, Trietbach, Kommer and Jüchener Bach. With an extension from southwest to northeast its surface area is seven hundred to three hundred metres. Liedberg is mentioned by Harald Floss under number 162 as the primary locality of tertiary quartzite<sup>113</sup>, which was used as raw material at different times. This is proven by archaeological finds in the northern Rhineland<sup>114</sup>. However, on-site investigations could not find any indication of a systematic exploitation of the locally occurring quartzite. Liedberg quartzite pebbles can be found in the middle terrace gravel of the Rhine<sup>115</sup>.

The mentioned sites are all interpreted as quartzite extraction sites. According to Bosinski, they are characterized by an immense account of flake material, many cores and small amounts of formal tools<sup>116</sup>. These criteria apply in different ways to the listed sites, whereby the differences in the topographical situation as well as in the systematic production of bifacial formal tools on site are striking. There is sufficient evidence at the Hessian sites (Reuthersruh, Rörshain, Lenderscheid-Voßberg), in Ratingen this production is assumed and at Troisdorf-Ravensberg

<sup>113</sup> H. Floss, Rohmaterialversorgung im Paläolithikum des Mittelrheingebietes. Monogr. RGZM 21 (Bonn 1994).

<sup>114</sup> Thissen/Pieper/Musshoff, Liedberg.

<sup>115</sup> Thissen/Pieper/Musshoff, Liedberg.

<sup>116</sup> Bosinski, Rörshain.

<sup>117</sup> L. R. Binford, In Pursuit of the Past. Decoding the Archaeological Record (New York 1983).

<sup>118</sup> W. Meier-Arendt, Die Steinzeit in Köln (Köln 1975).

<sup>119</sup> H. Floss, Bonn-Muffendorf und die Chalcedone des Rheinlandes. Natürliche Vorkommen und paläolithische Nutzung. Jahrb. RGZM 36, 1989, 159–177;

M. Baales, Bonn-Bad Godesberg, Ortsteil Muffendorf. Paläolithischer Fundplatz und Rohmaterialvorkommen. In: J. Kunow / H. H. Wegner (eds.), Urgeschichte im Rheinland (Köln 2006) 310 s.; M. Baales / I. Koch, Ein lohnenswerter Besuch in Muffendorf. Neue mittel- und jungpaläolithische Chalcedonartefakte aus dem Rheinland. Arch. Rheinland 2015, 67–69.

<sup>120</sup> J. Baena Preysler et al., Searchers and miners. First signs of flint exploitation in Madrid's region. In: M. Capote / S. Consuegra / P. Diaz-del-Rio et al. (eds.), Flint

and Battenberg the configuration of such tools was only marginally important. The fact that no reference to the configuration of bifacial formal tools could be documented on these two sites suggests that it is a different subtype of quartzite extraction site.

Apart from that, the Troisdorf-Ravensberg lithic reduction strategies are very similar to those in other Middle Palaeolithic quartzite extraction sites (Table II). The strategies, marked by presence and absence in the Table, are very unequal and not designed for a specific reduction system.

In conclusion, two subtypes of quartzite extraction sites can be identified: Troisdorf-Ravensberg and Battenberg without a systematic production of bifacial tools, and Ratingen, Reutersruh, Rörshain and Lenderscheid-Voßberg with such production. Within the M.M.O., two subtypes of quartzite extraction sites thus emerge.

## Conclusion

The site at Troisdorf-Ravensberg is a special Middle Palaeolithic site in the middle of a natural tertiary quartzite outcrop. Besides the evidence of tertiary quartzite extraction and exploitation on site, there is no evidence of any settlement activity, which makes it a site with qualified activities according to Binford's categorization<sup>117</sup>. By including the natural blocks, frost shards, pebbles and slabs without any traces of anthropogenic transformation in the overall analysis of the archaeological finds, the processes of selection and the first steps of initialisation and exploitation are investigated.

The interdisciplinary interaction of geoscientific and archaeological investigation shows once again that only in this way the genesis of the site can be reconstructed and dated. The site does not offer any conditions for the preservation of latent and evident features due to the embedding of the finds in deposits accumulated by gelisolifluctional transport. Therefore, spatial investigations of the documented activities do not make sense.

Prehistoric humans chose natural blocks and frost shards with a weight between one and five and a half kilo. Petrographic characterization of the quartzites shows that of three different types or varieties, one offers very good knapping properties (MA\_MQC). After first impressions this quartzite was preferred for further processing, but without evidence of their immediate use on site. Whether cores or flakes from the site were exported can only be assumed. However this cannot be ruled out, as the core of quartzite from the Ostfriedhof in Cologne-Dellbrück suggests<sup>118</sup>.

In order to further understand the role of Troisdorf-Ravensberg and the other Middle Palaeolithic quartzite extraction sites, it is necessary to include in future investigation other quartzite, flint or chalcedony extraction sites of different parts of Europe, such as Bonn-Muffendorf (North Rhine-Westphalia, Germany)<sup>119</sup>, El Cañaveral (Madrid, Spain)<sup>120</sup>, El Habario<sup>121</sup> or Chêne Vert à Dirac (Charente, France)<sup>122</sup>.

Due to the wide range of documented technological behaviour, the quartzite extraction sites are an appropriate subject for further considerations on the curated and expedient, or high-cost and low-cost debate<sup>123</sup> and thus on the efficiency of human technological behaviour. This is of particular relevance, because according to ethnographic studies, the economisation of resources

mining in Pre- and Protohistoric times. Proc. 2nd Internat. Conference UISPP Commission, Madrid 2009. B.A.R. Series 2260 (Oxford 2011) 203–220.

<sup>121</sup> E. Carrión / J. Baena Preysler, El Habario. Una ocupación musteriense al aire libre en los Picos de Europa. In: R. Montes / J.A. Lasheras (eds.), *Actas de la reunión científica: Neandertales cantábricos, estado de la cuestión*. Museo de Altamira 2004 (Madrid 2005) 446–460; A. Prieto et al., Quartzite procurement in

conglomerates and deposits. Geoarchaeological characterization of potential catchment areas in the central part of the Cantabrian Region, Spain. *Geoarch. Early View*, 2021, 1–21.

<sup>122</sup> M.-C. Dawson et al., Nouvelles données sur l'exploitation des gîtes de silex au Paléolithique moyen. L'atelier de taille moustérien du Chêne Vert à Dirac (Charente, France). *Paléo* 23, 2012, 55–84.

<sup>123</sup> See Vaquero/Romagnoli, *Assemblages*.

was of vital interest and part of adaptation strategies in hunter-gatherer communities. Mobility and changing accessibility to predictable and non-predictable resources govern economic behaviour<sup>124</sup>. Besides this basic strategy, there are situations among recent hunter-gatherers in which all available stocks are consumed at once. This behaviour is called prodigality<sup>125</sup>. However, prodigality must be seen in its context. It is free of obsessions of scarcity and rather testifies to an affluent moment embedded in the trust in the abundance of nature's resources<sup>126</sup>. In summary, for recent hunter-gatherers economic management of natural resources is important and sometimes interrupted by moments of deviant behaviour. Whether the quartzite extraction sites are evidence of any kind of prodigality is very interesting but cannot and should not be decided at this point. The preference of certain raw pieces – their quality and their dimensions – and the early discard of cores after knapping accidents offer sufficient opportunities to discuss these questions of technological behaviour efficiency.

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*Image credits.* Figure 1–3 LVR-ABR, Erich Claßen, Map base: Geobasis NRW 2020. Major geological units were taken from the Informationssystem Geologische Karte von Nordrhein-Westfalen sine anno. Geologische Karte von Nordrhein-Westfalen. 1:100.000 (Krefeld sine anno). – Figures 15 and 16 Felix Henselowsky. – Figures 17–38 Martin Kehl. – Figure 39 Georgina King. – All others Andreas Pastoors, partly in cooperation with Josef Halm (4 and 5), Felix Henselowsky (6) and Martin Kehl (7–14).

<sup>124</sup> M. J. Casimir, The dimensions of territoriality. An introduction. In: id. / A. Rao (eds.), *Social and Spatial Boundaries among Foragers, Fishers, Pastoralists and Peripatetics* (New York 1992) 1–26; S. L. Kuhn, *Mousterian Lithic Technology. An Ecological Perspective* (Princeton 1995); C. S. Fowler / N. J. Turner, *Ecological/cosmological knowledge and land management among hunter-gatherers*. In: R. B. Lee / R. Daly (eds.),

*The Cambridge Encyclopedia of Hunters and Gatherers* (New York 1999) 419–425; I. J. Wallace / J. J. Shea, *Mobility patterns and core technologies in the Middle Paleolithic of the Levant*. *Journal Arch. Scien.* 33, 9, 2006, 1293–1309.

<sup>125</sup> M. Sahlins, *Stone Age Economics* (Chicago 1972) 30.

<sup>126</sup> *Ibid.*

## Abbreviations

Boëda, Levallois	E. Boëda, <i>Le concept Levallois. Variabilité des méthodes.</i> Monogr. CRA 9 (Paris 1994).
Bosinski, Paläolithikum	G. Bosinski, <i>Das Paläolithikum.</i> In: id. / J. Richter (eds.), <i>Paläolithikum und Mesolithikum. Geschichtlicher Atlas der Rheinlande II 1</i> (Köln 1997) 3–33.
Bosinski, Rhein	id., <i>Urgeschichte am Rhein</i> (Tübingen 2008).
Bosinski, Rörshain	id., <i>Der mittelpaläolithische Fundplatz Rörshain, Stadtkreis Schwalmstadt (Hessen).</i> Arch. Inf. 2/3, 1974, 27 s.
Fiedler/Veil, Ravensberg	L. Fiedler / S. Veil, <i>Ein steinzeitlicher Werkplatz mit Quarzitartefakten vom Ravensberg bei Troisdorf, Siegkreis.</i> Bonner Jahrb. 174, 1974, 378–407.
Heidenreich, Lenderscheid	H. Heidenreich, <i>Die Quarzitschlagplätze bei Lenderscheid, Gemeinde Frielendorf, Schwalm-Eder Kreis. Rohstoffzentrum eines Siedlungsraumes vom Paläolithikum bis zum Neolithikum.</i> Kleine Schr. Vorgesch. Seminar Marburg 45 (Marburg 1996).
Luttropp/Bosinski, Reutersruh	A. Luttropp/G. Bosinski, <i>Der altsteinzeitliche Fundplatz Reutersruh bei Ziegenhain in Hessen.</i> Fundamenta A 6 (Köln und Wien 1971).
Richter, Sesselfelsgrötte III	J. Richter, <i>Sesselfelsgrötte III. Der G-Schichten-Komplex der Sesselfelsgrötte. Zum Verständnis des Micoquien.</i> Quartär-Bibliothek 7 (Saarbrücken 1997).
Richter, Altsteinzeit	J. Richter, <i>Altsteinzeit. Der Weg der frühen Menschen von Afrika bis in die Mitte Europas</i> (Stuttgart 2018).
Schmitz, Neandertal	R. W. Schmitz, <i>Das Alt- und Mittelpaläolithikum des Neandertals und benachbarter Gebiete</i> (Diss. Cologne 1996).
Schwabedissen, Quarzit-Fundplätze	H. Schwabedissen, <i>Quarzit-Fundplätze mit Faustkeilen aus dem Rheinland.</i> In: id. / K. Gripp / R. Schüttrumpf (eds.), <i>Frühe Menschheit und Umwelt I.</i> Festschrift Alfred Rust. Archäologische Beiträge (Köln 1970) 99–109.
Thissen/Pieper/Musshoff, Liedberg	J. P. Thissen / P. Pieper / F. Musshoff, <i>Das Mittelpaläolithikum vom Liedberg.</i> Bonner Jahrb. 193, 1993, 221–235.
Vaquero/Romagnoli, Assemblages	M. Vaquero / F. Romagnoli, <i>Searching for Lazy People. The Significance of Expedient Behavior in the Interpretation of Paleolithic Assemblages.</i> Journal Arch. Method and Theory 25, 2, 2018, 334–367.

*Resümee.* Neue Ausgrabungen an der mittelpaläolithischen Fundstelle Troisdorf-Ravensberg wurden im Jahr 2015 durchgeführt und beleuchten die Erschließungsmechanismen eines natürlichen primären Quarzit-Vorkommens mit dem Ziel der Weiterverwendung bei der Produktion von Steinartefakten. Stratigraphie und Altersstellung der lang bekannten Fundstelle sowie das technologische Verhalten des Steinmaterials wurden untersucht. Die Funde dort wurden in der Jüngeren Dryaszeit als Teil eines postsedimentären Umlagerungsprozesses in die heutige Position verlagert. Neandertaler haben an dieser Stelle natürliche Blöcke und Frostscherben ausgewählt und vor Ort mit verschiedenen Methoden aufwandsarm weiterverarbeitet. Aufgrund typologischer und taphonomischer Argumente ist das Inventar als Moustérien mit Micoquien-Option-B zu bestimmen.

*Abstract.* New excavations carried out in 2015 at the Middle Palaeolithic site of Troisdorf-Ravensberg shed light on the exploitation mechanisms of a natural primary quartzite outcrop with the aim of further use in the production of lithic artefacts. The site, known already for a long time, has been investigated concerning stratigraphy, dating and technological behaviour of the resource. The finds were relocated to their present position in the Younger Dryas as part of post-sedimentary repositioning processes. Here, Neandertals selected natural blocks and frost sherds and processed them with little effort applying various concepts/methods. Based on typological and taphonomic arguments, the inventory is to be addressed as Mousterian with Micoquian-Option-B.

*Résumé.* De nouvelles fouilles menées en 2015 sur le site du Paléolithique moyen de Troisdorf-Ravensberg mettent en lumière les mécanismes d'exploitation d'un gisement naturel de quartzite dans le but d'une utilisation ultérieure pour la production d'objets lithiques. Au site connu depuis longtemps, on a appliqué des études détaillées sur la stratigraphie, la datation et le comportement technologique de la matière première. Les vestiges ont été déplacés dans leur position actuelle pendant le Dryas récent dans le cadre de processus de repositionnement post-sédimentaire. Les Néandertaliens ont sélectionné ici des blocs naturels et des éclats de gel et les ont transformés avec peu d'efforts en appliquant diverses méthodes. Sur la base d'arguments typologiques et taphonomiques, l'inventaire doit être considéré comme Moustérien à Option Micoquienne-B.