Ines Medved

Continuity vs. Discontinuity

Epipaleolithic and Early Neolithic in the Mediterranean Southeast of the Iberian Peninsula

Inaugural dissertation submitted
in fulfilment of the requirements for the doctor's degree
at the Faculty of Philosophy at the University of Cologne

Supervisors: Prof. Dr Gerd-Christian Weniger,
Prof. Dr Andreas Zimmermann & Prof. Dr Thomas Widlok

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Content

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Unfortunately my Spanish remained on a basic level and entering in the completely new research topic was challenging. Thanks to all the kind colleagues, who encouraged me patiently in my work and hardly expressed doubts, but supported me with suggestions, their broad knowledge and always welcomed me very sincerely. Several colleagues also entrusted me with their unpublished works.

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After the data acquisition, I faced to the evaluation of the research questions. In this context, I thank Dr Georg Roth, who supported me with extended expert advice and with a spontaneous R Statistical Computing course.

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Collaborative Research Center 806

The present study is part of the Collaborative Research Center (CRC) 806 *„Our Way to Europe. Culture-Environment Interaction and Human Mobility in the Late Quaternary*“ (www.sfb806.uni-koeln.de) funded by the German Research Council (DFG). The CRC focuses on various dispersal processes of the anatomical modern humans over the last 190,000 years in and around Europe under varying climatic and environmental conditions. Of course colleagues investigate evidence relating to "Out of Africa II", but, amongst others, the Neolithization is also a research object ("secondary dispersals").

Within this CRC the study area of the C-Cluster comprises Spain and NE Morocco. Prof. Gerd-Christian Weniger is principal investigator of *"The Western Mediterranean – Bridge or Barrier?"*. In subproject C2 *"Early Holocene Contacts between Africa and Europe and their Palaeoenvironmental Context"* Dr Jörg Linstädter, myself and several research assistants and bachelor students studied the transition to the Neolithic in the Alboran region, i.e. Murcia, Almería, Granada, Málaga and NE Morocco. For about 15-20 years, members of the project have been investigating in Spain and Morocco. Particularly Middle and Upper Paleolithic are another research focus in Spain. Three other PhD projects deal with the Middle and Upper Paleolithic transition in N Spain (Yvonne Tafelmaier), the Solutrean on the Iberian Peninsula (Isabell Schmidt), the Gravettian (Marcel Brathmöller) of NE Spain, and the Climate reconstruction (Nicole Höbig). Additionally, AP Dr Martin Kehl supervised several theses with geographical foci on the W Mediterranean. Affiliated with the *Institut National de Sciences de l'Archéologie et du Patrimoine* (*INSAP*, Rabat/Morocco) and the *Kommission für Archäologie außereuropäischer Kulturen* of the *Deutsches Archäologisches Institut* (*KAAK, DAI*, Bonn/Germany) research took place in NE Morocco.

1. Approach and research questions

This study deals with the initial Neolithization process in the SE Iberian Peninsula, i.e. the transition from Epipaleolithic to Early Neolithic approached by attribute comparisons and selected, specific statistical analyses (see **Fig. 1**). An aim is to complete related studies (cf. **2.1. Overview**) in presenting alternatives to the single-item-comparisons based on typology. The complete database is available in NESPOS (2013) associated with the DOI 10.12853/RESDB.NESPOS.0001.

The short overview of the research (**2.1. Overview**) unfolds a variety of investigations. These investigations depict on the one hand a multi-facetted picture of the Early Neolithic with many individual cases. However, on the other hand, the Early Neolithic dispersal and settlement of SE Spain remains of course still incomplete. It is partly the poor state of publishing that aggravates the interpretation of confusing sequences and stratigraphies. The revival of ancient, even obsolete, research-historical terms is confusing (cf. **2. Current state of research on Early to Middle Holocene archaeology in SE Spain**). These terms have not been unmistakably falsified, but rather inwardly displaced by new designations. A really serious problem arises from the lack of radiocarbon datings (cf. **2.2. Chronology**), i.e. the missing verification of relative chronologies by 14C-ages. In particular for the Epipaleolithic in SE Spain, specialized, intensive research is missing (pers. comm. N. Gallego Lletijós). Furthermore, Epipaleolithic findings have rarely been consulted to explain the transitional process, and only one single study compares sites of both stages systematically (AFONSO MARRERO 1993). However, the data so far recorded in previous studies is inaccessible and prevents additional comparisons with respect to other aspects or the integration of more recently studied assemblages. Neolithization is predominantly approached via modeling based on the Neolithic sites and findings. Generally chronological classifications are made of apparently "soft" criteria, i.e. partly single "similarities". E.g. CÁMALICH ET AL. (2004, 190) revive the statement of MARTÍN SOCAS ET AL. (1998) about CNP/AL: "This corresponds to findings from other Western Andalusia locations *such as*…".

A general review of the current discussed Neolithization models and adaptive cycles is compiled in **2.3. The Neolithization of the W Mediterranean in its European context**. In this study I focus on the regional Neolithization in the working area (cf. **3. Study area**). The selection of sites is problematic: The relative chronological classification of the assemblages evaluated here is a big issue and is generally ambiguous. This generalization should be kept in mind when considering the approaches and results of this study. In the near future, more reliable data from recently excavated and currently studied sites is to be expected (cf. **3.1. Sites**).

Farming, animal husbandry and ceramic production and usage are great, allochthonous innovations and detach the Early Neolithic unequivocally and obviously from the previous Epipaleolithic. With the initialization of these truly unprecedented matters, one could expect a transitional stage, especially when considering a transfer of ideas as a cause. E.g. a limited implementation, a low number of animals or pottery, small fields, a limited spectrum of domesticated species, pottery forms, decorations or the like, and through time, gradual increases could be characteristic of a transition. In contrast, the sudden occurrence of the complete "Neolithic package" points to the migration of farmers.

On the basis of the present research recorded in the literature and the new data acquisition in this study, the following questions will be addressed to elaborate the models on a regional scale (cf. also **Fig. 2**). Indicators and applied methods as well as the reference to the relevant sections are given in brackets and compiled in **Fig. 1**.

1. How did Neolithic elements disperse in the research area?
   1.1. Who were the predominant active agents in this process? Similarities or dissimilarities in the evidence from Epipaleolithic and Early Neolithic could point on the one hand to a continuity and thus the Epipaleolithic residue should be determined as base for the Early Neolithic in terms of tradition with an introduction of the new elements predominantly by a transfer of ideas. Or, on the other hand, a rupture between both periods could mark a demographic change with colonizing farming communities. Of course intermediate positions between these two extremes, combined or varying approaches for different areas can be expected.
      1.1.1. Do the sites (site structure/organization and features) of Epipaleolithic and Early Neolithic differ? (cf. **3.1. Sites**). What kinds of sites are there? How are the sites structured? Are activity areas distinguishable and are features preserved? Are the sites due to seasonal, repetitive, short-term stays? Did people occupy sites to conduct special tasks or to exploit certain resources? What kinds of activities took place on-site and in the surrounding? Or are the sites long-term settlements, e.g. with fixed structures? How mobile were Epipaleolithic and Early Neolithic settlers (cf. additionally, **5.3.1.2. Temper types and raw material origins**)? What was the subsistence like? (cf. **3.1. Sites** and **3.1.2.5. Evaluated sites and archaeological characterization**).
      1.1.2. How do the find assemblages of both stages differ? Which of the various find categories are present? (cf. **3.1. Sites** and **3.1.2.5. Evaluated sites and archaeological characterization**).
      1.1.3. Is an initial stage of pottery introduction feasible, indicating a gradual or stepwise introduction or was the pottery knowledge introduced all at once by colonists? (cf. attribute comparison in **5.4. Descriptive analyses**, **5.6. Conclusion: The pottery assemblages as indicators of the Neolithization process**, paragraph II and cf. thoughts about a relative chronology of the Early Neolithic in **5.5.2.2. CA of pottery decoration motifs**).
      1.1.4. Do lithic assemblages of the Epipaleolithic and Early Neolithic differ? How do lithic assemblages vary concerning the various stages of the *chaîne operatoire*, e.g. raw material supply, reduction process, on-site and off-site activities in both stages? (cf. attribute comparisons in **4.4. Descriptive analyses: Reconstruction of the reduction sequence (*chaîne operatoire*)**). How intensely did people conduct the activities present? (cf. Stage 5 of the reduction sequence in **4.4. Descriptive analyses: Reconstruction of the reduction sequence (*chaîne operatoire*)**). Are Epipaleolithic and Early Neolithic occupation horizons dissimilar in their blank and tool spectrum or is the dissimilarity due to their location? (cf. distance matrices in **4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra**). Are the different groupings of the sites concerning blank spectrum equivalent to the groupings of the tool spectrum? (cf. Mantel test in **4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra**).
2. Did the Neolithic disperse along different (bioclimatic) zones or via regional groups?
   2.1. Do variances in the finds (i.e. distinct lithic or pottery attributes) and sites occur locally clustered allowing to define zones or regional groups? (cf. attribute comparisons concerning the pottery in **5.4. Descriptive analyses** and the lithic artifacts in **4.4. Descriptive analyses: Reconstruction of the reduction sequence (*chaîne operatoire*)**, furthermore the sequence by the correspondence analyses of the pottery decorations in **5.5. Similarities in pottery**

decoration: Sequence as defined by correspondence analyses (CA) and the distance matrices applied to the location of the sites in **4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra**).

2.2. How do occurrences of various combined pottery decorations correlate with each other? Do clusters appear? (cf. **5.5. Similarities in pottery decoration: Sequence as defined by correspondence analyses (CA)**).

2.3. What about culture-environment-interaction and adaptive cycles?

3. When precisely around 7500 calBP did the transition took place absolute chronologically? (cf. **2.2. Chronology** and **6. New radiocarbon dates**).

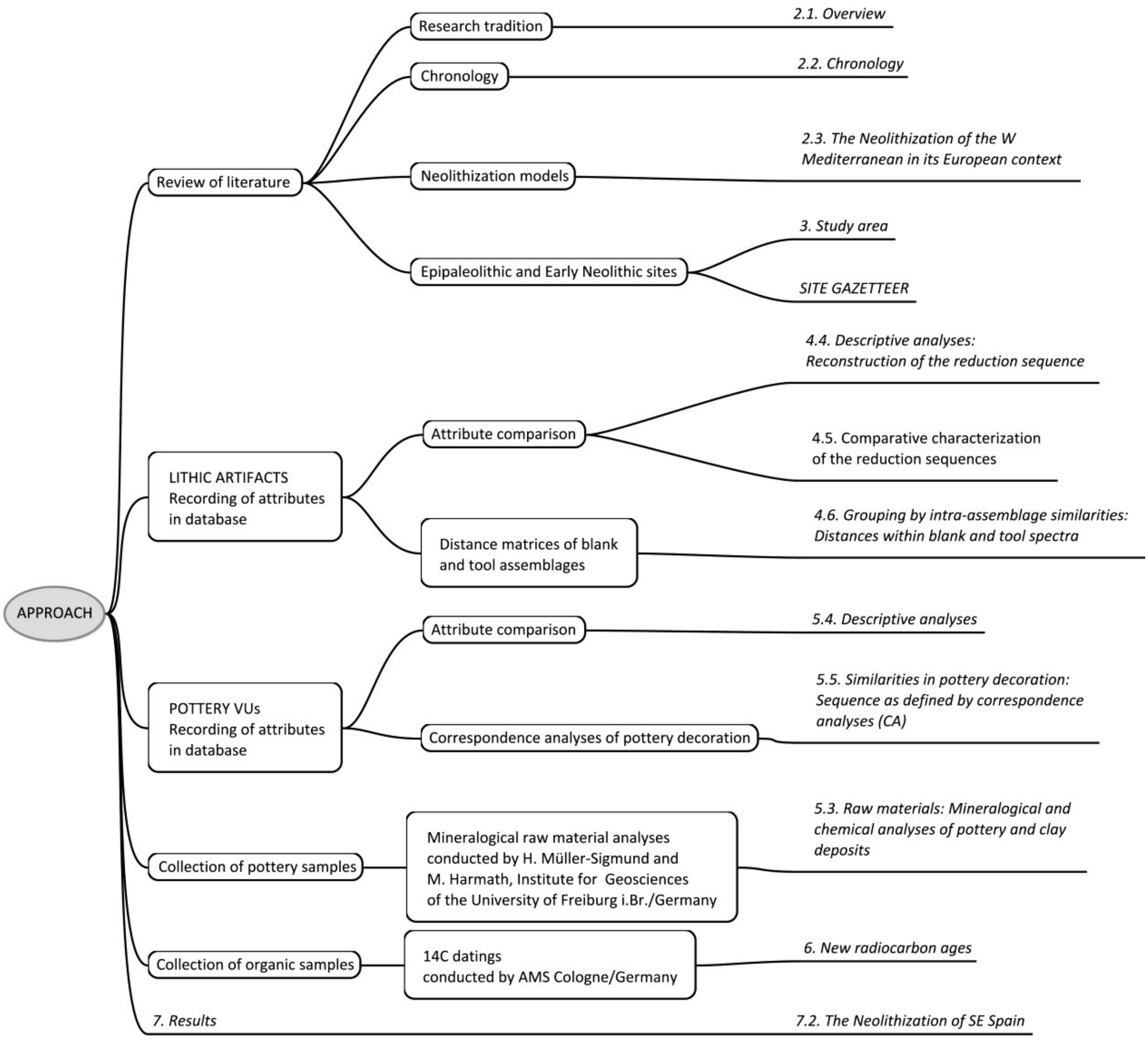

Fig. 1 Approaches used in this study to address the research questions and references to the evaluation chapters.

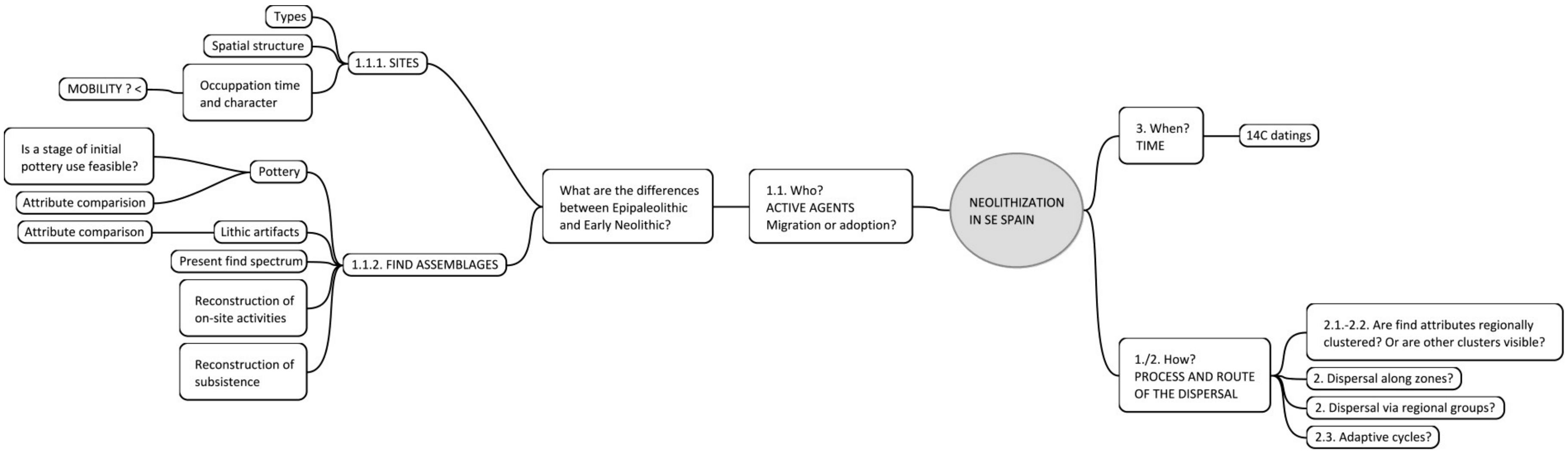

Fig. 2 Research questions.

2. Current state of research on Early to Middle Holocene archaeology in SE Spain

2.1. Overview

VAN WILLIGEN (2006, 16-34, 38-42; 59) recently presented diverse research concerned with the Neolithization, Early Neolithic and the Holocene hunter-gatherers in the W Mediterranean. ROMAN DÍAZ (1996) summed up the main investigators, who dealt with the SE Iberian Neolithic. Generally research about Early to Middle Holocene archaeology in SE Spain is influenced by a long tradition originating in the 19th century. Various sites were excavated for several seasons – some even for decades – and by various teams. Based on this work, scientists developed different concepts to explain the records: Besides initial works by VILANOVA Y PIERRA (1872) and SIRET/SIRET (1887), especially the cultural definitions by BOSCH GIMPERA (from 1932 onwards) echo still in the research community. He defined amongst others the *Cultura de las cuevas* that currently corresponds more or less to Early Neolithic sites and the *Cultura de Almería* for the subsequent Neolithic and Bronze Age (in summary ROMAN DÍAZ 1996, 56-78 with references therein).

A supra-regional explanation for the Neolithic dispersal and characteristics including the N African coast came in focus shortly before the middle of the 20th century (MARÍNEZ SANTA-OLALLA 1946; SAN VALERO APARISI 1946; cf. LINSTÄDTER ET AL. 2012b). Another milestone was the study by BERNABÓ BREA (1946, 1956) of the Arene Candide-site in Liguria/Italy presenting the impressed pottery decoration as a central feature of the Early Neolithic.

After excavations of Cueva de la Carigüela/Granada (Pellicer 1959 and 1960 cf. **Tab. 9**), NAVARRETE (1976) insisted on Early Neolithic settlers as predominantly cave-dwellers near the coast. She presents a large study of pottery assemblages from sites so far known and describes in particular the inventory of Carigüela in detail (cf. **SITE GAZETTEER**: **Cueva de la Carigüela/Granada**). Additionally, she did archeometric pottery and clay analyses (cf. **5.3. Raw materials: Mineralogical and chemical analyses of pottery and clay deposits**).

Since MARTÍNEZ FERNÁNDEZ' thesis (1985), attribute comparisons are commonly applied. Previously the study and comparison of typology and the classification by single types was symptomatic (AFONSO MARRERO 1993, 470). Martínez Fernández studied several Granadian sites of different Neolithic affiliation and presented a systematic of attributes (amongst others blank types, preservation, platform remnants, typology). His former PhD student AFONSO MARRERO (1993) analyzed lithic assemblages of Epipaleolithic up to Chalcolithic or Bronze Age origin and adapted the typology. Meanwhile one could speak of a "Granadian school" with Martínez Fernández and Afonso Marrero (and students such as SÁNCHEZ ROMERO 2000) diligently evaluating various E Andalusian lithic assemblages (cf. recently MARTÍNEZ FERNÁNDEZ ET AL. 2010).

Additionally the very well investigated province of Alicante provides hints that could certainly at least partly be transferred to the working area. Several sites were excavated and systematically studied (cf. e.g. GARCÍA PUCHOL 2006, 174 Fig. 5.1.). Based on this work, BERNABEU AUBÁN (1988) characterized two main Neolithic stages I and II, initially with Cardium- and impressed pottery decoration. Another focus of the "Valencian school" (AFONSO MARRERO 1993, 49-50) is Cueva de Nerja/Málaga (recently GARCÍA BORJA ET AL. 2010), an extraordinary site that was excavated in the years 1959-1987 (SIMÓN VALLEJO 2003, especially 255 cuadro 2). Accordingly JORDÁ PARDO/AURA TORTOSA (2010, 410 Fig. 1) refer to the countless publications. Nerja is one of few sites in the working area with an outstanding stratigraphy that comprises both Epipaleolithic and Early Neolithic stages and a whole sequence of radiocarbon datings (JORDÁ PARDO/AURA TORTOSA 2008). In contrast, these absolute ages also verify several settlement gaps (cf. **Fig. 3** with references). Whether these gaps are due to research or reflect archaeological reality is ambiguous.

In the frame of the project „*La Edad del Cobre en la Cuenca del Bajo Almanzora*" (Almería) CAMALICH MASSIEU and MARTÍN SOCAS (1999a) have investigated since 1985 the lower Almanzora region and discovered more than 400 sites. Amongst others they excavated Cabecicos Negros, one of the few present (Early) Neolithic open-air sites (cf. **SITE GAZETTEER**: **Cabecicos Negros-El Pajarraco/Almería** with references). Since then agreement has been reached that the previously characteristic cave-sites are *one* amongst other site types. The preservation and research foci explain the dominance of cave sites.

The Early Neolithic is even more sparsely represented in Murcia as depicted by MARTÍNEZ SÁNCHEZ (1988) and is represented by only three, not even unmistakably dated, sites (cf. **SITE GAZETTEER**: **Abrigos del Pozo/Murcia** and **Hondo de Cagitán/Murcia**). Of those sites so far only the Abrigos del Pozo/Calasparra (MARTÍNEZ SÁNCHEZ 2005) are promising but analyses are still unpublished.

For the previous Epipaleolithic, FORTEA PERÉZ (1973) sub classified it based on the Valencian lithic typology into the principal periods of *Epipaleolítico microlaminar* and *Epipaleolítico geometrico*, which are each further subdivided in two to three facies. AFONSO MARRERO affirmed 1993 (p. 11) the persisting topicality of this scheme and it is currently generally accepted (pers. comm. J. Zilhão) – even if not completely absolutely chronologically verified for over the whole of Mediterranean Spain. MARTÍNEZ ANDREU (publications from 1981 onwards) studied another large number of mostly late Upper Paleolithic and also probable Epipaleolithic sites in Murcia (cf. **SITE GAZETTEER**: **Cueva del Algarrobo/Murcia**; **Abrigo del Monje/Murcia** or **Cueva de los Zagales/Murcia**). He compared several attributes. Currently he sees no justification for a separation of the Epipaleolithic from the Upper Paleolithic (pers. comm. M. Martínez Andreu).

Meanwhile the models concerning the Neolithization have also been repeatedly modified and researchers tended at one point towards an initial colonization process, while subsequently others have stressed the role of hunter-gathers or postulated a duality (cf. **2.3. The Neolithization of the W Mediterranean in its European context** with references). Probable African influences were picked up again for the W Mediterranean (cf. e.g. MANEN/MARCHAND/CARVALHO 2007). GIBAJA and CARVALHO (2010) initiated a project studying both S Spanish and N Moroccan sites. Recently CORTÉS SÁNCHEZ ET AL. (2012) have further specified their hypotheses concerning probable African input items (in detail **2.3. The Neolithization of the W Mediterranean in its European context**).

2.2. Chronology

2.2.1. Cultural chronology

The Early and Middle Holocene transition to farming involved several postglacial hunter-gatherer and Neolithic stages in the Alboran Region as the relative stages in **Fig. 3** display. The current accumulation of circulating denominations reflects long lasting research efforts to classify the growing and diverse archaeological record against the background of various research traditions (cf. **2.1. Overview**).

In part, the Valencian chronological scheme is attached to the comparatively poorer Andalusia and Murcia record with fewer radiocarbon ages.

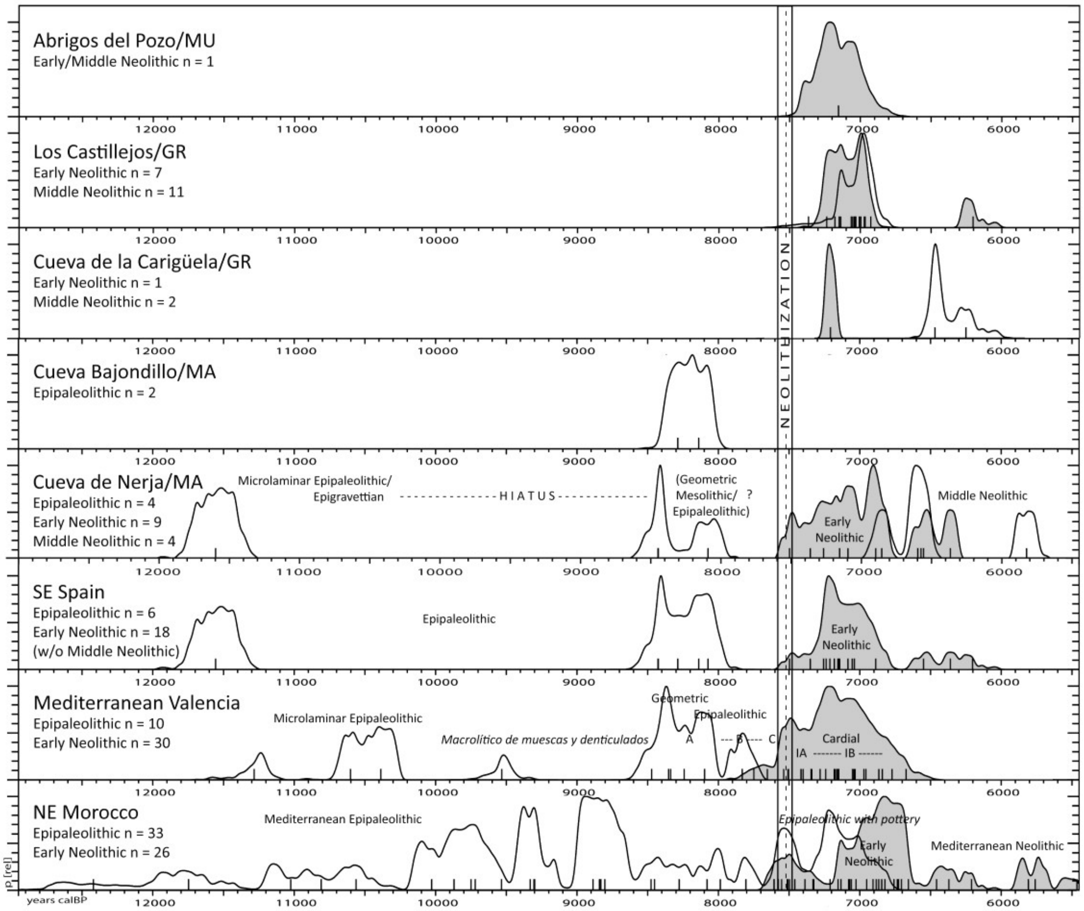

Fig. 3 Calibrated radiocarbon dates (calBP; calibrated with CalPal, WENINGER/JÖRIS/DANZEGLOCKE 2011; ages collected till 06/2011; see **Tab. 1** to **Tab. 3**) of Epipaleolithic, Early (shaded graphs) and Middle Neolithic per site, of SE Spain (Málaga, Granada, Almería, Murcia), the Mediterranean Valencian region and NE Morocco with cultural attribution (according to LINSTÄDTER 2008; GARCÍA PUCHOL/AURA TORTOSA 2006; GARCÍA ATIÉNZAR 2009; BERNABEU AUBÁN 1988).

2.2.1.1. Epipaleolithic vs. Mesolithic

In this and related studies (LINSTÄDTER ET AL. 2012b) the term Epipaleolithic is applied to post-Paleolithic – *epi* as Greek equivalent to the Latin *post* – hunter-gatherers of the Early Holocene, who followed Upper Paleolithic industries (Magdalenian/Iberomaurusian). This application makes the work consistent with the Moroccan chronology proposed by LINSTÄDTER (2008, 44-45). The Epipaleolithic is a heterogen phenomenon and varies in time and space (MARTÍNEZ ANDREU 1989-90, 56). Generally assemblages include end scrapers, burins and backed bladelets. Dominant blanks are prismatic blades (AFONSO MARRERO 1993, 17-18). Without exception, the faunal remains consist of savage animals (AFONSO MARRERO 1993, 22).

Synchronous to the Early Neolithic, Epipaleolithic facies partly with single Neolithic features coexisted: Epipaleolithic with pottery and Geometric Mesolithic (LINSTÄDTER 2008, 51; cf. LINSTÄDTER ET AL. 2012b; cf. **2.3. The Neolithization of the W Mediterranean in its European context**).

SE SPAIN (study area)

Lab-N°	14C BP	±1σ	Δ13C ‰	sample material	sample species	site	stage	references
NA	7325	65	NA	charcoal	NA	Bajondillo, C. 4	EPI	Cortés Sánchez et al. 2007a
NA	7475	80	NA	charcoal	NA	Bajondillo, C.3	EPI	Cortés Sánchez et al. 2007a
Pta-9163	6260	20	NA	organic	NA	Carigüela, C.	NEO	Fernández et al. 2007
Pta-9162	5690	30	NA	organic	NA	Carigüela, C.	NEO	Fernández et al. 2007
Beta-141049	5470	90	NA	organic	NA	Carigüela, C.	NEO	Fernández et al. 2007
ß-193269	6180	40	NA	NA	NA	L. Castillejos, 1	E NEO	Martínez Fernández et al. 2010
Ly-5218	6420	60	NA	NA	NA	L. Castillejos, 2	E NEO	Martínez Fernández et al. 2010
ß-131577	6590	40	NA	NA	NA	L. Castillejos, 3	E NEO	Martínez Fernández et al. 2010
Ly-5217	7240	80	NA	NA	NA	L. Castillejos, 3	E NEO	Martínez Fernández et al. 2010
GifA-102.010	7610	90	NA	NA	NA	L. Castillejos, 5	E NEO	Martínez Fernández et al. 2010
ß-193271	7620	40	NA	NA	NA	L. Castillejos, 5	E NEO	Martínez Fernández et al. 2010
ß-156020	10040	40	NA	NA	NA	L. Castillejos, 6	E NEO	Martínez Fernández et al. 2010
I-16783	6260	120	NA	NA	NA	L. Castillejos, 7	M NEO	Martínez Fernández et al. 2010
Ua--6215	6310	45	NA	NA	NA	L. Castillejos, 7	M NEO	Martínez Fernández et al. 2010
Ua-36213	6120	40	NA	NA	NA	L. Castillejos, 7	M NEO	Martínez Fernández et al. 2010
Ua-36214	6260	45	NA	NA	NA	L. Castillejos, 8	M NEO	Martínez Fernández et al. 2010
ß-135663	6120	40	NA	NA	NA	L. Castillejos, 9	M NEO	Martínez Fernández et al. 2010
Ua-37844	6140	45	NA	NA	NA	L. Castillejos, 10a	M NEO	Martínez Fernández et al. 2010
Ua-36211	5400	45	NA	NA	NA	L. Castillejos, 10b	M NEO	Martínez Fernández et al. 2010
Ua-36212	6240	45	NA	NA	NA	L. Castillejos, 11a	M NEO	Martínez Fernández et al. 2010
ß-135664	6470	150	NA	NA	NA	L. Castillejos, 11b	M NEO	Martínez Fernández et al. 2010
ß-145302	6240	80	NA	NA	NA	L. Castillejos, 11b	M NEO	Martínez Fernández et al. 2010
Ua-36210	6100	45	NA	NA	NA	L. Castillejos, 11b	M NEO	Martínez Fernández et al. 2010
Ua-37839	6130	50	NA	charcoal	NA	Nerja, C. d.	E NEO	
Ua-37837	6065	50	NA	charcoal	NA	Nerja, C. d.	G EPI	
Beta-193268	6000	40	NA	charcoal	NA	Nerja, C. d.	NEO	Jordá Pardo/Aura Tortosa 2008 (with references therein)
Beta-168972	5789	40	NA	charcoal	NA	Nerja, C. d.	NEO	
Beta-195998	5760	40	NA	charcoal	NA	Nerja, C. d.	NEO	
Beta-271213	6230	40	NA	charcoal	NA	Nerja, C. d.	E NEO	
Beta-270018	5570	40	NA	charcoal	NA	Nerja, C. d.	E NEO	
Beta-270019	6040	40	NA	charcoal	NA	Nerja, C. d.	E NEO	Aguilera Aguilar/Medina Alcaide/Romero Alonso 2011
Beta-270023	6330	40	NA	charcoal	NA	Nerja, C. d.	E NEO	
Beta-270034	6040	40	NA	charcoal	NA	Nerja, C. d.	E NEO	
Beta-270037	5740	40	NA	charcoal	NA	Nerja, C. d.	E NEO	
Ua-37838	6095	45	NA	charcoal	NA	Nerja, C. d.	ev. E NEO	Aura et al. 1998; Jordá Pardo/Aura Tortosa 2008
Ua-36208	6120	40	NA	charcoal	NA	Nerja, C. d.	MESO	
Ua-36209	6090	40	NA	bone	NA	Nerja, C. d.	ev. E NEO	
Ua-37835	6155	45	NA	charcoal	NA	Nerja, C. d.	MESO	Jordá Pardo/Aura Tortosa 2008 (with references therein)
Ua-36203	6115	40	NA	bone	NA	Nerja, C. d.	EPI	
GRN-?	5065	40	NA	cereals	NA	Nerja, C. d.	NEO	Hopf/Pellicer 1970; Jordá Pardo/Aura Tortosa 2008
Ua-37834	6085	45	NA	charcoal	NA	Pozo, A. d.	E/M NEO	Martínez Sánchez 1994

Tab. 1 Uncalibrated radiocarbon ages available for SE Spain ((G) EPI = (geometric) Epipaleolithic; MESO = Mesolithic; E/M NEO = Early/Middle Neolithic; ev. = evolved).

MEDITERRANEAN VALENCIA

Lab-N°	14C BP	±1σ	Δ13C ‰	sample material	sample species	site	stage	references
ß-75217	6150	80	NA	charcoal	NA	Cendres, C. d.l.	CAR	CalPal-database; van Willigen 2006
ß-75218	6260	80	NA	charcoal	NA	Cendres, C. d.l.	CAR	CalPal-database; van Willigen 2006
ß-107405	6280	80	NA	bone	NA	Cendres, C. d.l.	CAR	García Atiénzar 2009
ß-142288	6340	70	NA	cereals	NA	Cendres, C. d.l.	CAR	García Atiénzar 2009
ß-142289	6510	70	NA	charcoal	NA	Cendres, C. d.l.	CAR	CalPal-database; van Willigen 2006
ß-221431	6510	50	NA	charcoal	NA	Cendres, C. d.l.	E NEO	Olária i Puyoles 1994, 30
ß-162092	6600	50	NA	charcoal	NA	Cendres, C. d.l.	CAR	CalPal-database; van Willigen 2006
ß-166727	6600	50	NA	cereals	NA	Cendres, C. d.l.	CAR	García Atiénzar 2009
ß-231879	6610	40	NA	seed/fruit	NA	Cendres, C. d.l.	E NEO	Bernabeu Aubán 2006
ß-231880	6660	40	NA	seed/fruit	NA	Cendres, C. d.l.	E NEO	
ß-116624	8310	80	NA	charcoal	NA	Cendres, C. d.l.	CAR	CalPal-database; van Willigen 2006
ß-75216	6010	80	NA	bone	NA	El Barranquet	CAR	García Atiénzar 2009
ß-75219	6420	80	NA	bone	NA	En Pardo	CAR	García Atiénzar 2009
Gif-101360	6490	90	NA	bone	NA	En Pardo	CAR	García Atiénzar 2009
H1754/1208	6265	75	NA	cereals	NA	Falguera, A. d.	CAR/NEO IA,B	García Atiénzar 2009
Oxa-10191	6275	70	NA	seed/fruit	NA	Falguera, A. d.	G MESO A	Rubio/Barton 1992; García Puchol et al. 2009
Oxa-10192	6310	70	NA	seed/fruit	NA	Falguera, A. d.	G MESO A	García Puchol 2005; García Puchol et al. 2009
ß-156022	9220	40	NA	charcoal	NA	Filador	M EPI	González-Sampériz et al. 2009
ß-156021	9370	40	NA	charcoal	NA	Fosca, C.	NEO	Olária i Puyoles 2000
AA-8647	9830	80	NA	charcoal	NA	Fosca, C.	NEO	Olária i Puyoles 2000
Gif-7063	8530	90	NA	charcoal	NA	Fosca, C.	NEO	Olária i Puyoles 2000
Gif-6897	7560	80	NA	charcoal	NA	Fosca, C.	NEO	Olária i Puyoles 2000
Gif-6898	7660	80	NA	charcoal	NA	Fosca, C.	NEO	Olária i Puyoles 2000
ß-171910	7280	40	NA	charcoal	NA	Fosca, C.	E NEO: CAR	Olária i Puyoles 2000
AA-2295	7410	70	NA	charcoal	NA	Fosca, C.	E NEO: CAR	Olária i Puyoles 2000
AA-59519	7526	44	NA	bone	ibex	Lagrimal	L MESO	López Pablo/Gómez Puche 2009
ß-249933	6990	50	NA	cereals	NA	Mas d'Is	CAR	García Atiénzar 2009
ß-149007	6130	60	NA	cereals	NA	Mas d'Is	CAR	García Atiénzar 2009
ß-149001	6140	90	NA	bone	NA	Mas Nou, Cingle	E NEO	Olária i Puyoles 2000, 32; Alday Ruiz 2009
ß-149004	6150	70	NA	bone	NA		E NEO I	Olária i Puyoles 2000, 32; González-Sampériz et al. 2009
UBAR-172	5990	80	NA	cereals	NA	Or, C. d.l.	E NEO	Olária i Puyoles 1994, 30; Schubart/Pascual 1966
ß-149005	6070	80	NA	cereals	NA	Or, C. d.l.	CAR	García Atiénzar 2009
ß-149000	6080	80	NA	cereals	NA	Or, C. d.l.	E NEO	López Pablo/Gómez Puche 2009
K-1754/1008	6265	75	NA	cereals	NA	Or, C. d.l.	CAR	García Atiénzar 2009
ß-136677	6900	70	NA	cereals	NA	Or, C. d.l.	CAR	García Atiénzar 2009
ß-149006	6250	80	NA	seed/fruit	NA	Santa Maria	EPI	García Puchol et al. 2009
ß-136676	6800	70	NA	bone	NA	Santa Maria	EPI	
GifA101354	5860	80	NA	bone	NA	Tossal Roca	G MESO	Cacho et al. 1995; García Puchol et al. 2009
GifA101356	5930	80	NA	bone	NA	Tossal Roca	G MESO	García Puchol et al. 2009; Cacho et al. 1995
ß-149009	6390	40	NA	NA	NA	Tossal Roca	EPI	Olária i Puyoles 1994

Tab. 2 Comparable uncalibrated radiocarbon ages of Mediterranean Valencia ((G/M) EPI = (geometric/microlaminar) Epipaleolithic; (G/L) MESO = (geometric/late) Mesolithic; E/M NEO = Early/Middle Neolithic; CAR = Cardial; CalPal-database from Weninger/Jöris/Danzeglocke 2011).

NE MOROCCO

Lab-N°	14C BP	±1σ	Δ13C ‰	sample material	sample species	site	stage	references
Hd-19868	6139	30	-22,58	charcoal	NA	Hajra 3	E NEO	LINSTÄDTER ET AL. 2012b
UtC-6185	6230	70	-22,0	charcoal	NA	H. Ouenzga	EPI pot	LINSTÄDTER 2004
KIA-437	6240	40	-23,04	charcoal	NA	H. Ouenzga	EPI pot	LINSTÄDTER 2004
KIA-436	6270	40	-22,36	charcoal	NA	H. Ouenzga	EPI pot	LINSTÄDTER 2004
UtC-6186	6378	44	-23,4	charcoal	NA	H. Ouenzga	EPI pot	LINSTÄDTER 2004
UtC-6187	6540	50	-21,5	charcoal	NA	H. Ouenzga	EPI pot	LINSTÄDTER 2004
Bln-4957	6611	40	NA	charcoal	NA	H. Ouenzga	EPI pot	LINSTÄDTER 2004
Bln-4913	6683	48	NA	charcoal	NA	H. Ouenzga	EPI pot	LINSTÄDTER 2004
KIA-434	6710	50	-21,12	charcoal	NA	H. Ouenzga	EPI pot	LINSTÄDTER 2004
KIA-39288	6970	40	-25,8 ±0,4	charcoal	NA	H. Ouenzga	Med EPI	LINSTÄDTER 2004
Hd-19880	7166	38	-22,5	charcoal	NA	H. Ouenzga	EPI pot	LINSTÄDTER 2004
Hd-19543	7248	39	-22,69	charcoal	NA	H. Ouenzga OA	Med EPI	LINSTÄDTER ET AL. 2012b
Erl-12419	7451	56	-17,0	charcoal	NA	H. Ouenzga OA	Med EPI	LINSTÄDTER ET AL. 2012b
Erl-9986	7633	81	-23,1	charcoal	NA	H. Ouenzga OA	Med EPI	LINSTÄDTER 2010a
Erl-9985	7666	76	-23,2	charcoal	NA	Ifri Armas	E NEO	LINSTÄDTER 2008
KIA-433	7930	50	-17,46	charcoal	NA	Ifri Armas	E NEO	LINSTÄDTER 2008
KIA-39292	7955	40	-21,4 ±0,11	charcoal	NA	Ifri el-Baroud	Med EPI	NAMI 2007
Bln-5040	7977	56	NA	charcoal	NA	Ifri el-Baroud	Med EPI	NAMI 2007
Bln-5041	8019	46	NA	charcoal	NA	Ifri el-Baroud	Med EPI	NAMI 2007
KIA-510	8290	40	-22,99	bone	sus scofra	Ifri Oudadane	Med EPI	LINSTÄDTER 2010b
Bln-5042	8302	37	NA	bone	ammotragus lervia	Ifri Oudadane	Med EPI	LINSTÄDTER 2010b
Bln-5043	8302	54	NA	charcoal	NA	Ifri Oudadane	E NEO	LINSTÄDTER 2010a
Bln-4872	8556	52	NA	charcoal	NA	Ifri Oudadane	E NEO	LINSTÄDTER 2008
Bln-5044	8726	53	NA	charcoal	NA	Ifri Oudadane	E NEO	LINSTÄDTER 2010a
KIA-31007/2	8745	55	NA	humid acid	NA	Ifri Oudadane	E NEO	LINSTÄDTER 2010a
KIA-39293	8800	45	-21,3 ±0,1	cereal	lentil	Ifri Oudadane	E NEO	LINSTÄDTER ET AL.2012b
KIA-31007	8880	35	NA	charcoal	NA	Ifri Oudadane	E NEO	LINSTÄDTER 2010a
Erl-9993	9350	65	-22,2	cereal	emmer wheat	Ifri Oudadane	E NEO	LINSTÄDTER ET AL. 2012b
Erl-12418	9496	183	-23,9	cereal	barley	Ifri Oudadane	E NEO	LINSTÄDTER ET AL. 2012b
Bln-4755	9677	60	NA	cereal	emmer wheat	Ifri Oudadane	E NEO	LINSTÄDTER ET AL. 2012b
Bln-4756	10570	177	NA	cereal	indeterminated wheat	Ifri Oudadane	E NEO	LINSTÄDTER ET AL. 2012b
Erl-9991	10130	68	-22,1	cereal	pea	Ifri Oudadane	E NEO	LINSTÄDTER ET AL. 2012b
Bln-4956	6035	47	NA	cereal	barley	Ifri Oudadane	E NEO	LINSTÄDTER ET AL. 2012b
KIA-39297	6155	30	-19,6 ±0,2	cereal	barley	Ifri Oudadane	E NEO	LINSTÄDTER ET AL. 2012b
Erl-9988	6175	50	-23,9	charcoal	spec	Ifri Oudadane	E NEO	LINSTÄDTER 2008
KIA-39299	6400	90	-24,7 ±0,4	charcoal	spec	Ifri Oudadane	E NEO	LINSTÄDTER 2010a
Erl-9984	6481	53	-22,7	charcoal	NA	Ifri Ouzabour	Med EPI	LINSTÄDTER ET AL.2012b
Bln-5039	6588	62	NA	charcoal	NA	Ifri Ouzabour	Med EPI	LINSTÄDTER ET AL.2012b
KIA-39299/2	6615	30	-21,6 ±0,2	charcoal	NA	Ifri Ouzabour	E NEO	LINSTÄDTER ET AL.2012b
Erl-9996	6739	52	-23,3	charcoal	juniperus	Mtlili 1	Med EPI	LINSTÄDTER ET AL.2012b
NA	6740	50	NA	humid acid	NA	Mtlili 1	Med EPI	LINSTÄDTER 2008
Erl-9995	7106	53	-23,1	charcoal	juniperus	Mtlili 1	Med EPI	LINSTÄDTER ET AL.2012b
KIA-39295	7840	40	-21,6 ±0,1	charcoal	NA	Mtlili 1	Med EPI	LINSTÄDTER 2008
KIA-39287	4745	65	-25,9 ±0,2	humid acid	NA	Mtlili 5	E NEO	LINSTÄDTER 2008
KIA-39296	5000	30	-25,1 ±0,1	charcoal	NA	Mtlili 5	E NEO	LINSTÄDTER 2008
KIA-31008/2	5040	35	NA	humid acid	NA	Mtlili 5	E NEO	LINSTÄDTER 2008
KIA-39291	5390	35	-22,4 ±0,2	charcoal	NA	Mtlili 5	E NEO	LINSTÄDTER 2008
NA	5590	40	NA	charcoal	NA	Mtlili 5	E NEO	LINSTÄDTER 2008
NA	5670	40	NA	charcoal	NA	Mtlili 6	E NEO	LINSTÄDTER 2008

Tab. 3 Comparable uncalibrated radiocarbon ages of NE Morocco ((Med) EPI (pot) = (Mediterranean) Epipaleolithic (with pottery); E NEO = Early Neolithic).

NE MOROCCO

Lab-N°	14C BP	±1σ	Δ13C ‰	sample material	sample species	site	stage	references
NA	5670	40	NA	charcoal	NA	Mtlili 6	E NEO	Linstädter 2008
KIA-31003	5840	35	NA	charcoal	NA	Taghit Haddouch	Med EPI	Hutterer et al. 2011
KIA-31008	5880	30	NA	charcoal	NA		Med EPI	Hutterer et al. 2011
NA	5900	40	NA	charcoal	NA		Med EPI	Hutterer et al. 2011
NA	5910	40	NA	charcoal	NA	Taghit Haddouch	Med EPI	Hutterer et al. 2011
NA	5930	40	NA	charcoal	NA		Med EPI	Hutterer et al. 2011
NA	5980	40	NA	charcoal	NA	Taghit Haddouch	Med EPI	Hutterer et al. 2011
NA	5980	40	NA	charcoal	NA		Med EPI	Hutterer et al. 2011
KIA-31001/2	6000	35	NA	charcoal	NA	Taghit Haddouch	Med EPI	Hutterer et al. 2011
KIA-31001	6020	40	NA	charcoal	NA		E NEO	Hutterer et al. 2011
Erl-9989	6053	50	-23,8	charcoal	juniperus	Taoungat 1	Med EPI	Linstädter et al. 2012b
KIA-39298	6085	25	-20,9 ±0,1	charcoal	juniperus	Taoungat 1	E NEO	Linstädter et al. 2012b
KIA-31002	6110	35	NA	charcoal	pistacia	Taoungat 7	E NEO	Linstädter et al. 2012b

Tab. 3 continued.

The term “Epipaleolithic” is based on the classification by Fortea Peréz (1973 cf. **2.1. Overview**) with Microlaminar and Geometric Epipaleolithic. These terms are still common – in turn with the term Mesolithic. But it remains a subject of controversial debate and is rather ambiguous, what authors mean when using these terms. In some publications and neighboring regions the term “Mesolithic” is used synonymously for this period (Aparicio Perez 1979, 11; 147 ff.; 169 Fig. 37; 269 Fig. 52; Afonso Marrero 1993, 13; van Willigen 2006, 57 – 87; according to Martí Oliver 2012, 550: “*grupos epipaleolíticos-mesolíticos*”).

In other works, Epipaleolithic is before Mesolithic and connected with backed bladelets. The following Mesolithic refers to notched and denticulated pieces or microliths (two facies; Geometric Mesolithic; García Puchol/Aura Tortosa 2006; Aura Tortosa et al. 2009a, 3 Fig. 2; recapitulatory Gehlen 2010, 502-506). But a Mesolithic occupation in this sense has not yet been found in the working area (cf. Cueva Nerja/Malaga, Aura Tortosa et al. 2009b, 349).

However, Afonso Marrero (1993, 470) stated that there is no difference in lithic technology between various Epipaleolithic stages, Early Neolithic and even Late Magdalenian assemblages. Martínez Andreu (pers. comm.) noted that a strict separation of Upper Paleolithic and Epipaleolithic is not appropriate: The so-called Epipaleolithic facies only continues Upper Paleolithic traditions in the Post-Glacial. Besides these issues, a subdivision of the Epipaleolithic is difficult due to the incomplete occupation horizons available in the working area. Martínez Fernández/Aguayo de Hoyos (1984, 36) suggest an elongated continuation of the Microlaminar Epipaleolithic in Upper Andalusia and possibly only a shortened occurrence of the Geometric facies.

2.2.1.2. Early Neolithic

The following Neolithic was tripartite, with Early, Middle and Late Neolithic (Bernabó Brea 1949; Gavilán Cevallos 1997, 25; Acosta Martínez 1995, 42; Martínez Fernández et al. 2009, 17 Fig. 2), but lately the Valencian periodization of Bernabeu Aubán (1988) with two stages – Early and Late Neolithic (Cardial I and II) – also affects Andalusia. Thus, on the one hand Early Neolithic and Middle Neolithic mingled together (e.g. Cueva de Nerja/MA, Jordá Pardo/Aura Tortosa 2008) and on the other hand Early Neolithic sites are relatively rare or nearly absent (e.g. in Murcia, see **Fig. 5**). Gabriel Martínez stated that there is no typological difference between Early and Middle Neolithic (pers. comm.). Van Willigen (2006, 37; 276-277 with references therein) characterized an Epicardial with fluted-impressed ware that occurred contemporaneously, but mutually exclusive in the periphery of Cardial dispersals in S France, Catalunya and Valencia due to acculturation processes of late hunter-gatherers. The traditional classification *Cultura de las Cuevas* matches with fairly Early Neolithic occurrences, whereas *Cultura de Almería* classified later stages of the current chronology (Epicardial, Middle/Late Neolithic to Chalcolithic; ARTEAGA/ROOS 2009, 43; CÁMALICH ET AL. 2004, 184).

In recent studies, researchers (CORTÉS SÁNCHEZ ET AL. 2012) have favored groups of a characteristic Initial Pre-Cardial Neolithic as agents of the Neolithization (cf. **2.3. The Neolithization of the W Mediterranean in its European context**), but a clear assignment of sites in the working area to this facies is lacking. Thus, so far the Early Neolithic is associated with the Cardial complex, using the dominance of Cardium-impressed pottery as an index fossil (MORALES HIDALGO ET AL. 2010, 428; GAVILÁN CEBALLOS 1997, 26 compare OLÁRIA I PUYOLES 2000, 27). However, one Cardium-decorated sherd does not permit inevitably an affiliation to an Early Neolithic (GAVILÁN CEBALLOS 1997, 26). In contrast to the Epipaleolithic, people needed these durable, long-term storage items (AFONSO MARRERO 1993, 33). Additionally, other impressed decorations and sculptured bands are characteristic.

As far as the lithic artifacts are concerned, Afonso Marrero states that Epipaleolithic types are mostly absent in Neolithic assemblages except microliths, abrupt retouches and prismatic blades. Borers and intentional thermal treatment occur. Additionally, blanks increase in size and become more standardized (AFONSO MARRERO 1993, 17-19; 38; FORTEA PERÉZ 1985, 44-49). Sickles appear, but only to a very rare extent. Added to this, several sites with cereal remains are lacking sickle inserts (GIBAJA ET AL. 2012, 89). Ground stone tools, such as grinding stones or axes, are rarely found (ARTEAGA/ROSS 2009, 52).

During the Early Neolithic the relevance of domestic animals and cereals is estimated as fairly marginal. Present animal bones indicate the maintenance of hunting (rabbit, deer, ibex) or even that hunting remained really essential for the subsistence of Early Neolithic people. Neolithic economy increased stepwise with domesticates (predominantly sheep and goat) and agriculture to various amounts (AFONSO MARRERO 1993, 22-23; cf. **3.3. Early to Middle Holocene climate and vegetation**). Pastoralism dominates the lifeway. Settlers maintained mobility and gathered complementary wild plants and products (AFONSO MARRERO 1993, 38).

So generally material culture and Neolithic elements vary severely in the Early Neolithic settlements (AFONSO MARRERO 1993, 15). There are sites with evidence of a dominant Neolithic lifestyle contemporaneously more or less side by side with sites where settlers profit only from single Neolithic innovations. This could be due to a real difference in lifestyles or to a settlement system with different site types.

Agriculture and sedentariness increased in later Neolithic and the subsequent periods (AFONSO MARRERO 1993, 38). Recently PEÑA-CHOCARRO and ZAPATA (2010, 193-195) ascribed this evolutionary, gradual character with more and more agricultural indicators to the current state of source material postulating an initial Full-Neolithic.

2.2.2. Radiocarbon chronology

During the last decades, several authors[1] collected 14C-dates for the mentioned time frame in single regions as well as over the whole Iberian Peninsula. The CalPal 2007-database (WENINGER/JÖRIS/DANZEGLOCKE 2011) and the INQUA Radiocarbon Paleolithic Database Leuven (VERMEERSCH 2013) also provide data.

The radiocarbon dates used in **Fig. 3** and listed in **Tab. 1** to **Tab. 3** represent a selective process in which ages with standard deviations around ≥ 100 14C-years and outliers per sites, levels or time period were excluded. I did not observe divergent datings caused by different kinds of sample materials (charcoal, mollusks or bone). Calibrated datasets per sample sort each show similar time spans. The numerical age for the Early Neolithic of Abrigo Grande II del Barranco de los Grajos/Murcia (Har-179III: 7200±160 14Cyrs BP, 8030±160 calBP) seems too old to fit into the presented model (cf. WALKER 1977, 363). In contrast, the dating of charcoal from Cueva de la Carigüela/GR presented by WIGAND (1978, 256; WSU-1981: 4840±80 14Cyrs BP) with a calibrated age of 5570±90 calBP obviously belonged to a subsequent period (calibrated with CalPal; WENINGER/JÖRIS/DANZEGLOCKE 2011).

Datings attributed to Epipaleolithic, Microlaminar Epipaleolithic, Early, Late or general Mesolithic and *Macrolítico de Muescas y denticulados* (MM-D) were summed up under "Epipaleolithic" in **Fig. 3**. The shaded graphs of the Early Neolithic are based on datings taken from Early/Initial Neolithic and Cardial horizons.

The existence of postglacial hunter-gatherers and the transition to the first farming communities took place between ca. 11600 to 7000 calBP, and the Neolithic began around 7600 calBP more or less contemporaneously in the whole W Mediterranean – including areas up to S France (GUILAINE/MANEN 2007, 37; 43). There is no chronological gradient between Valencia and Morocco as implied by some Neolithization models (see **2.3. The Neolithization of the W Mediterranean in its European context**), which postulate a gradual dispersion of the Neolithic subsistence from E to SW. Thus, a very fast expansion can be concluded, but it is not possible to deduce a direction of the Neolithization on the basis of radiocarbon ages. The Early Neolithic persists in SE Spain until approximately 7900-6850 calBP (CÁMARA SERRANO/MOLINA GONZÁLEZ/AFONSO MARRERO 2005, 846).

Thus, regarding radiocarbon-based chronology, the Valencian Mediterranean and the NE Moroccan regions illustrate a continuous transition from Epipaleolithic to Early Neolithic without a gap and fairly overlapping ages (cf. **Fig. 3**). Remarkably, the transition in the research area is currently characterized by a gap. As the region lies exactly between and connects both comparison areas, I assume that the gap is due to research and caused by missing samples, contamination or other issues. It does not reflect the occupation of the area. A continuous chronological transition can be expected. However, the occupation of the sites does not always have to be continuous, and hiatuses are possible – as probably in Nerja (cf. **3.1.2.5. Evaluated sites and archaeological characterization**).

[1] Amongst others ALDAY RUIZ (2009), MORALES HIDALGO ET AL. (2010), BERNABEU AUBÁN (2006, 207-211 Tab. 5.1.), GEHLEN (2010, 507-568 Tab. 51-61), GONZÁLEZ-SAMPÉRIZ ET AL. (2009, 124-127 Tab. 1-2), LÓPEZ PABLO/GÓMEZ PUCHE (2009, 71 Tab. 1; 81 Tab. 2), GARCÍA ATIÉNZAR (2009, 17-24), OLÁRIA I PUYOLES (2000, 1994) and MEDEROS MARTÍN (1996).

2.3. The Neolithization of the W Mediterranean in its European context

The term Neolithization describes the development and the dispersal of the Neolithic in the Middle East (here equivalent to *Naher Osten/Oriente Próximo*, region of the Fertile Crescent in parts of Israel/Palestine, Jordan, Lebanon, Syria, SE Turkey, Iraq and Iran) and Europe (KUNST 2008; KUNST 2010).

Neolithization is a complex, multifaceted, dynamic and long-term process with several stages (see **2.2. Chronology**; JOVER MAESTRE/MOLINA HERNÁNDEZ/GARCÍA ATIÉNZAR 2008), centers (BOCQUET-APPEL ET AL. 2009), and directions. Beyond that, it can be understood on varying scales as a superregional, regional or even local phenomenon (MCCLURE/MOLINA BALAGUER/BERNABEU AUBÁN 2008, 327).

I will present various genetic studies throughout this chapter. These have to be treated and evaluated with special caution inasmuch as the studies are emerging, partly non-committed and based on very few prehistoric remains. In her thesis about ancient mtDNA in the Mediterranean FERNÁNDEZ DOMÍNGUEZ (2005, 636-638) shows that these analyses are difficult to interpret. For the consolidation of the human genetic markers in the context of the Neolithization see also FERNÁNDEZ DOMÍNGUEZ (2005, 35-42).

The discussion around the Neolithization models is timeless and an interdisciplinary topic (SCHUMACHER/WENIGER 1995, 133; CORTÉS SÁNCHEZ ET AL. 2012). Connected subjects provide a variety of additional data, proxies and models (**Tab. 4**). Neolithization entails essential further developments in the history of anatomical modern humans.

	APPROACH	SCALE	REFERENCE
Archaeology	Space-time distribution of 14C dates and Kriging interpolation technique illustrated in vector maps	supraregional	BOCQUET-APPEL ET AL. 2009
	Distribution of rock art groups (Linear geometric, Macroschematic, Levantine and Schematic) and interpreting it as expressions of Mesolithic and various Neolithic "agents"	supraregional	CRUZ BERROCAL/VICENT GARCÍA 2007; MCCLURE/MOLINA BALAGUER/BERNABEU AUBÁN 2008; BERNABEU AUBÁN 2002, 225-228
	Data from cemetry to model demographic growth	local	BOCQUET-APPEL 2002
Ethnology	Study of hunter-gatherer and original farming communities, inter-group relations, colonization, acculturation, adoption processes	various	JOCHIM 2009
Soziology	Assignment of sociological forms of hierarchy or rule to archaeological finds (sites, grave goods, depictions in art etc.)	local/ regional/ supraregional	MARTÍNEZ/ESCORIZA-MATEU/OLTRA-PUIGDOMENECH 2006; GARCÍA MARTÍNEZ DE LAGRÁN 2008, 161
Biology	Analysis of genetic markers of humans and cattle (blood groups, (a)DNA, mtDNA, Y-Chromosome) to trace Neolithization and the origin based on recent local populations and archaeological remains (iniciated by morphological, cytological and hemoglobin studies)	supraregional	see **Tab. 6** and GAMBA ET AL. 2008; GAMBA ET AL. 2012; RICHARDS 2003; HAAK ET AL. 2005; ZEDER 2008; FERNÁNDEZ DOMÍNGUEZ 2005, 35-42; PINHASI ET AL. 2012
	Dental anthropology		RUIZ ET AL. 2012
Mathematic	Detection of the source and the speed of dispersal of the Neolithic by modeling on the basis of absolute dated sites	Supraregional	DAVISON ET AL. 2009; FORT 2009; FEUGIER ET AL. 2009

Tab. 4 *(on the previous page!)* Selection of subjects and recent methods exploring Neolithization.

2.3.1. Evidence

The Neolithic seems to appear as a more or less complete "Neolithic package" throughout Europe and in the Alboran region. An indigenous development of agriculture and domestication of cattle is generally refuted (Gehlen 2010, 587). Records show that the package consisted of crops (cereals and pulses; **Tab. 5**), sheep and goat (**Tab. 6**), pottery and polished stone tools. Since their earliest invention connected technologies such as agriculture, animal husbandry, production techniques of ceramic, and processing ground stone tools were elaborate in Central Europe. The few present preserved records in SE Spain (cf. **3.1. Sites**) mean that there is a lack of evidence (crop remains) for Early Neolithic agriculture in Andalusia (sampling technique without flotation, Peña-Chocarro 1999, 4; Peña-Chocarro/Zapata 2010, 193-195).

Research into the natural habitats of crops and domestic animals in the Fertile Crescent and the lack of wild progenitors in Iberia indicate a Middle Eastern origin (**Tab. 4** and **Tab. 5**). However, the cultivation of opium poppy could have originated in the W Mediterranean (Peña-Chocarro 1999, 132). Genetic studies on remains and current populations of plants and cattle all along the Mediterranean and especially Iberia and N Africa support this hypothesis (in summary Zeder 2008, 11599-11601).

Horticulture appeared in Early Neolithic times along the E Iberian coast (Alicante) and (subsequently) especially barley and naked wheat in Andalusia (Peña-Chocarro 1999, 3; López Sáez/Pérez Díaz/Alba Sánchez 2011; compare Cortés Sánchez et al. 2012, 3; Gibaja et al. 2012, 90). Thus, earlier agriculture may be expected. The farming communities started to grow cereals and introduced pulses (Peña-Chocarro 1999, 131). In the course of time, they specialized their crops and sowed seeds of selected species possibly due to a better adaptation to environmental conditions (Peña-Chocarro 1999, 4). Antolín/Buxó (2012, 99) even assume an exchange of crops. Even during Early Neolithic times one could expect permanent fields to grow wheat – probably as monocrops – as Antolín/Buxó (2012, 99 and citations therein) assume for Los Castillejos/Granada. Querns and fragmentation of the grains imply a processing of the crops. Storage items are so far not known in Andalusia (Antolín/Buxó 2012, 99).

DOMESTIC SPECIES	WILD ANCESTORES	ORIGIN/PLACE OF DOMESTICATION
einkorn *Triticum monoccocum*	*Triticum boeoticum*	Middle East (Wilcox 2002; Zohary 1996; Peña-Chocarro 1999)
emmer *Triticum diccocum*	*Triticum dicoccoides*	
wheat *Triticum aestivum*	hybrid	
durum *Triticum durum*	hybrid	
barley *Hordeum vulgare*	*Hordeum vulgare spontaneum*	
pulses		
opium poppy *Papaver somniferum*		W Mediterranean? (Peña-Chocarro 1999, 132)

Tab. 5 Founder crops and plants connected with the Neolithization.

Ancient and modern mtDNA analysis of ovicaprids in S France suggests by trend a single introduction of those. The genetic diversity of Portuguese sheep and goat is higher and the patchy dispersal of distinct haplotypes among modern successors indicates the descent from multiple introductory events from the Middle East along Italy and France but also out of Africa (Zeder 2008, 11600-11601). Sheep are the most frequent domestic animals in Neolithic S Spain (Cortés Sánchez et al. 2012, 3).

DOMESTIC SPECIES	ORIGIN/PLACE OF DOMESTICATION
goat *Capra aegagrus hircus* sheep *Ovis orientalis aries* cattle *Bos primigenius*	Middle East (PEREIRA ET AL. 2009; LUIKART ET AL. 2006; BRUFORD/TOWNSEND 2006; BEJA-PEREIRA ET AL. 2006; EDWARDS ET AL. 2007)
pig *Sus scrofa domestica*	Europe ? (LARSON ET AL. 2007)

Tab. 6 Domestic animals connected with the Neolithization. Their natural habitat and the comparison of modern and ancient mtDNA haplogroups imply their origins.

GEHLEN (2010, 587) states that the domestication of cattle and pigs could be due to an autochthonous development (**Tab. 6**). Current populations of domestic pigs are genetically closely related to the European wild boar, but extracted mtDNA from archaeological faunal remains suggests a Middle Eastern origin and a subsequent replacement of the Middle Eastern variety by the European swine. Therefore, the foreign introduction and also the indigenous domestication and thus several centers of origin are mirrored in the ancestry of the pig (LARSON ET AL. 2007; ZELDER 2008, 11601).

In research on the current human population, genetics (modern and ancient mtDNA and y-chromosome studies cf. **Tab. 4**) assign various impacts from colonizing early European farming communities: GAMBA ET AL. (2012) or PINHASI ET AL. (2012) conjecture continuity, whereas HAAK ET AL. (2005), RICHARDS (2003) and BERTRANDPETIT/CAVALLI-SFORZA (1991) favor a genetic rupture from Neolithic times down to the present day implying that “first Neolithic farmers did not have a strong genetic influence on modern European female lineages” and “a Paleolithic ancestry for modern Europeans” is likely (HAAK ET AL. 2005, 1016). Thus, the ratio of hunter-gatherers and adoption/acculturation processes predominate. But on the basis of dental morphology RUIZ ET AL. (2012) also demonstrate at the least “punctual entries of foreign populations”. Additionally, GEHLEN (2010, 587) conjectures that production and use of pottery and grinding stones could be due to an autochthonous development.

The domesticated species, innovations in material culture and associated technologies were accompanied by distinct ideologies, beliefs and new concepts such as sedentariness, property or e.g. the import of wild game and game stocking in Cyprus (ZEDER 2008, 11599-11600). Similar habits are conceivable for other regions, too. Additionally, the Neolithic way of life entailed population growth and possibly further social differentiation within (cf. PÉREZ RODRÍGUEZ 2008, 388). Taking in account the rock art, MARTÍNEZ/ESCORIZA-MATEU/OLTRA-PUIGDOMENECH (2006, 8-10) suggest a hereditary leadership with hunters dominating society.

2.3.2. Causation

The reasons for the development of the Neolithic and its dispersal are another essential research topic (CASTRO-MARTÍNEZ/ESCORIZA-MATEU/OLTRA-PUIGDOMENECH 2006, 7): Why did the Neolithic evolve? Why did it disperse? Why was the Neolithic way of life successful and why did it finally become totally accepted in Europe?

Possibly climate and environmental changes or a crisis (extremes, aridification, cooling cf. **3.3. Early to Middle Holocene climate and vegetation**) prepared the grounds and created a tolerant attitude towards subsistence changes. Insofar people could have responded to decreasing food resources with the addition of farming to hunting and gathering (in the W Mediterranean; CORTÉS SÁNCHEZ ET AL. 2012, 7-11). Thus, the Neolithic communities intensified and diversified the exploitation of food resources and their subsistence strategies (RAMOS MUÑOZ 2006, 819; MCCLURE/SCHMICH 2009, 179). They had a wider range of possibilities and reactions to environmental impacts at their disposal and finally improved their adaption to the ecological conditions (BERNABEU AUBÁN 2002, 211).

GUILLAINE/MANEN (2007; cf. LEE 1966) interjects social pressure (demography or conflicts) in Pre-Cardial groups. Also densely settled areas and the shortened use of the environment by hunter-gatherers could have driven the dispersal: only foraging strategies without farming and thus fallow fields and “unconsumed forestall resources” attracted farming communities (ZIMMERMANN 2009; JOCHIM 2009, 302). It is conceivable that people moved due to “perception of attractive or repulsive qualities of the landscapes” (WIDLOK ET AL. 2012, 270).

A remarkable increase and intensification of agriculture impacted the landscape from the 7th/6th millennium calBP onwards in W Andalusia (LÓPEZ SÁEZ/PÉREZ DÍAZ/ALBA SÁNCHEZ 2011). A worsening of the soil fertility might have pushed the farming groups spatially further on (AGUILERA ET AL. 2008). They could have abandoned their settlement area, moved and accessed a new place (extensifiers). Another possibility is that they interrupted and reversed this cycle by weeding and fertilizing (intensifiers, JOCHIM 2009, 304). The latter is mirrored in the analyzed grains of Los Castillejos in Granada (JOCHIM 2009, 304).

A focus on handcrafts and thus a certain specialization on single activities could have supported the consolidation of agriculture and decreasing mobility. Thus, certain people were primarily in charge of acquisition and transformation of raw materials, whereas others could have supplied them with agricultural goods (in CNP/AL; CÁMALICH ET AL. 2004, 195).

The positive results of farming are increased security and predictability of food resources through storage, possibly preventing food crises (MARTÍNEZ/ESCORIZA-MATEU/OLTRA-PUIGDOMENECH 2006, 7). Additionally, by being stationary (sedentariness), the whole collective endowed stability and allowed higher reproduction. Furthermore, the conditions improved continually and led to population growth (an accumulation of larger groups and further spatial spread).

In contrast a higher workload in various areas, social inequality and possibly stress had to be accepted (CASTRO-MARTÍNEZ/ESCORIZA-MATEU/OLTRA-PUIGDOMENECH 2006, 6; CRUZ BERROCAL/VICENT GARCÍA 2007, 686). Additionally, it appears from our current point of view that the living conditions did not improve (pathology: diseases and deformity, studies on expectancy of life and age of death).

2.3.3. Models

Numerous compilations of Neolithization models are available (e.g. MÜLLER 1993; OOSTERBEEK 2001; SCHARL 2004; GEHLEN 2010, 587-603; VAN WILLIGEN 2006, 28-31; ZIMMERMANN 2009). **Tab. 7** summarizes current theories focused on the W Mediterranean. The records of archaeology and related subjects (**Tab. 4**) indicate the origin of the European Neolithic in the Middle East and its dispersal along the N Mediterranean coasts. From the Adriatic Sea (Impresso) it spread to the E and S Iberian Peninsula (Cardial), to N Morocco and to Portugal (VAN WILLIGEN 2006, 28; BOCQUET-APPEL ET AL. 2009, 814 Fig. 10 limits 8, 9 and line B, 816). References for a transfer along the African coasts or from Italy along Tunisia, Algeria and Morocco are scarce (GARCÍA BORJA ET AL. 2010; CORTÉS SÁNCHEZ ET AL. 2012).

The models can be classified according to provenance and dispersion of the Neolithic (LINSTÄDTER ET AL. 2012b). A subdivision is due to the acting “agents” in the transition process: Thus, discontinuous findings could imply immigrating farmers (migrationism/colonization, demic diffusion with Neolithic package and assimilation/displacement of local hunter-gatherers) or hunter-gatherers could be visible by a continuous archaeological record (indigenism, cultural or diffusion of ideas and adoption of Neolithic items via exchange by hunter-gatherers; GEHLEN 2010, 587; ZIMMERMANN 2009).

MODEL	CONTENT	EVIDENCE
Wave of advance AMMERMANN/ CAVALLI-SFORZA 1984	The Neolithic originates in the Middle East (sedentariness – population growth – agriculture – domestication). The dispersal was due to population growth and migration with a rate of approximately 25 km/generation or 1 km/year. Local populations were assimilated (acculturation).	Wild forms of cereals and sheep/goat occurred only in the Middle East; 14C dates of cereals; genetic distribution of current European population.
Availability model ROWLEY-CONWY/ ZVELEBIL 1984; ZVELEBIL 1986; 2000; ROWLEY-CONWY 2003	1. step by step transformation of the Ertebølle-groups to farming communities in three phases: *Availability phase:* exchange with neighboring farmers; *Substitution phase:* immigration of farming communities in their habitat or partial adoption of the Neolithic lifestyle; external or internal competition; *Consolidation phase:* Full Neolithic. 2. Neolitization in general: The Neolithic originates in Anatolia and the Middle East. Mobile farming communities migrate to SE and central Europe and meet residential hunter-gatherers. Hunter-gatherers adopt the Neolithic way of life due to contacts and exchange with the farmers. Knowledge and traditions were passed down generations. Further dispersal was due to social networks.	Archaeological continuity from the Mesolithic to the Neolithic 1. 14 C-dates, pollen and faunal analysis and archaeology in the context of Ertebølle 2. Genetic analysis provide little foreign material in the European Neolithic.
Network model MÜLLER 1993, 35	Single Neolithic elements diffuse through hunter-gatherer networks. In conjunction with feedback processes, regional variable groups developed. They disperse further and Neolithic societies appear.	(Supra-)Regional dispersion of similar Mesolithic finds; Mesolithic sites with single Neolithic features and younger Fullneolithic sites.
Dual model/ two worlds model various authors between 1978-2000[2]	Fullneolithic settlers colonize the Spanish Levant and exist partly contemporaneously with indigenous hunter-gatherers. The latter adopt several Neolithic features and disperse them.	Different artifact assemblages in the two cultural groups: discontinuity in subsistence, material culture and rock art; Cardial: Neolithic package (Cueva de l'Or, Cueva Cendres, Cueva de la Sarsa); Epipaleolithic: hunter-gatherers with ceramic, grinding stones, domestic animals (Cueva de la Cocina III-IV/all in Valencia).
One World model SCHUMACHER/ WENIGER 1995, 129	Subsistence is based on two components: In residential settlements agriculture dominates, while specialized, seasonal camps serve for hunting, raw material exploitation or pasture.	Contemporaneous sites evidence differing subsistence ways: Besides hunter-gatherer sites with few Neolithic elements, Fullneolithic sites occur.
Cardial Model and Maritime pioneers MORAIS ARNAUD 1990 ZILHÃO 1993; 1997; 2000; 2001	Neolithic settlers colonize the W Mediterranean (in particular Portugal) by boat along insular, at that time uninhabited spots near the coast with distinct, suitable ecosystems. They expand their habitat quickly. Mesolithic groups are assimilated and adopt the new lifestyle.	Quick, coastal dispersal and homogeneity of Cardial in S France and Iberia between 5700 and 5400 calBC; discontinuity between Meso- and Neolithic: in dispersal, burial practices, dietes (δ 13) and osteology; interaction: changes in pottery decoration in younger periods (Gruta da Caldeirão/Tomar, Galeria da Cisterna/Almonda/both in Portugal).
Island filter model LEWTHWAITE 1986	The Neolithic way of life diffuses along the Mediterranean over the Tyrrhenian islands to the Iberian Peninsula. These islands operate as a filter for the Neolithic package. The island-population adopts just singular Neolithic elements and disperses them.	Differences between the W and E Mediterranean Neolithic: only pottery and sheep/goat, no villages; E: discontinuity; W: continuity (sites on Corsica, Sardinia).
Social Model LEWTHWAITE 1986	Hunter-gatherers adopt Neolithic elements over cross-cultural contacts for prestige and social hierarchy reasons. Individual members of the hunter-gatherer society are interested in Neolithic goods. Later these goods became objects of daily use.	Isolated Neolithic finds, such as ceramic, on otherwise hunter-gatherer sites.
Axial/arterial model VICENT GARCÍA 1997 and citations therein	An exchange of ideas leads to the Neolithic dispersal throughout the Iberian Peninsula from E to W via different routes through the countryside.	

Tab. 7 General European and Iberian Neolithization models (cited and compiled from SCHARL 2004, 23-26; 151-152; 156; GEHLEN 2010, 588-590; VICENT GARCÍA 1997, 2-11; SCHUHMACHER/WENIGER 1995, 129; OOSTERBEEK 2001; MANEN/MARCHAND/CARVALHO 2007; VAN WILLIGEN 2006, 30).

[2] MARTÍ OLIVER 1978, 1982; FORTEA PERÉZ/MARTÍ OLIVER 1984; FORTEA PERÉZ ET AL. 1987; JUAN CABANILLES 1990, 1992; SCHUMACHER/WENIGER 1995, 129; BERNABEU AUBÁN 1997; MARTÍ OLIVER/JUAN CABANILLES 2000.

MODEL	CONTENT	EVIDENCE
Mosaic model Capillary model/ Model of interactive relationships SCHUMACHER/WENIGER 1995; VICENT GARCÍA 1997; SOARES 1997	The Neolithic innovations disperse by reciprocal exchange via networks of hunter-gatherer bands (diffusion of ideas; more or less static populations; migration not completely denied). Originally these networks guaranteed economic stability, but led to inequality and accumulation of power and reorganization. Dispersals reflect intergroup relations and internal social dynamics. The quick changes were due to the open-minded hunter-gatherer groups or the social conditions (ready for change, risk reduction).	Similar microliths, regular blades and related production techniques (originally Epipaleolithic) and Cardium/similar decorated pottery and potential dispersal of domesticates (Early Neolithic origin) in distinct regions of the W Mediterranean.
Recomposition of the Neolithic Package/ African origin model MANEN/MARCHAND/ CARVALHO 2007; CORTÉS SÁNCHEZ ET AL. 2012	The Neolithic disperses from the SE Iberian Peninsula to N Morocco. Apart from the Moroccan Cardial a second technical and cultural unity evolves contemporaneously. Thus, the Neolithic package was recomposed and elements were modified and added. The new recomposed Neolithic diffuses further on to Portugal and back to Andalusia.	Similarities between S Iberian and N Moroccan sites: high frequency of segments, pressure debitage, heat treatment, "bag-like" pottery forms (pointed-based vessels?), *almagra* decoration, various impressed and incised decorations, a broad variety of domesticated plants, a distinct sickle construction, similar mtDNA haplogrous in ancient human remains.

Tab. 7 continued.

These models suffer from simplification and generalization, but recently the two extreme positions have become less rigid and are converging (MCCLURE/MOLINA BALAGUER/BERNABEU AUBÁN 2008, 327). Scientists have not been able to explain the multifaceted process with a one-sided model; hence the remains were made comprehensible in a combined model (BERNABEU AUBÁN 1997, 1; cf. for Portugal BICHO ET AL. 2003 or DINIZ 2007). Neolithization of hunter-gatherer groups in addition to immigrating pioneer farmers is likely (group 4 Geometric Neolithic of Principal Component Analysis of BERNABEU AUBÁN 2002, 213; 229).

A general model to describe cultural changes is the model of adaptive or cultural cycles (GUNDERSON/HOLLING 2002 cf. ZIMMERMANN 2012; PETERS 2011; WIDLOK ET AL. 2012). It allows a combination of interdisciplinary approaches and culture-environment interaction on different scales "households, settlements, largest cooperating groups, self-organized *archaeological cultures*, local, regional, supra-regional or continental"/*panarchy* (ZIMMERMANN 2012, 256-257; PETERS 2011). The model stem from the resilience theory according to which each system should pass the phases listed in **Tab. 8** (recently summarized by PETERS 2011; CLARE 2013, each with citations and case studies for applications in archaeology therein). These stages do not necessary have to follow each other in the listed order, but e.g. another r-phase may succeed a K-phase (ZIMMERMANN 2012, 256-257). Moreover, the Ω-phase may be a rather "creative destruction" and allows the expression of the following r-phase as expansion and immigration, resistance of groups, retreat, micro- or macro-extinction or finally system breakdown (*Repeated Replacement Model*; BRADTMÖLLER ET AL. 2012, 46 Fig. 8 with further case studies). The phases are characterized by varying amounts of resilience (*Widerstandtsfähigkeit*) or contrariwise vulnerability (*Verwundbarkeit*). In particular, K-, Ω- and α-stage are less resilient and more vulnerable (CLARE 2013). The length of a cycle is an indicator for its resilience, e.g. hunter-gatherers with residential mobility were apparently more resilient over thousands of years than farming communities (ZIMMERMANN 2012, 256-257; 257 Fig. 5). Besides environmental exterior influences, hardly tangible cultural influences such as networks, exchange, mobility patterns and cultural memory/traditions including value systems, kinship, heritage, residence rules, territoriality, decision structures and belief system also have to be considered (ZIMMERMANN 2012, 255; 257). Finally the model of adaptive cycles may explain various phenomena on both large and on small scales: E.g. WIDLOK ET AL. (2012, 270) criticize the Wave of Advance-model (cf. **Tab. 7**) because although the supra-regional continuous dispersal of the Neolithic is well depicted, regional discontinuities were not captured.

PHASE	CHARACTERISTICS	*example:* LBK IN THE LOWER RHINE BASIN (approximately 7250-6900 calBC)
r – growth	Plentiful resources, small societies with a growing population, immigration, accumulation of asset such as raw material, knowledge, large social networks, diverse structures; opportunistic use of resources, uniform material culture, innovations; in hunter-gatherer context: fusion of bands > high resilience and barely vulnerable	I-VII + houses > population growth + pottery diversity > marital networks + Bohemian adzes and Rijckholt flint > exchange networks equal amountn of unmodified flakes > no specialization; >> flexible vs. external influences
K – preservation/ conservation	Increase of efficiency, intensification and optimation, specialization, regionalization, centralization; stagnation of population, technology and asset "law of diminishing results"/carrying capacity (*Grenzen des Wachstums*); claiming of privileges, decreasing networks; in hunter-gatherer contexts: formation of band clusters > low resilience and vulnerable	VIII-XII equal number of houses (demographic stagnation) - pottery diversity > - marital networks - Bohemian adzes and Rijckholt flint > - exchange - unmodified flakes > + specialization + cemeteries, peregrine pottery > rigid vs. external influences
Ω – disturturbance/ distortion/collapse	Local shortcomings multipy and disturbances affect the system increasingly; destruction of the system, freeing of asset and basis for changes "creative destruction", emigration; in hunter-gatherer contexts: fission of band clusters > vulnerable	XIII-XV - houses > population decline -- pottery diversity > -- marital networks -- Bohemian adzes and Rijckholt flint > -- exchange -- unmodified flakes > ++ specialization +/- cemeteries, peregrine pottery + enclosures > very rigid vs. external influences >> collapse or release
α – reorganization	Changes in the system, investment, building activities, high workloads, immigration > decreasing vulnerability, increasing resilience	?

Tab. 8 Phases and characteristics of adaptive cycles exemplified by developments (+ in-/- decreases) in the Rhenish Linear Pottery culture (LBK) in pottery style phases I to XV (compiled according to CLARE 2013; PETERS 2011; WIDLOK ET AL. 2012; ZIMMERMANN 2012).

2.3.4. Starting hypotheses concerning the W Mediterranean

LINSTÄDTER ET AL. (2012b) postulate, that – originating from the Middle East (Model of Eastern origin, SCHUHMACHER 1994, 65; WHITTLE 1996, 294) – Fullneolithic settlers migrated quickly and expansively by boat in costal, at that time uninhabited spots with limestone based soils of the Spanish Levant (compare mathematic modeling of the speed of the Neolithic front, references in **Tab. 4**). Innovations differing from the Epipaleolithic tradition indicate foreign influence via demic diffusion in Early Neolithic contexts in Málaga (CORTÉS SÁNCHEZ ET AL. 2012, 3).

The diffusion gained an essential drive mechanism by the use of boats (MÜLLER 1993, 32; for the importance of waterways in the Mediterranean Neolithization see DAVISON ET AL. 2006). Nevertheless, it was a heterogeneous dispersion in leaps with events of fast and fluent expansion, but also of interruptions and abidance (cf. MANEN/CONVERTINI 2012) at geographical, ecological, population or cultural "expansion fronts". "Centers of renewed expansions" initiated "arrhythmic" waves of dispersal (BOCQUET-APPEL ET AL. 2009, 807; 811, 816). Various conditions and decisions influenced this process (JOACHIM 2009, 302-305).

An encounter of pioneer farmers with Holocene hunter-gatherers in neighboring areas is highly probable (Maritime pioneers, ZILHÃO 2001; ZEDER 2008, 11600 cf. in contrast MARTÍ OLIVER 2012: colonization of uninhabited areas). Similarities in Epipaleolithic and Neolithic material culture assemblages are indicators of this encounter ("direct acculturation": JOVER MAESTRE/MOLINA HERNÁNDEZ/GARCÍA ATIÉNZAR 2008, 93; GARCÍA PUCHOL ET AL. 2009, 246-248). This "encounter" could have ranged from single-item adoptions (adaptation) to interaction, reciprocal influence, acculturation (intercultural contact) and assimilation (absorption of minorities) or perhaps even to violent conflicts (KUNST 2008, 20 or KUNST 2010, 19; for ethnographic evidence cf. LINSTÄDTER ET AL. 2012b).

Farmers did not replace Epipaleolithic groups. Their survival is testified by persisting hunter-gatherer enclaves: Depending on the region, the environmental conditions and the optimal subsistence strategy they existed contemporaneously for different durations: In Valencia, the Moroccan E Rif and Portugal hunting-gathering persisted longer than in SE Spain (Geometric Epipaleolithic and Early Neolithic in Valencia, JOVER MAESTRE/MOLINA HERNÁNDEZ/GARCÍA ATIÉNZAR 2008, 91; Epipaleolithic with pottery and Early Mediterranean Neolithic in NE Morocco, LINSTÄDTER 2008, 44-45; Portuguese shell middens, ZILHÃO 2000, ZILHÃO 2001; ZEDER 2008, 11600).

Alternatively the population could have decreased during the times of late hunter-gatherers (ZEDER 2008, 11600). GARCÍA PUCHOL ET AL. (2009, 244; 246-248 and GARCÍA PUCHOL/MOLINA BALAGUER/GARCÍA ROBLES 2004, 77) assert a stratigraphical hiatus or even excluding settlement areas and territories between late hunter-gatherers and Early Neolithic settlers in Valencia. CORTÉS SÁNCHEZ ET AL. (2012, 2; 5:”erosional hiatus”) identify only an erosion between these stages.

Hunter-gatherers adopted several Neolithic features stepwise (Dual model/two worlds model – in summary MARTÍ OLIVER/JUAN CABANILLES 2000; SCHUMACHER/WENIGER 1995, 129; GEHLEN 2010, 588; 590; Availability Model). The inclusions were selected according to the social and cultural context, the tolerance, convenience, symbolism/prestige, relations/identities and as it fitted to the surrounding conditions of the group’s location, the potential of soils, dispersal/availability of resources (Social and capillary model; compare SOARES/DA SILVA 2003, 45; OOSTERBEEK 2001, 77 with citations therein).

The settlement systems remained initially as in the foraging contexts (SCHUMACHER/WENIGER 1995). Harsh environmental conditions challenged the new lifestyle and thus the maintenance of foraging strategies, and it is likely that seasonal mobility remained necessary for the exploitation of various territories (CRUZ BERROCAL/VICENT GARCÍA 2007, 692). Varying settlement patterns and ephemeral, variable records indicate a certain amount of time till the consolidation of the farming (JOCHIM 2009, 309).

It is likely that a Pre-Cardial (*sillon d’impression* cf. recently CORTÉS SÁNCHEZ ET AL. 2012) Initial Neolithic was the source for the Early Cardial Neolithic in the W Mediterranean, which could have originated in Liguria/Italy. BOCQUET-APPEL ET AL. (2009, 812 Fig. 8 N° 6, 813) detected coherently a “centre of renewed expansion” at the Ligurian coast. The S French sites of Pendimoun (Alpes-Maritime), Pont de Roque-Haute, Peiro-Signado (both Herault; GUILAINE/MANEN 2007; BRIOIS/MANEN 2009) and the Valencian El Barranquet (BERNABEU AUBÁN ET AL. 2009, 84-89) with absolute dates decreasing from NE to SW from 7800 to 7400 calBP indicate the westward dispersal (LINSTÄDTER ET AL. 2012b). Additionally, S France and the Valencian region correspond to “centre[s] of renewed expansion” N° 5 and 7 of BOCQUET-APPEL ET AL. (2009, 812 Fig. 8, 813). From the various Early Neolithic enclaves the farming lifestyle dispersed to central Spain (JIMÉNEZ-GUIJARRO 2010, 583 Fig. 308 C).

However, the Initial Pre-Cardial Neolithic is hardly evident in SE Spain and Morocco: “Cardialoid” decorations are rare in Málaga (but those that are available probably refer to the Pre-Cardial) and a Pre-Cardial stage is absent in the arid Almería region (CORTÉS SÁNCHEZ ET AL. 2012, 3; 11). Therefore, CORTÉS SÁNCHEZ ET AL. (2012, 10-11) assumed a Maghrebian origin of the Pre-Cardial (African origin model – an advancement of the Recomposition model).

The Pre-Cardial phenomenon was then overtaken and replaced by a second wave of the Early Cardial Neolithic (CORTÉS SÁNCHEZ ET AL. 2012, 10). The Cardial stage was shaped in the W Mediterranean and was present almost contemporaneously in S France (LINSTÄDTER ET AL. 2012b; GUILAINE/MANEN 2007, 47; MANEN/PERRIN 2009), coastal and estuary Spain and Morocco from 7600/7500 calBP onwards (cf. **2.2. Chronology**). One center with an accumulation of variable Cardial sites was located in Valencia (JOVER MAESTRE/MOLINA HERNÁNDEZ/GARCÍA ATIÉNZAR 2008, 92).

The innovations of the Cardial Neolithic diffused very rapid through Andalusia and N Morocco by reciprocal exchange via intercontinental networks of hunter-gatherer bands, so the populations stayed more or less static in their territories. The routes and velocity of the dispersal reflect well-established, long-time intergroup relations and internal social dynamics (Mosaic model/Capillary model, SCHUHMACHER/WENIGER 1995, 129; VICENT GARCÍA 1997).

In N Morocco elements of the Neolithic were modified and added. Influenced by an emerging second technical and cultural unity, the Neolithic package was recomposed (Recomposition of the Neolithic package, MANEN/MARCHAND/CARVALHO 2007). This development was closely linked to the distribution of bioclimatic zones (EMBERGER ET AL. 1962) as contacts within a similar environmental setting were tight and more elaborate. The recomposed Neolithic diffused “back” to E Andalusia and further on to W Andalusia and Portugal. Thus, the Neolithic developed synchronously in these regions (CORTÉS SÁNCHEZ ET AL. 2012, 10). Finally the Neolithic sustenance also occupied the hinterlands and inner Spain (cf. JIMÉNEZ-GUIJARRO 2010, 583 Fig. 308 D).

Transcontinental contacts between S Spain and N Morocco are evident in archaeological similarities (MANEN/MARCHAND/CARVALHO 2007, LINSTÄDTER ET AL. 2012b). Pre-Chalcolithic African migration flows to Iberia (dispersal of human mtDNA haplogroup L; GAMBA ET AL. 2008, 464) and gene flow between livestock populations from both regions (PEREIRA ET AL. 2009, 2770; 2771 Fig. 4; BEJA-PEREIRA ET AL. 2006, 8117; ANDERUNG ET AL. 2005) are additional supportive findings.

3. Study area

The working area in SE Spain is located in the inner belt of the Betic Cordillera at the Alboran Sea, the most W part of the Mediterranean directly E of the Straits of Gibraltar. From E to W the following regions are the content of the study: Murcia, Upper Andalusia with Almería, Granada and Málaga with Guadalhorce river as most W limit (cf. **Fig. 4**).

The focus lies primarily on the coast and the hinterland up to 70-80km inland. The bioclimate is predominantly thermomeditrranean (cf. **Fig. 5**). Neighboring sites in the submediterranean zone were included for site comparison.

This region is located opposite the long term research area in NE Morocco (LINSTÄDTER ET AL. 2012b).

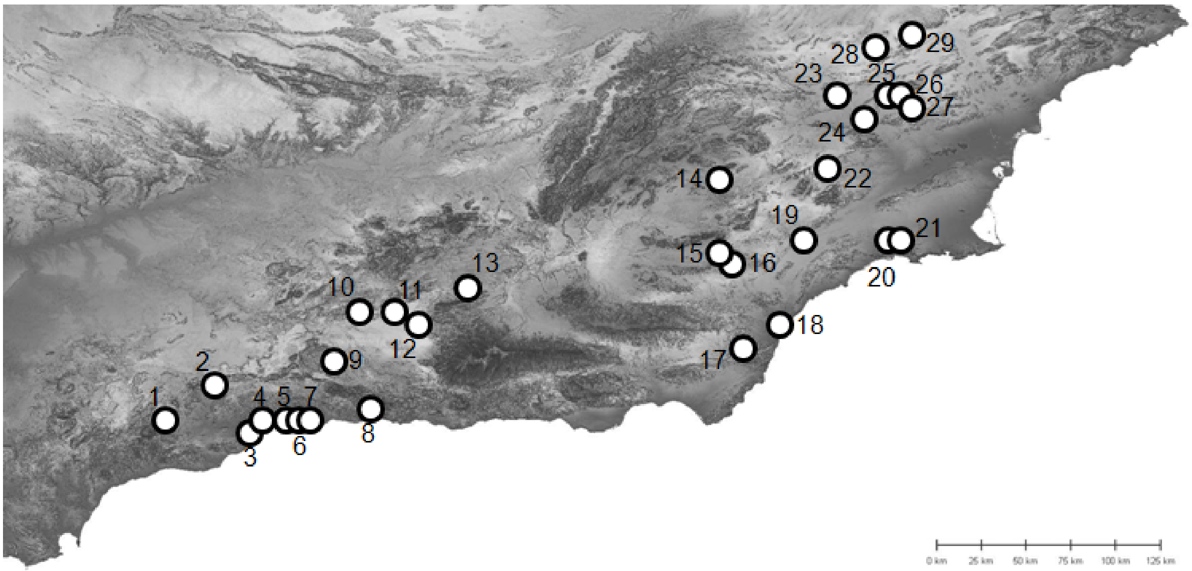

Fig. 4 Study area in SE Spain (modified from LINSTÄDTER ET AL. 2012b, 6 Fig. 2) and sites mentioned in the text: 1 El Charcón, El Duende, 2 Cueva de las Goteras, 3 Cueva Bajondillo, 4 Abrigo 6 Complejo del Humo, 5 Hoyo de la Mina, 6 Cueva Victoria, 7 Cueva del Higuerón, 8 Cueva de Nerja (Málaga); 9 Cueva de Cacín, 10 Los Castillejos, 11 Cueva de Malalmuerzo, 12 Las Majolicas, 13 Cueva de la Carigüela (Granada); 14 Cueva del Buho (Murcia); 15 Cueva Ambrosio, 16 Cerro de las Animas, 17 El Gárcel, 18 Cabecicos-Negros El Pajarraco (Almería); 19 Abrigo del Enevro, 20 Cueva del Algarrobo, 21 Cueva de la Higuera, 22 Barranco de la Hoz, 23 Abrigos del Pozo, 24 Hondo de Cagitán, 25 Abrigo Grande II del Barranco de los Grajos, 26 La Boracha II, 27 Callado Norte Santa Ana, 28 Cueva del Monje, 29 Cueva de los Zagales (Murcia).

3.1. Sites

At first looking at **Fig. 4** one might gain the impression that there are many Epipaleolithic and Early Neolithic sites known in the working area (cf. also LINSTÄDTER ET AL. 2012b). Numerous sites have appeared in the literature over the past 100 years: A site, once typologically classified in the 60s or 80s, became repetitively cited in overviews of the settlement area and cultural frame (cf. e.g. MUÑOZ AMILIBIA 1987; NAVARRETE/MOLINA 1987; MARTÍNEZ SÁNCHEZ 1988; LÓPEZ 1988; PELLICER CATALÁN 1995, 84 Fig. 84; RAMOS MUÑOZ 1988-89, 120-121; MUÑIZ PÉREZ 1997; KUNST 2001; VAN WILLIGEN 2006, 199 map 30). Recently this subject has been dominated by a broader perspective: Even though a recent focus on the transitional process *sensu stricto* – i.e. Epipaleolithic and Early Neolithic – is missing, research has also been extended to the later Neolithic to illustrate a complete and encompassing development (VAN WILLIGEN 2006, 199).

years	MU							AL		GR		MA					years
	AL	AM	CH	CZ	HC	Hoz	Pozo	CA	CNP	Car	Cast	A6	Bj	Du	Got	Ner	
1944								X									1944
1945																	1945
1946											X						1946
1947											X						1947
1948																	1948
1949																	1949
1950																	1950
1951																	1951
1952																	1952
1953											X						1953
1954										X							1954
1955										X							1955
1956																	1956
1957																	1957
1958																	1958
1959										X						X	1959
1960										X							1960
1961																	1961
1962																X	1962
1963																X	1963
1964																	1964
1965																X	1965
1966																X	1966
1967																X	1967
1968																X	1968
1969										X						X	1969
1970										X						X	1970
1971										X	X					X	1971
1972											X					X	1972
1973											X					X	1973
1974					subsequently prospection | discovery of stray finds in 1974						X					X	1974
1975		X						X								X	1975
1976															discovery of finds unknown; previous to study of Navarrete 1976	X	1976
1977																X	1977
1978																X	1978
1979																X	1979
1980				excavations before 1980ies												X	1980
1981																X	1981
1982			X					X		X		X				X	1982
1983								X		X		X				X	1983
1984										X				excavation (?) and surface collection previous to the study of Martínez Fernández/Aguayo de Hoyos 1984		X	1984
1985										X						X	1985
1986	X		X					X		X		X				X	1986
1987	X		X							X						X	1987
1988	X																1988
1989	X																1989
1990	X							X									1990
1991	X					clandestine excavations before 1991			X		X						1991
1992	X						X				X						1992
1993	X							X			X						1993
1994	X										X						1994
1995	X																1995
1996	X																1996
1997																	1997
1998																	1998
1999																	1999
2000									X				X				2000
2001			X										X				2001
2002													X				2002
2003																	2003
2004			X				↓ ← excavations										2004
2005			X														2005
2006																	2006
2007			X														2007
2008																	2008
2009																	2009

Tab. 9 Excavation campaigns of the sites with relevant Epipaleolithic and Early Neolithic levels (cf. **SITE GAZETTEER** with references).

However, a closer look unfolds poor investigation and research gaps especially in the SE most corner of Spain. This is illustrated on the maps of ACOSTA MARTÍNEZ (1995, 35 Fig. 1), GEHLEN (2010, 503 Fig. 158) or CORTÉS SÁNCHEZ ET AL. (2012, 222 Fig. 1). Thus, the aforementioned mass of sites requires a selection to require an adequate dataset of reliable more or less unambiguous Epipaleolithic and Early Neolithic sites. Because of ambiguous stratigraphies and mixed assemblages, correct cultural classifications are among the most acute problems. Additionally, isolated settlement areas of the first farming communities represent only parts of the ancient dispersal and are most probably due to the research areas investigated. CRUZ BERROCAL/VICENT GARCÍA (2007, 686) even stated that the coastal sides and thus the coastal spread of the Early Neolithic is only due to archaeological research traditions and does not reflect reality. Furthermore, as a result of research foci and preservation, caves dominate the identified sites. Inaccurate or old excavations (no early remains of cereals; debatable fauna), bad bone conservation and very few, intermittent absolute dates challenge the research (GEHLEN 2010, 587; “Cardial disorder”, LEWTHWAITE 1982). 20 years ago AFONSO MARRERO (1993, 6) faced the same problem and asserted that it is difficult to select a sufficient sample of sites. Currently, several additional sites are known that promise relevant results after their evaluation (e.g. Cueva Bajondillo/MA, Abrigos del Pozo/MU). The numerous finds of Cueva de Nerja/MA are still under study, and excavations have been taking place for decades (cf. **Tab. 9** and **SITE GAZETTEER**: **Cueva (de) Nerja/Málaga**).

3.1.1. Outline

Tab. 10 to **Tab. 13** list sites with finds classified in some publications as Epipaleolithic, Early Neolithic and general Neolithic. A further literature review uncovers them as neither Epipaleolithic nor Early Neolithic: The majority of "Neolithic" sites could unfortunately not be identified more precisely with one distinct Neolithic stage (**Tab. 14**). Eventually, several sites could be excluded because their material is of Middle or Late Neolithic origin (**Tab. 15** and **Tab. 16**). ROMÁN DIAZ/MAICAS RAMOS (2002, 65) assume an Initial to Middle Neolithic origin for the ceramic spoons of Las Palas, La Era/AL, Cueva de la Cantera/MA, Cueva el Toro/MA. But generally Neolithic assemblages of these sites are categorized as middle Late Neolithic during 7^{th}-6^{th} mil. calBP (for Las Palas and La Era/AL see ROMÁN DÍAZ/MAICAS RAMOS 2002, 51 cf. p. 52: Cabezo de las Eras and FERNÁNDEZ-MIRANDA ET AL. 1993, 80-81; Cueva de la Cantera/MA, pers. comm. J. Enrique Marquez Romero and cf. CARRIÓN/CONTRERAS 1979, 33; 35 or NAVARRETE 1976, 350-356; for Cueva el Toro/MA see CÁMALICH MASSIEU/MARTÍN SOCAS 1999, 109, MARTÍN SOCAS ET AL. 2004, 70-71 or RODRÍGUEZ RODRÍGUEZ ET AL. 1995, 161). The Neolithic levels of La Boja/MU are dated to later Neolithic periods (pers. comm. J. Zilhão).

3.1.2. Specification

Many sites provide ambiguous evidence and issues due to poorly documented excavations, old investigations, and missing stratigraphies and radiocarbon dates. Typological classifications appear inexplicit or lack previous clear definitions. Inventories are incomplete or not accessible and in some cases results remain unpublished. But these deficient assemblages also represent the current available data pool. Thus, the outcomes have to be dealt cautiously and reservations kept in mind.

In the following paragraphs, an evaluation of the available sites is presented. The **SITE GAZETTEER** contains site related information and references.

3.1.2.1. Almería

With reservations Epipaleolithic and Early Neolithic levels and finds are preserved from the following sites in Almería: Cabecicos Negros-El Pajaraco/Vera, Cerro de las Animas/Veléz Rubio and Cueva Ambrosio/Las Cuevas de Ambrosio.

Cabecicos Negros-El Pajaraco consists of two sites, including Cabecicos Negros (abbreviated as CNP in this study) with Neolithic occupation(s). Excavations took place recently (1991, 2000) and the documentation and deposition of finds in the Museum of Almería is very precise and almost self-explanatory. CNP is extraordinary as one of the few Early Neolithic sites in Almería and moreover it is an open-air site with many jewelry finds (CAMÁLICH MASSIEU ET AL. 1999a, 109). However, small doubts remain concerning its relative chronological classification: There is no stratigraphy and radiocarbon datings cannot be expected due to insufficient amounts of organic remains (pers. comm. D. Martín Socas). Additionally, the finds of CNP were earlier characterized as Middle Neolithic (e.g. CÁMALICH MASSIEU ET AL. 1999a, 109; cf. **SITE GAZETTEER**: **Cabecicos Negros-El Pajarraco/Almería**).

SITE	REFERENCES
Cabecico del Aguilar	Fernández-Miranda et al. 1993, 78
Cabezo de la Mata	Fernández-Miranda et al. 1993, 74; Delibes et al. 1996, 165; 165 Tab. 1
Cabezo de la Raja Ortega	Fernández-Miranda et al. 1993, 78; 81
Cañada del Jurado	Ramos Muñoz 1988-89; Ramos Muñoz 1998, 68 Fig. 4
Cerrá de Arboleas	Román Díaz et al. 2005, 467 Fig. 2
Cerro de las Chinchillas	Ramos Muñoz 1998, 68 Fig. 4
Cerro Urraca	Román Díaz et al. 2005, 467 Fig. 2
Cerro Virtud	Ruiz Taboda/Montero Ruíz 1999
Cortijo de las Guindas	Román Díaz et al. 2005, 467 Fig. 2
Cortijo Gátar	Fernández-Miranda et al. 1993, 79
Cortijo La Muela	Román Díaz et al. 2005, 467 Fig. 2
Cueva de El Palo	Sánchez Quirante et al. 1996, 610
Cueva del Castillico	Navarrete 1976, 395; Ramos Muñoz 1998, 68 Fig. 4
Diana/Llano de Herrerías	Delibes et al. 1996, 165; 165 Tab. 1
El Argar	Fernández-Miranda et al. 1993, 81
El Faz	Román Díaz et al. 2005, 467 Fig. 2
Ermita de Cela	Román Díaz et al. 2005, 467 Fig. 2
Jocalla	Román Díaz et al. 2005, 467 Fig. 2
La Cuca	Román Díaz et al. 2005, 467 Fig. 2
La Mancoba	Román Díaz et al. 2005, 467 Fig. 2
Las Herrerías	Fernández Miranda et al. 1993, 79, 81
Las Pilas	Fernández-Miranda et al. 1993, 81
Libertao	Román Díaz et al. 2005, 466 Fig. 1
Loma de Rutillas	Ramos Muñoz 1988-89
Lugarico Viejo	Fernández-Miranda et al. 1993, 79
Mojácar la Vieja	Fernández Miranda et al. 1993, Fig. 15, 16
Pago del Guarda Jurado	Fernández-Miranda et al. 1993, 79
Paraje de Qurémina	Fernández Miranda et al. 1993, Fig. 15,1-7; 79
Piedra Labrá	Román Díaz et al. 2005, 467 Fig. 2
Sierra del Madroño	Román Díaz et al. 2005, 466 Fig. 1
Siret 3	Delibes et al. 1996, 165; 165 Tab. 1
Terren Ventor	*NA*
Tres Cabezos	Fernández-Miranda et al. 1993, 79; Mariën/Ulrix-Closset 1985, 32-34
Zájara	Cámalich et al. 2004, 190; 192

Tab. 10 Relevant Almerían sites based on initial literature review (*NA* = reference not available).

SITE	REFERENCES
Cueva de la Campana/Ventana	*NA*
Cueva de la Mujer	Navarrete 1976, 286; Navarrete et al. 1991, 82-86
Cueva de la Pastora	Sánchez Quirante et al. 1996, 611
Cueva de la Ventana	Navarrete et al. 1991, 70-73; Navarrete/Molina 1987, 647
Cueva de las Campanas	Navarrete et al. 1991, 111-112; Ramos Muñoz 1998, 68 Fig. 4
Cueva de las Canteras	Carrión/Contreras 1979
Cueva de los Intentos	Navarrete/Molina 1987, 647
Cueva de los Molinos	Navarrete et al. 1991, 104-106
Cueva de los Murciélagos	Navarrete 1976, 307; Alfaro Giner 1980; Cacho Quesada et al. 1996
Cueva de Malalmuerzo	Carrión/Contreras 1979; Navarrete et al. 1991, 66-70
Cueva del Agua	Navarrete et al. 1991, 91-95; Navarrete/Molina 1987, 647
Cueva del Agua de Pradonegro	Navarrete/Capel 1977; Navarrete et al. 1991, 74-82
Cueva del Puntal	Pellicer 1964, 10
Cueva Horá	Pellicer 1964, 10
Cuevas de las Peñas de los Gitanos	*NA*
La Molaina	Navarrete et al. 1991, 112-116
Las Majolicas	Navarrete et al. 1991, 61-66; Navarrete/Molina 1987, 647
Llano de las Canteras	Ramos Muños 1988-89, 118
Sima Blanca	Sánchez Quirante et al. 1996, 610; cf. van Willigen 2006, 339 (with references therein)
Sima Carburero	*NA*
Sima de la Maquila	Guerrero Misa 1992, 86
Sima del Conejo	Navarrete et al. 1991, 100-101
Sima Rica	Navarrete 1976, 300; Navarrete et al. 1991, 95-98

Tab. 11 *(on the previous page!)* Relevant sites of Granada based on initial literature review (*NA* = reference not available).

SITE	REFERENCES
Acinipo	RAMOS MUÑOZ 1988-89, 118
Casco urbano de Ronda	GUTIÉRREZ LÓPEZ ET AL. 1995, 631; RAMOS MUÑOZ 1988-89, 118
Cerca Niebla	RAMOS MUÑOZ 1988-89, 118
Cueva Bajondillo	CORTÉS SÁNCHEZ ET AL. 2007a
Cueva de Ardales	RAMOS MUÑOZ 1998, 68 Fig. 4
Cueva de Hunditero Gato	cf. VAN WILLIGEN 2006, 341 (with references therein)
Cueva de la Fájara	RAMOS MUÑOZ 1998, 68 Fig. 4
Cueva de la Pileta	NAVARRETE 1976, 362
Cueva de la Pileta	NAVARRETE 1976, 362
Cueva de la Pulsera	NAVARRETE 1976, 386
Cueva de las Goteras	NAVARRETE 1976; NAVARRETE/MOLINA 1987, 646
Cueva del Boquete de Zafarraya	RAMOS MUÑOZ 1998, 68 Fig. 4; MARTÍN CÓRDOBA 1988, 52
Cueva del Espino	RAMOS MUÑOZ 1998, 68 Fig. 4
Cueva del Gran Duquer	cf. VAN WILLIGEN 2006, 341 (with citations therein)
Cueva del Hostal Guadalupe	*NA*
Cueva del Sahara	NAVARRETE 1976, 356
Cueva del Tesoro	NAVARRETE 1976, 372
Cueva Tapada	BOSCH GIMPERA 1974, Plate XII, 2; NAVARRETE 1976, 374
Cuevas de la Sierra de la Camorra	RAMOS MUÑOZ 1998, 68 Fig. 4
El Chusco	RAMOS MUÑOS 2006, 23 Fig. 1; 42
Guaycos	*NA*
La Herriza	RAMOS MUÑOZ 1988-89, 118
Los Pinos	RAMOS MUÑOS 2006, 23 Fig. 1; 42
Peña de Hierro	RAMOS MUÑOZ 1988-89, 118
Portillo de Zafarraya	PELLICER 1964, 14
Puerto de Las Atalaya	RAMOS MUÑOZ 1988-89, 118
Puerto de Los Alazores	RAMOS MUÑOZ 1988-89, 118
Sierra del Torcal	cf. VAN WILLIGEN 2006, 341 (with citations therein)
Sima de la Mesa	NAVARRETE 1976, 375
Sima Hoyo del Tambor	cf. VAN WILLIGEN 2006, 341
Tajo de Gomer	RAMOS MUÑOZ 1988-89, 118

Tab. 12 Relevant sites of Málaga based on initial literature review (*NA* = reference not available).

SITE	REFERENCES
Abrigo de la Rogativa	MARTÍNEZ SÁNCHEZ 1994, 159; 159 Fig. 2; 160
Abrigo de los Grajos I, III	*NA*
Abrigo de Valdeinfierno	*NA*
Abrigo del Cerro de la Cueva	ARQUEOMURCIA 2011
Abrigo del Enevro	(pers. comm. J. Ponce García)
Abrigo II de Cantos de la Visera	MUÑOZ AMILIBIA 1987
Cerro de la Torre de Mingo Andrés	PELLICER 1964, 13
Chorrillo I, III	*NA*
Cortijo de Roser	LOMBA MAURANDI ET AL. 1998, 494-495
Cuartilles (Los Millares)	*NA*
Cueva de Cala Doncellas	*NA*
Cueva de Campotéjar	PELLICER 1964, 13
Cueva de los Mejillones	MARTÍNEZ SÁNCHEZ 1988, 187; MARTÍNEZ ANDREU 1986
Cueva de los Pájaros	MARTÍNEZ SÁNCHEZ 1988, 187; MARTÍNEZ ANDREU 1995
Cueva de los Secos	MARTÍNEZ SÁNCHEZ 1994, 159 Fig. 2
Cueva de los Tollos/Toyos I	MARIËN/ULRIX-CLOSSET 1985, 21-22; MARTÍNEZ SÁNCHEZ 1988, 186-187
Cueva del Calor	MARTÍNEZ SÁNCHEZ 1988, 175-180
Cueva del Cerro del Cantellón	PELLICER 1964, 13
Cueva Santa de Caudete	MUÑOZ AMILIBIA 1987
Cueva-Sima de la Serreta	MARTÍNEZ SÁNCHEZ 1994, 159; 160
El Arteal/Loma del Arteal	DELIBES ET AL. 1996, 165; 165 Tab. 1; ROMÁN DÍAZ/MAICAS RAMOS 2002, 71
Fuente de la Zarza	MUÑOZ AMILIBIA 1987
Garzel	*NA*
Junto a casa de Felí	*NA*
Junto a Torrealvilla	LOMBA MAURANDI ET AL. 1999
La Isleta	
Lagrimal III	MUÑOZ AMILIBIA 1987
Las Enredaderas	MARTÍNEZ SÁNCHEZ 1994, 161
Lebrija (Lebrija) ?	RAMOS MUÑOZ 1998, 68 Fig. 4
Loma de Mora II	J. LOMBA MAURANDI ET AL. 1998, 487-488
Los Viveros	*NA*
Luchena I	*NA*
Macael	*NA*
Mesa Alta I y II	J. LOMBA MAURANDI ET AL. 1998, 492-493
Partaloa	*NA*
Peñón de Ricote	MARTÍNEZ SÁNCHEZ 1994, 159 Fig. 2
Pequeña de Huesa Tacana	MUÑOZ AMILIBIA 1987
Poblado del Capitán	ARQUEOMURCIA 2011
Selvarejo II	*NA*
Selvarejo III	*NA*
Sierra de la Puerta	MARTÍNEZ SÁNCHEZ 1988, 170-174
Sierra Machorio	*NA*
site n.s.	cf. VAN WILLIGEN 2006, 341 (with reference therein)
site n.s.	cf. VAN WILLIGEN 2006, 341 (with reference therein)
Tumba del Ajo	ROMÁN DÍAZ ET AL. 2005, 467 Fig. 2
Tumba Torroba	ROMÁN DÍAZ ET AL. 2005, 467 Fig. 2
Tumbas del Rito	ROMÁN DÍAZ ET AL. 2005, 467 Fig. 2
Zorrera de la Cañada Honda	PELLICER 1964, 13

Tab. 13 Relevant Murcian sites based on initial literature review (*NA* = reference not available).

Almería	Málaga	Murcia
Cabecico del Aguilar	Abrigos de Cupiana 1 y 2	Abrigo de la Rogativa
Cabezo de la Mata	Acinipo	Abrigo de Valdeinfierno
Cabezo de la Raja Ortega	Casco urbano de Ronda	Abrigo de los Grajos I, III
Cañada del Jurado	Castillo Calaña	Abrigo del Cerro de la Cueva
Cerrá de Arboleas	Cerca Niebla	Chorrillo I, III
Cerro Urraca	Cueva de Ardales	Cortijo de Roser
Cortijo de las Guindas	Cueva de Doña Trinidad	Cuartilles (Los Millares)
Cortijo Gátar	Cueva de Hunditero Gato	Cueva de Cala Doncellas
Cortijo La Muela	Cueva de la Cuerda	Cueva de los Mejillones
Cueva de El Palo	Cueva de la Fájara	Cueva de los Secos
Diana/Llano de Herrerías	Cueva de la Pulsera	Cueva del Calor
El Faz	Cueva de Marinaleda	Cueva-Sima de la Serreta
Ermita de Cela	Cueva del Boquete de Zafarraya	El Arteal/Loma del Arteal
Jocalla	Cueva del Craneo	Garzel
La Cuca	Cueva del Espino	Junto a casa de Felí
La Mancoba	Cueva del Gran Duquer	Junto a Torrealvilla
Las Herrerías	Cueva del Hostal Guadalupe	La Isleta
Las Pilas	Cueva del Labradillo	Las Enredaderas
Loma de Rutillas	Cueva del Peñón Berrueco	Lebrija (Lebrija) ?
Lugarico Viejo	Cueva del Sahara	Loma de Mora II
Mojácar la Vieja	Cueva del Tesoro	Los Viveros
Pago del Guarda Jurado	Cuevas de la Sierra de la Camorra	Luchena I
Paraje de Qurémina	Guaycos	Macael
Piedra Labrá	La Herriza	Mesa Alta I y II
Siret 3	Pecho Redondo	Partaloa
Terren Ventor	Peña de Hierro	Peñón de Ricote
Granada	Peñas de Alfarnatejo	Poblado del Capitán
Cueva CV-3	Puerto de Las Atalaya	Selvarejo II
Cueva de la Pastora	Puerto de Los Alazores	Selvarejo III
Cueva de las Canteras	Raja de Miraflores	Sierra de la Puerta
Cueva de los Intentos	Sierra del Torcal	Sierra Machorio
Cueva de los Molinos	Sima del Pasillo	Tumba del Ajo
Cueva del Puntal	Sima Hoyo del Tambor	Tumba Torroba
Cueva Horá	Tajo de Gomer	Tumbas del Rito
Cuevas de las Peñas de los Gitanos		2 sites n.s.
Sima Blanca		
Sima Carburero		
Sima de la Maquila		
Sima del Conejo		

Tab. 14 Sites generally classified as "Neolithic". A further specification of the stages is impossible (for references see **Tab. 10** to **Tab. 13**).

SITE	PROVINCE	REFERENCES
Cerro Virtud	AL	MONTERO RUIZ/RIHUETE HERRADA/RUIZ TABOADA 1999, 125
Cueva del Castillico	AL	NAVARRETE 1976, 395; RAMOS MUÑOZ 1998, 68 Fig. 4
Cabezo de las Eras	AL	ROMÁN DÍAZ/MAICAS RAMOS 2002, 51
Cueva de los Murciélagos	GR	CACHO QUESADA ET AL. 1996, 106
Las Majolicas	GR	NAVARRETE ET AL. 1991, 61-66; NAVARRETE/MOLINA 1987, 647
Cueva de la Mujer	GR	NAVARRETE ET AL. 1991, 29
Cueva del Agua	GR	NAVARRETE ET AL. 1991, 91-95
Sima Rica	GR	NAVARRETE 1976, 300; NAVARRETE ET AL. 1991, 95-98
Cueva de las Campanas	GR	NAVARRETE ET AL. 1991, 111-112
Cueva del Agua de Prado Negro	GR	NAVARRETE/CAPEL 1977, 59
La Molaina	GR	NAVARRETE ET AL. 1991, 112-116
Cueva de la Ventana	GR	NAVARRETE ET AL. 1991, 70-73
Cueva Tapada	MA	NAVARRETE 1976, 374
Sima de la Mesa	MA	NAVARRETE 1976, 375
Cueva de los Pájaros	MU	MARTÍNEZ SÁNCHEZ 1988, 187

Tab. 15 Excluded Middle Neolithic sites

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SITE	PROVINCE	REFERENCE
Almizaraque	AL	FERNÁNDEZ MIRANDA ET AL. 1993, 79, 81
Cerro de los López	AL	MARTÍNEZ GARCIA/RUBIA 1990, 166
Cuartillas	AL	ROMÁN DÍAZ/MAICAS RAMOS 2002, 63
Cueva del Coquino	GR	FERNÁNDEZ-MIRANDA ET AL. 1993, 81
Cueva de las Cabras	GR	NAVARRETE/MOLINA 1987, 646, 649
Los Castillejos	GR	NAVARRETE ET AL. 1991, 123-131
Cueva del Capitán	GR	NAVARRETE ET AL. 1991, 106-109; RAMOS MUÑOZ 1998, 68 Fig. 4
Cueva del Algarrobo/Alozaina	MA	DELIBES ET AL. 1996, 165 Tab. 1
Cueva de los Botijos	MA	NAVARRETE 1976, 357
Cueva del Gato	MA	NAVARRETE 1976, 365
Parazuelos	MU	MARIËN/ULIX-CLOSSET 1985, 55-57
Cerro de las Viñas	MU	AYALA JUAN ET AL. 1995, 252-253

Tab. 16 Excluded later Neolithic sites.

Cerro de las Animas is also an open-air site. Since its presentation by NAVARRETE (1976), Cerro de las Animas is one of the sites repeatedly cited and put in an Early Neolithic stage. Effectively only very little is known about it: Only one pot is associated with Cerro de las Animas as a finding spot, but actually the provenience of the vessel is ambiguous and it is a stray find without context (cf. MARTÍNEZ GARCÍA 1994, 42-43). Thus, I will *not* include it in this study. Furthermore, I suggest it would be better to stop citing this find in the context of the Early Neolithic in Almería because it does not help to clarify this period.

In Cueva Ambrosio (CA), several excavation seasons from the middle of the 20th century onwards took place. The Early Neolithic classification of excavation levels from 1944 and 1960 have to be evaluated carefully. These materials are not kept in the Museum of Almeria and there are various other locations possible (Barcelona, Madrid, Valencia). Thus, I recorded only the Epipaleolithic lithic artifacts studied by SUÁREZ MARQUEZ (1980, 1981), despite existing doubts concerning their stratigraphic position and relative classification (PANIAGUA PÉREZ 1997, 102). Little and disordered bone remains appear insufficient for radiocarbon datings. Nevertheless, this site ranks among one of the few sites with both Epipaleolithic and Early Neolithic occupation (cf. **3.1.2.5. Evaluated sites and archaeological characterization**).

APARICIO PEREZ (1979, 125; 127) presents the open-air site El Gárcel or Aljoroque/Antas with mixed finds of Epipaleolithic and Neolithic occupations. Additionally, JIMÉNEZ NAVARRO (1956-1961, 17) mentioned the site Cueva Alta, apparently not the same site as described by MORENO ONORATO (1982). Finally nothing more is known about Cueva Alta. Neither site was included in this study.

3.1.2.2. Granada

In Granada there are two stratified Early Neolithic sites (pers. comm. F. Molina González): Cueva de la Carigüela/Piñar (Car) and Los Castillejos/Montefrío (Cast).

Numerous excavations in Car since the 1950s have revealed all kinds of materials, but the identified stratigraphies of the different seasons cannot be correlated (FERNÁNDEZ ET AL. 2007, 84). Existing 14C-dates could not be associated with archaeological levels. Currently only Pellicer 1959 and 1960's excavations provide an apparently useful relative chronology. But VEGA TOSCANO ET AL. (1997, 72-73) doubts the stratigraphy. Of the Early Neolithic levels, the pottery is particularly known from NAVARRETE's study (1976). The corresponding lithic assemblage is evaluated within an unpublished thesis (MARTÍNEZ FERNÁNDEZ 1985). As a result of either artificial intermixture during the excavation or Neolithic reutilization, MARTÍNEZ FERNÁNDEZ (1985) identified and thereafter excluded Middle

Paleolithic artifacts from the Neolithic inventories. Assemblages from the other excavations are supposed to be predominantly of Paleolithic origin, but they lack publications. WIGAND (1978; unpublished thesis) evaluated Neolithic and younger finds of the latter excavations by members of the Washington State University (cf. **SITE GAZETTEER**: **Cueva de la Carigüela/Granada**). Despite continuous occupation from Paleolithic times onwards, no Epipaleolithic finds are known from Car. Radiocarbon dates on bones are provided in this study (cf. **6. New radiocarbon dates**) and partly fit in the chronological frame and support the classification of levels and complexes.

BLÁZQUEZ GONZÁLEZ (2011; pottery, mineralogy) and MARTÍNEZ FERNÁNDEZ ET AL. (2010; lithics) are currently studying the materials from Los Castillejos. Therefore, the assemblage is *not* recorded, but due to elaborate publications (MARTÍNEZ FERNÁNDEZ ET AL. 2010; SÁNCHEZ ROMERO 2000) it could serve for site comparison of the lithics.

From other sites (Las Majolicas/Alfacar and Cueva del Malalmuerzo/Moclín; CARRIÓN/CONTRERAS 1979; 1983), there are only mixed Neolithic assemblages. These inventories are stored at the University of Granada and are the content of another recent study (J. Gámiz Caro: pottery, mineralogy). I did *not* study these assemblages here, because the Early Neolithic finds are mixed with finds from other periods.

NAVARRETE (1976, plate 260) presented a single vessel of Cueva de Cacín/Alhama de Granada and classified it as Early Neolithic. But this relative chronological classification of a single find appears approximate and is thus *not* included in the present study.

3.1.2.3. Málaga

Three sites with remains of both Epipaleolithic and an Early Neolithic occupation are known in Málaga: Abrigo 6 del Complejo del Humo/La Araña (A6), Cueva Nerja/Maro and Hoyo de la Mina/Rincón de la Victoria.

A6 is a primary site of this study. Comparatively recently excavated in the 1980s, it provides a well defined stratigraphy and organic remains for absolute datings (faunal bones, cf. **6. New radiocarbon dates**). So far, short reports have been published by the excavator RÁMOS FERNÁNDEZ (2004a, b; ET AL. 2005). Thus, in this study, I can present first comprehensive studies about the lithic artifacts (cf. **4.4.10. Abrigo 6/Málaga (A6/MA)** and **5.4. Descriptive analyses**). Unfortunately only very few pottery (but mostly complete vessels) is stored in the Museum of Málaga. I doubt that those represent the complete pottery assemblage of the Early Neolithic level 7, but was not able to find out where further remains could be deposited. A settlement gap between Epipaleolithic and Early Neolithic and a probable chronological depth between those facies is intangible. Despite this general positive evaluation, inappropriate absolute dates (cf. **6. New radiocarbon dates**) challenge the relative chronology and make the apparently clear stratigraphy questionable.

Cueva Nerja (Ner) is another flagship site. Due to various past excavation seasons (**Tab. 9**) and ongoing studies about the site and remains, Nerja is very well documented and provides an exhaustive overview. The materials are spread throughout SE Spain: Very few and incoherent artifacts are stored at the Archaeological Museum of Málaga, at the *Patronado de Cueva de Nerja* in Nerja and at the University of Valencia, where up to now studies are continuing. Thus, Epipaleolithic to Early Neolithic assemblages will serve as a reliable site comparison from literature. However, the site was apparently not occupied during the complete transition, but hiatuses occured (cf. **SITE**

GAZETTEER: **Cueva (de) Nerja/Málaga** with references; **2.2. Chronology** and **3.1.2.5. Evaluated sites and archaeological characterization**).

The large materials of Hoyo de la Mina are stored well sorted in numbered boxes, but the documentation has been los, so that an assignation to the levels and stages in SUCH (1920) is impossible. So an inclusion in this study is pointless. In 1963 family Such delivered the pottery and the listing (pers. comm. V. Jiménez Jáimez). More recent excavations confirm a general Neolithic occupation around 7300-6900 calBP (BALDOMERO ET AL. 2005).

Apart from these sites, several other sites indicate an Early Neolithic occupation, so in Cueva de las Goteras/Molina (Got, 7 frags.) and Cueva del Higuerón/Rincón de la Victoria (2 frags., Colección Santa Olalla 73/58/HG; LÓPEZ/CACHO 1979, 60; NAVARRETE 1976, 346-347; GIMÉNEZ REYNA/LAZA PALACIOS 1962) each with single pottery sherd with Cardium impressions. The seven sherds of Got were recorded (partly from literature), whereas the assemblage of Cueva del Higuerón is left aside as the cave was occupied during several Neolithic stages. Materials gathered during a prospection on the open-air site of El Charcón/Alozaina are also typologically assigned to the Early Neolithic (*conjunto* 1/1999 with 139 frags. and 2/2000 "*ceramic fabricada a mano*" with 4140 frags. cf. FERNÁNDEZ RUIZ ET AL. 2005; FERNÁNDEZ/MÁRQUEZ/CRESPO 2006; FERNÁNDEZ RUIZ/JIMÉNEZ JAIMEZ/CONEJO PEDROSA 2004 and citations therein). In addition to the assemblage being big, everything is mixed up and no clear Early Neolithic finds are detectable (pers. comm. V. Jiménez Jáimez). Thus, El Charcón is *not* studied.

Malagan sites with only Epipaleolithic occupation are represented by Cueva Bajondillo/Torremolinos, El Duende/Ronda and Cueva Victoria/Rincón de la Victoria.

Cueva Bajondillo (Bj) presents a precise stratigraphy with several Paleolithic occupations and Epipaleolithic horizons in level 3 and 4. Several papers and a monograph (CORTÉS SÁNCHEZ 2007) cover the Upper Paleolithic with a few pages about the Epipaleolithic finds. Amongst others M. Cortés Sánchez (pers. comm.) is currently investigating the Epipaleolithic remains. Therefore, these are neither available for this study nor – so far – sufficiently published for site comparison.

Not much is published on the Epipaleolithic assemblage of the open-air site of El Duende (Du) stored in Ronda. But the site provided abundant lithic artifacts that were systematically analyzed by MARTÍNEZ FERNANDEZ/AGUAYO DE HOYOS (1984) and AFONSO MARRERO (1993). However, it is a mixed assemblage of Magdalenian, Epipaleolithic and probable later occupations (cf. **SITE GAZETTEER**: **El Duende/Málaga**). I will refer to this assemblage on the base of the mentioned studies.

In contrast, only Neolithic materials of Cueva Victoria are stored in the Museum of Málaga without hints of the depository of the Epipaleolithic artifacts (APARICIO PEREZ 1979, 131). Publications focused on rock art (CANTALEJO DUARTE ET AL. 2006; MAURA MIJARES ET AL. 2003-2004 cf. GIMÉNEZ REYNA 1941). Thus, suitable finds from this site are not available for the present study.

3.1.2.4. Murcia

Resulting from studies by MARTÍNEZ ANDREU (amongst others 1981, 1983, 1989, 1989-1990) several Murcian sites are known in an Epipaleolithic context: Cueva del Algarrobo/Mazarrón (AL), Cueva del Buho/Mula (CM), Cueva de los Zagales (CZ) and Abrigo del Monje/both in Jumilla (AM). Amongst these sites, the findings of CM do obviously not provide a representative assemblage: The inventory is divided between a private collection and the Archaeological Museum of Cartagena. Only the pieces collected in the Museum of Cartagena were available for recording. A quantitative evaluation reveals

CM often as outlier, thus indicating a selection in some way and not a representative sample. Therefore, CM is *not* important for comparison in this study, but the dataset is available in the database in NESPOS (2013) associated with the DOI 10.12853/RESDB.NESPOS.0001.NESPOS 2013.

AL provided primarily Magdalenian artifacts, but additionally level 1 could probably be of Epipaleolithic origin (MARTÍNEZ ANDREU 1989, 91).

CZ and AM are spatially and temporally closely related sites. The stone artifacts originate from the surface as well as from several levels of small-sized excavations and were together classified as Epipaleolithic (MARTÍNEZ ANDREU 1983, 42). Ceramic within the assemblage of CZ indicates a displacement and ambiguous stratigraphy (bioturbation/rabbit den; MOLINA GRANDE/MOLINA GARCÍA 1991, 109). The inventory of AM is very small and both assemblages were partly intermixed, but could be assorted.

The finds of the Epipaleolithic site Callado Norte del Pinar de Santa Ana/Jumilla (MOLINA GRANDE/MOLINA GARCÍA 1991, 75-78) could not be found in the Museum of Jumilla.

The small sites Barranco de la Hoz (Hoz) and Abrigo del Enevro or Enebro/both in Lorca lack clarity. Nothing is published about the Epipaleolithic of either site (cf. LILLO CARPIO/LILLO CARPIO 1982-1983). Small characterizations are available in the site index of ARQUEOMURCIA (2011) and both sites are registered as Epipaleolithic in the Museum of Lorca (pers. comm. J. Ponce García). Hoz consists of seven geological beds (unpublished manuscript without reference available in the Museum of Lorca) but without direct cultural assignation. In this study, Hoz will be compared to the other sites concerning probable Epipaleolithic similarities. One characteristic projectile has apparently been preserved from Abrigo del Enevro, but it could not be found in the Archaeological Museum of Lorca.

Several recent excavation seasons have revealed potential Epipaleolithic and Early Neolithic occupations in Cueva de la Higuera/Isla Plana (CH). CH provided many finds and rock art. So far publications focus on rock art and neglected stratigraphy and the findings. A publication on the matter is in preparation (pers. comm. M. Martínez Andreu). Preliminary reports of the excavation seasons in 2004, 2005 and 2007 imply Epipaleolithic finds in distinct areas and excavation levels: 2004, square 14F level 3; 2005, square 13/14F lower level 3 ("*final del Paleolítico Superior*"; MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2006, 45) and 2007 13/14F ("*finipaleolítico/una fase Epipaleolítica*"; MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2008, 47). The cultural classification of the levels is aggravated by the fact that the numbering of the levels do not correlate between the divers seasons and excavation areas in the cave and cannot be transferred. The Early Neolithic finds of season 2007 lack precise information about squares and levels (MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2008, 47). However, in this study, all artifacts of the above mentioned probably Epipaleolithic units are compared with the other assemblages.

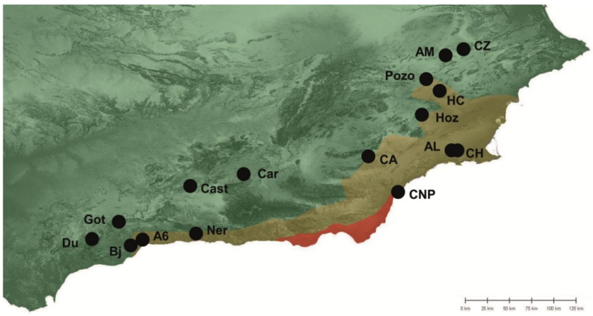
Abrigo Grande II del Barranco de los Grajos/Cieza contains several cultural horizons, amongst others, both Epipaleolithic and a Cardial Neolithic (WALKER 1977; SALMERÓN JUAN/RUBIO MARTÍNEZ 1991). But it remains ambiguous whether these horizons correspond to an actual stratigraphy. Precise statements concerning level numbers are missing. The radiocarbon date 8030±160 calBP (Har-179-III: 7200±160 14Cyrs BP, WALKER 1977, 363; calibrated with CalPal, WENINGER/JÖRIS/DANZEGLOCKE 2011) is too old for an Early Neolithic horizon. Unfortunately, the finds were not available due to the renovations in the National Archaeological Museum in Madrid (pers. comm. C. Cacho).

Further Early Neolithic evidence is very poor in Murcia: Abrigos del Pozo/Calasparra and Hondo de Cagitán/Mula (HC). Recently excavations have revealed Epipaleolithic and Early Neolithic finds in the Abrigos del Pozo (pers. comm. C. Martínez Sánchez). Currently, C. Martínez Sánchez is studying the assemblages; promising results can be expected. In contrast, the available finds of HC are rather problematic: Approximately 17 sherds with Early Neolithic impressed decoration were discovered randomly during agricultural work and during a subsequent survey (MARTÍNEZ SÁNCHEZ 1995). During this prospection, the actual site could not be located – solely the mentioned stray finds. Additionally, only the decorated sherds were available in the Archaeological Museum of Murcia. But, as these seven VUs remain the only Early Neolithic evidence available in Murcia, I studied these.

Several characteristics in the lithic kit of the multi-phased surface findings of La Borracha II/Jumilla also imply a late Epipaleolithic or Early Neolithic occupation (GIL GONZÁLEZ 2000, 19-25). These finds cannot be separated from the whole mixed assemblage and were therefore *not* analyzed.

Although the Murcian assemblages of AL, CZ, AM, Hoz, CH and HC hold more or less ambiguities, they were recorded and evaluated in this study.

3.1.2.5. Evaluated sites and archaeological characterization



PROVINCE	SITE	ABBR.	TYPE	STAGE
Almería	Cabecicos Negros	CNP	OA	NEO
	Cueva Ambrosio	CA	abri	EPI
Granada	Cueva de la Carigüela	Car	cave	NEO
	Los Castillejos*	Cast	OA	NEO
Málaga	Abrigo 6	A6	cave	EPI/NEO
	Cueva Bajondillo*	Bj	cave	EPI
	Cueva de Nerja*	Ner	cave	EPI/NEO
	Cueva de las Goteras	Got	cave	NEO
	El Duende*	Du	OA	EPI
Murcia	Abrigo del Monje	AM	abri	EPI
	Abrigos del Pozo*	Pozo	abri	EPI/NEO
	Barranco de la Hoz	Hoz	abri	EPI
	Cueva de la Higuera	CH	cave	EPI
	Cueva de los Zagales	CZ	cave	EPI
	Cueva del Algarrobo	AL	abri	EPI
	Hondo de Cagitán	HC	OA	NEO

Fig. 5 Epipaleolithic and Early Neolithic assemblages analyzed in the present study and plotted in the bioclimatic zones (green=meso/submediterraenan; yellowish green=xerothermo/thermomediterranean; red=semiarid; *additional reliable sites; OA = open-air site; cf. **SITE GAZETTEER** with references).

Fig. 5 lists the sites with adequate and available assemblages that are analyzed in this study or could serve for site comparison from the literature (Los Castillejos/GR, Cueva Nerja and El Duende/both in MA). From Cueva Bajondillo/MA and Abrigos del Pozo/MU we can expect promising results. Thus, there are 11 Epipaleolithic and eight Early Neolithic *assemblages* (cf. **Tab. 17** and **Tab. 18**).

The majority of these sites are situated in Murcia (7) and Málaga (5), whereas Almería and Granada each only provide two sites (cf. information provided in LINSTÄDTER ET AL. 2012b). The coastal semi-arid parts of Almería were obviously not occupied during Epipaleolithic and Early Neolithic times (cf. **3.3.3. Culture-environment interaction**). CNP lies at its margin. This may be due to arid, unfavorable conditions (CARRIÓN ET AL. 2010a, b). The map shows another obvious settlement gap between Granada and Almería. This lack of sites could reflect insufficient research in this area or, alternatively, this absence of sites could be explained by the inhospitable landscape of the Sierra Nevada (cf. **3.2. Topography**). However, pottery raw materials originating from Cabo de Gata prove that people went there at least temporarily (cf. **5.3.1.2. Temper types and raw material origins**).

OCCUPATION	*W*			Málaga		Granada		Almería		Murcia					*E*
	A6	Bj	Du	Got	Ner	Car	Cast	CA	CNP	AL	AM	CH	CZ	HC	Hoz	Pozo
Neolithic	X	X			X	X	X	X	X			X				X
Early Neolithic	X			X	X	X	X	X	X			?		X		X
Epipaleolithic	X	X	X		X			X		X	X	X	X		X	X
Magdalenian	X	X			X			X		X						X

Tab. 17 Presence (marked with X) and absence of relative complexes at the sites in the working area (cf. **SITE GAZETTEER** and **2.2. Chronology**; Early Neolithic occupation of CH/MU cf. **SITE GAZETTEER: Cueva de la Higuera/Murcia**).

Generally the sites show an inhomogeneous dispersal of both chronological stages in the research area: Fairly equal amounts of Epipaleolithic and Early Neolithic assemblages are present in Almería and Málaga.

OCCUPATION	MA	GR	AL	MU	ALL
Epipaleolithic	4		1	6	11
Early Neolithic	3	2	2	2	8
total	7	2	3	8	19
thereof both (EPI&NEO)	2		1	1	4

Tab. 18 Total numbers of Epipaleolithic and Early Neolithic assemblages in the working area (cf. **Tab. 17**).

In contrast, in Granada only Early Neolithic inventories are known and only Car and Cast are really securely attributable to a stratigraphy (pers. comm. F. Molina González). This during the Epipaleolithic obviously very sparsely populated area could have pulled Neolithic pioneers into the vacuum. But then again, further E in Murcia, Epipaleolithic sites dominate the area by far with only two Early Neolithic sites implying probable Epipaleolithic enclaves and a spatial occupation gap or retarded occupation during the Early Neolithic.

Only very few sites display occupations of late hunter-gatherers as well as of early farming groups: Abrigo 6, Cueva Nerja/MA; Cueva Ambrosio/AL and Abrigos del Pozo/MU). These sites show levels with Epipaleolithic and Early Neolithic materials, but a continuous record of radiocarbon ages is missing. However, radiocarbon datings are generally scarce in the research area (cf. **2.2. Chronology**) and present many gaps that should not be taken seriously (all over). Furthermore, real chronological gaps of up to a few centuries are hardly feasible with the present record (cf. **2.2. Chronology**).

A6/MA and CA/AL provide continuous cultural remains from the Solutrean to the Chalcolithic and Bronze Age, but of course the duration of single occupations remains open and leaves room for intangible hiatuses. Thus, further verifications through detailed studies of the deposits and old surfaces would be worthwhile (e.g. by geomorphologic, sedimentological and geochemical analyses as by LINSTÄDTER/KEHL 2012). Moreover, a detailed description of the phases in the occupation of Pozo/MU is forthcoming: Currently MARTÍNEZ SÁNCHEZ (2005 and others cf. **SITE GAZETTEER**: **Abrigos del Pozo/Murcia**) mentioned only generally Paleolithic occupation(s) of the abris, but within a personal communication C. Martínez Sánchez referred to an Epipaleolithic occupation. In Ner/MA, hiatuses during the Epipaleolithic are evident in the stratigraphy (AURA TORTOSA ET AL. 2009b, 347-349). Additionally, finds originating from the latest Geometric hunter-gatherer horizon (Mesolithic cf. **2.2. Chronology**) do *not* occur: Only a mixed level of Epipaleolithic and Early Neolithic remains is obviously due to post-depositional processes (AURA TORTOSA ET AL. 2010). However, more than 7800 years old anthropogenic charcoal fragments (cf. radiocarbon ages in **2.2. Chronology**) indicate a presence of humans on-site during or at least (shortly) before the re-occupation by first farming communities. AURA TORTOSA ET AL. (2009, 249) take this gap in the transition to the Early Neolithic for granted and postulate another at least 200-calendric-years lasting hiatus between both stages. However, this gap is unlikely to be indicative for the transitional process in the working area in general (cf. **2.2. Chronology**). Apart from that, MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ (2008, 47) classified finds from CH/MU as Early Neolithic. However, the published documentation of the Early Neolithic finds from the excavation 2007 found in the vestibule in -1.27m depth is too vague to record these artifacts and to describe the character of the transition from the Epipaleolithic (cf. **SITE GAZETTEER: Cueva de la Higuera/Murcia**).

Hence, the transitional process is poorly represented in the available archives. Nevertheless, I currently favor a positive interpretation of the available evidence: I.e. the few continuous deposits indicate at least partial spatial continuity with an occupation of the very same sites in Epipaleolithic and Early Neolithic (cf. LINSTÄDTER ET AL. 2012b). In contrast to the few continuous occupations, the other sites provide either Epipaleolithic and later Neolithic stages *or* Early Neolithic and following Neolithic occupation.

SITE	AL	GR	MA	MU
cave		Car^{N}	A6$^{E/N}$ Bj* Got^{N} Ner$^{E/N}$*	CH CZ
abri	CA			AL Hoz AM Pozo$^{E/N}$*
open-air	CNP^{N}	Cast^{N}*	Du*	HC^{N} ?

SITE	AL	GR	MA	MU	Σ
cave		1	4	2	7
abri	1			4	5
open-air	1	1	1	1 ?	4

Tab. 19 Site types (generally Epipaleolithic, ^{N}Early Neolithic, $^{E/N}$both, *additional sites with reliable, but non-recorded assemblage): During both stages finds stem mostly from caves and rock shelters (9 Epipaleolithic/5 Early Neolithic sites). Only 4 reliable open-air sites are known.

Concerning the site type, cave sites and rock shelters dominate 3:1 (12 caves and rock shelters; cf. **Tab. 19**) compared to open-air sites (four settlements). The Epipaleolithic occupation is especially preserved in caves or abris (10 assemblages). El Duende is the only Epipaleolithic open-air site. Two third of the Early Neolithic sites are caves and rock shelters (absolutely 5 to 3 open-air sites). This circumstance is probably due to research. Alternatively, it is possible that only sites with particular activities are captured in the record so far and thus the larger part of settlements were open-air sites and so far intangible (cf. LINSTÄDTER ET AL. 2012b). This is falsified by the open-air site CNP/AL that is roughly the same as the cave sites:

However, regardless of the site type, most sites – including open-air settlements – are characterized as small, seasonally repetitively frequented, ephemeral camps (so MARTÍNEZ ANDREU 2002, 60; 65 for AL; LILLO CARPIO/LILLO CARPIO 1982-1983, 9-10 for Hoz/both in MU; CÁMALICH ET AL. 2004, 190; 192 for CNP; Suárez Marquez/pers. comm. and RIPOLL LÓPEZ 1988, 590-595 for CA/both in AL and AFONSO MARRERO 1993, 9-10; 38 for Epipaleolithic and Early Neolithic in general) to exploit and process various resources around and with fire places and possibly ovens (cf. SÁNCHEZ ROMERO 2000, 89-90 and cf. therefore, information and references in the **SITE GAZETTEER**). No housing structures are known.

People hunted (prey animals as rabbit and deer in CNP/AL, A6/MA and CH/MU; deer, horse, ibex and rabbit in Car/GR and AL/MU), gathered marine resources (fish and malacofauna in A6/MA; CH and AL/MU) and exploited lithic and pottery raw material in the surrounding of the sites. Furthermore, sites were workshops and settlers did various handcrafts as processing arm rings, bone tools (CNP, CA/AL; Car/GR) and mobile art (pebble with engravings in A6/MA) or perforating shells and pendants (CNP/AL; Car/GR; A6/MA and AL/MU; cf. **Tab. 20**). Arm rings are exclusively typical for the Neolithic. A specialization of settlements in handcrafts while other groups were occupied with the food supplies is possible (CÁMALICH ET AL. 2004b, 190 cf. **2.3. The Neolithization of the W Mediterranean in its European context**). In addition, the Early Neolithic pastoralists kept animals in the surrounding area (pigs in CNP/AL; ovicaprids in Car/GR; cattle, pigs and ovicaprids in Cast/GR and cattle and pigs in A6/MA) and did little agriculture (sickle gloss in CNP/AL; cf. **Tab. 20**; for additional information and references see **SITE GAZETTEER**). In Cast/GR even fields and fertilizing is probable (ANTOLÍN/BUXÓ 2012). However, the conducted tasks, the application of Neolithic technologies and their intensity vary (AFONSO MARRERO 1993, 15 cf. **2.2. Chronology**).

So far the mentioned short-term camps are commonly interpreted as adaptations and indicators of a fairly mobile lifestyle of Epipaleolithic *and* Early Neolithic settlers (cf. references mentioned before). Recently JORGE/DIAS/DAY (in press and citations therein) emphasized that concepts of mobility and sedentariness should not be understood as mutually exclusive or two extreme styles of life. A variety of all kinds of gradual mobility or sedentariness for various reasons and interfering with differing subsistence can be imagined.

Additionally, both hunter-gatherers and first farmers occupied caves with Paleolithic paintings (e.g. CA/AL, Ner/MA, CH/MU for references see **SITE GAZETTEER**). However, apparently only Early Neolithic groups added their own paintings on the rocks (so in CH and Pozo/both in MU cf. **SITE GAZETTEER**). In contrast Epipaleolithic people obviously lived in the already designed places without being active artistically. So far only mobile art is known from Epipaleolithic contexts (cf. CRUZ BERROCAL/VICENT GARCÍA 2007, 679-680). Current interpretations of the cave art cover from conveying identities, definition of groups or structuring territories to "expression of ritual and ideological belief system" or "sanctuaries" (MCCLURE/MOLINA BALAGUER/BERNABEU AUBÁN 2008, 334 and citations therein). So people possibly occupied the same *ritual landscape* with Paleolithic cave art present, but active cave painting was only common in the Early Neolithic.

OTHER FINDS & DIET (faunal and botanic remains)		GROUND STONE TOOLS	pigments	grinding stones	axes/adzes	arm rings	beads	pebbles	other frags.	BONE INDUSTRY	PERSONAL ADORNMENT OF MALACOFAUNA	HUNTING-GATHERING			DOMESTIC ANIMALS			AGRICULTURE			
												wild game	malacofauna	fish	cattle	pigs	ovicaprids	wheat*	barley**	pulses	vegetables
MU	AL	X		X							X	X	X								
	AM	X	X						X			?	X								
	CH	X	X						X	X		X	X	X							
	CZ																				
	HC	X		X					X		X										
	Hoz									X		?									
	Pozo	X	X			X					?	X									
AL	CNP	X		X	X	X	X			X	X	X				X					
	CA	X	X	X				X	X	X	?	?									
GR	Car	X	X	X	X	X		X		X	X	X			X	X	X	X	X		
	Cast	X			X	X				X	?				X	X	X	X	X	X	X
MA	A6 EPI	X		X				X	X		X	X	X	X							
	A6 NEO	X	X	X		X		X	X		X	X	X	X	X	X					
	Bj	X	X										X								
	Du																				
	Got																				
	Ner EPI									X		X	X	X							
	Ner NEO	X	X	X		X	X		X	X	X	X	X	X	X	X	X		X		
EPI	(Σ=10)	6	4	3				2	4	3	2+1?	4+3?	6	3							
NEO	(Σ=8)	7	4	5	3	6	2	2	3	4	5+2?	5	2	2	4	5	3	2	3	1	1

Tab. 20 (*on the previous page!*) Presence (marked with X) and absence of ground stone tools, bone industry, objects of personal adornment, prey and domestic animals and cultivated plant remains in Epipaleolithic (EPI) and Early Neolithic (NEO; shaded) assemblages (no information about the Early Neolithic of CA/AL nor of CH/MU, neither about the Epipaleolithic of Pozo/MU; for details cf. **SITE GAZETTEER**; *contains emmer, durum and naked wheat; **contains amongst others naked barley).

3.2. Topography

3.2.1. Relief and geomorphodynamics

Generally Spain is characterized by the Meseta with its broad, elevated plateaus and high mountain edges restricting the access from the coast to the interior (BREUER 2008, 50; 52). In the SE the heterogeneous mountain ranges of the Betic Cordillera with the highest elevation in Sierra Nevada/Mulhacén of 3481m asl and a mean altitude of 800m asl (HOFFMANN 1988, 28) form a further barrier to the SE and shield the coasts from the precipitation and cooling of central Spain (HOFFMANN 1988, 9). This region provides the "highest seismic hazard" in Spain (SÁNCHEZ-GÓMEZ ET AL. 2009, 129). The interior zone, or the Cordillera Penibética, stretches across S Andalusia up to Murcia and consists of the locally developed geological complexes of Nevado-Filabride (Neogene/Quaternary: metamorphic mica schists) and the two units of foreign origin Alpujarride (metamorphic rocks) and Malagide (paleozoic non-metamorphic rocks; GARCÍA RUIZ ET AL. 2005, 92-95; HOFFMANN 1988, 24-25; 28). The mountains extend almost to the coast (400m-isophyse proximal to the coast) and finally merge partially into a narrow coastal strip with alluvial plains, bays and beaches (HOFFMANN 1988, 3; 5).

With steep declivities Spain has the highest erosion potential in Europe (cf. BREUER 2008, 92): Climatic-induced erosion and sedimentation in the valleys began in the Pleistocene. Morphodynamic processes augmented between approximately 2600 and 1550 calBP and peaked in Medieval to Modern times due to forest clearances and inappropriate agricultural practices in fluvial catchment areas. Complemented by the high relief energy, the poor resistance of the desiccated soils to erosion and torrential rain falls, particularly high sedimentation took place throughout the Holocene and led to the filling of lagoons and accumulation of the coastal plain (BREUER 2008, 92; 96-97; HOFFMANN 1988, 28; 121-122 cf. RODRÍGUEZ-ESTRELLA ET AL. 2011, 238).

The majority of the rainfalls drains into wide rivers into the Atlantic. Only approximately one third of the surface water amount passes from the Mediterranean landscape into the Mediterranean Sea (HOFFMANN 1988, 3; 6, Fig. 2.1.; BREUER 2008, 50 Fig. 34; 52). Apart from the Ebro, the rivers are fairly short and especially Andalusia and Murcia are located S of the big river systems. Rivers are about 100 to 200km long dropping 1000 to 2000m altitude difference to the coast. The water levels depend on the seasonal precipitation and the shorter the rivers the greater the fluctuation in water levels (BREUER 2008, 58). Rivers may run dry throughout summer and expose wide beds, but then after downpours a by far above-average discharge and floods can occur and cause damage (e.g. Almanzora river; BREUER 2008, 58; 53; HOFFMANN 1988, 3).

3.2.2. Distribution of the ancient coastline

The litoral zone changed periodically due to eustatic sea-level variation and underwent lasting modifications through Holocene estuary colluviation.

During deglaciation and in the Early Holocene, the sea level rose quickly by at least 15m per millennium (RODRÍGUEZ-ESTRELLA ET AL. 2011, 239; 241) from -90m in the Late Glacial (CORTÉS-SÁNCHEZ ET

AL. 2008, 2177). Around approximately 6000 calBP it reached the current level (HOFFMANN 1988, 24 Fig. 4.2.; 27). Thus, former river mouths and beaches were flooded, rias formed and a rocky coastline became characteristic – besides some remaining beaches between Almería and around Málaga (CÓRTES-SÁNCHEZ ET AL. 2008, 2190; HOFFMANN 1988, 3; 5). Thereby the coastal plain contracted e.g. in the Bay of Málaga from 10.5km to 2km and at Nerja from 5.5km to 2.5km width (CORTÉS-SÁNCHEZ ET AL. 2008, 2177). Until the Early Neolithic, the coastline shifted several kilometers inland as e.g. 4km Rambla de las Moreras/MU and Bay of Mazarrón (RODRÍGUEZ-ESTRELLA ET AL. 2011, 241). Subsequent cyclical trans- and regressions maintained the unstable coastline and caused changing littoral environments – amongst others the establishment of lakes (RODRÍGUEZ-ESTRELLA ET AL. 2011, 241-242 cf. BREUER 2008, 95 Fig. 66).

Due to increasing Holocene sedimentation in the river valleys, the coast line shifted in the S Spanish estuaries (ARTEAGA ET AL. 1988, 120; 125; HOFFMANN 1988, 121). Up to around the beginning of the Common Era, the Mediterranean Sea extended deeper inland. Estuaries dissolved into wider bays, small peninsulas and sea inlets of up to 1.5km width and 10km inland extant (HOFFMANN 1988, 121): E.g. the Antas/AL and Guadalmedina river/MA flowed in a wide bay (ARTEAGA ET AL. 1988, 114-117; HOFFMANN 1988, 37-43; 78-80). The Almanzora/AL, Adra, Verde river/both in GR, Vélez, Guadalmedina and Guadalhorce/all in MA were elongated 3.5-7km inland (ARTEAGA ET AL. 1988, 109-113; 117-120; HOFFMANN 1988, 76; 49-53). The delta of Guadalfeo river/GR also developed recently. Originally the river mouth was in the coastal hills (HOFFMANN 1988, 54-63).

Today parallel sea currents are eroding the coasts again (BREUER 2008, 96-97).

3.3. Early to Middle Holocene climate and vegetation

In the current section, I will review the Early to Middle Holocene climate and vegetation without going into detail about the proxies underlying these interpretations or the causes for climatic changes. For these data, one can refer to the references cited.

Paleoenvironmental reconstruction for SE Iberia are hampered by heterogeneous neighboring landscapes – apparently micro-regions (displayed e.g. by RIERA MORA 2006, 19-21) – with varying conditions such as elevation, insolation and humidity, with spatial differing substrates of former plant communities (distribution and composition cf. RODRIGUEZ TARROSO GOMES 2007 or CARRIÓN ET AL. 2012). Thus, regional proxies, complex climate and vegetation changes vary throughout time, while human interference increased (CARRIÓN ET AL. 2010a, 466-467; CORTÉS SÁNCHEZ ET AL. 2012, 229). It appears as if major changes accumulated in relatively short time periods within several decades or a century (CARRIÓN ET AL. 2010a, 464; 471). FLETCHER/ZIELHOFER (in press) postulated that the W Mediterranean responded highly sensitively to external perturbations (cf. GIL-ROMERA ET AL. 2010b), while PÉREZ-OBIOL ET AL. (2011, 90) state a higher resilience of the Mediterranean landscape and ecosystem and thus delayed aridity or unexpected response to climate changes (cf. CARRIÓN ET AL. 2010a, 466).

However, at least since the Middle Miocene (around 16 million years BP), SE Spain was an arid region (CARRIÓN ET AL. 2010b, 732) and during the last interglacial period a stunted tree population (cf. natural vegetation in **Tab. 21**) and water supply became characteristic (PÉREZ-OBIOL ET AL. 2011, 83). From the beginning of the Holocene up to today, the climate in SE Spain has been Mediterranean with warm and dry weather during summer and mild winters with little (or at times hardly any) precipitation (PÉREZ-OBIOL ET AL. 2011, 89 cf. BREUER 2008, 53-55). Similar bioclimatic conditions to those of the present day occurred at the earliest during the Epipaleolithic (cf. Ner/MA; AURA TORTOSA

ET AL. 2002, 29 with citations therein). It is commonly assumed that the Holocene environment was similar to the present conditions with arid or semi-arid climate with an annual precipitation of 300-800mm, a treeless landscape and high erosion (CÁMALICH ET AL. 2004, 184; HOFFMANN 1988, 5).

Vegetation/ Altitude zones	Semiarid-arid bioclimatic zone	Semihumid-humid bioclimatic zone
subalpine-alpine	mountain steppe dwarf-shrub cushion plant	mountain steppe dwarf-shrub *Pinus uncinata*
montane	cedar, fir *Cedrus atlantica* *Abies pinsapo* *Juniperus thurifera*	beech, fir *Fagus silvatica* *Abies alba* *Pinus silvestris*
submontane	evergreen oaks *Quercus ilex* *Quercus suber* *Quercus coccifera*	evergreen oaks *Quercus robur* *Quercus pyrenaica* *Quercus lusitanica* *Pinus nigra*
basal-hilly	thuja, Aleppo pine *Tetraclinis articulate* *Juniperus phonenicea* *Ceratonia siliqua* *Pinus halepensis*	evergreen oaks *Quercus ilex* *Quercus suber* *Pinus pinea* *Pinus pinaster*

Tab. 21 Natural Mediterranean vegetation in various altitude zones (redrawn from BREUER 2008, 99 Fig. 68).

Currently Almería, with 3000 sunny hours and only 1-2 humid months per year, and Murcia provide the driest and summer-hottest Iberian landscapes (BREUER 2008, 57; HOFFMANN 1988, 7; LAUTENSACH 1964, 74; 75; 611; AGENCIA ESTATAL DE METEROLOGÍA 2011, 36 Fig. 5; 67 Fig. 69). Climatically, SE Spain is situated in the Mediterranean subtropics effectively devoid of Atlantic influences with an annual average temperature of 18°C, an average minimum above 10°C and winter precipitation with severe fluctuations. SSW or SW winds in spring and autumn and a coastal W to E current (Gibraltar strait current) dominate. The elevated hinterland provides more humid conditions (HOFFMANN 1988, 9-11).

Thus, currently irrigation allows the growing of cereals, olives, vine and vegetables in spatially limited fields (BREUER 2008, 76). Meanwhile about one third of Spain bears coniferous forest again due to afforestation (*Pinus pinea, Pinus pinaster, Pinus halepensis*; BREUER 2008, 97). Animal husbandry has become possible due to transhumance with seasonal stays in complementary climatic zones (BREUER 2008, 87).

The most crucial factor affecting climate and environment is the amount of water, i.e. the frequency of rainfalls (BREUER 2008, 57; PÉREZ-OBIOL ET AL. 2011, 83): Besides groundwater, precipitation is the only fresh water resource feeding the rivers, but its level can fluctuate severely and cause droughts (cf. BREUER 2008, 61; 64; 66-67).

PÉREZ-OBIOL ET AL. (2011, 75; 90) proposed three general phases for the Holocene climatic oscillations in the Mediterranean basin. Roughly these stages correspond to results from SE Iberian studies (cf. PÉREZ-OBIOL ET AL. 2011, 89). But the Early to Middle Holocene climate alternated with mild, warm and cold on average approximately 1000-years-lasting periods (RODRÍGUEZ-ESTRELLA ET AL. 2011, 241) and especially the humid phase between 12000 and 7000 calBP was less homogeneous on the Iberian Peninsula and bore interruptions (cf. PÉREZ-OBIOL ET AL. 2011, 89; YANES ET AL. 2011).

The time frame of the present study corresponds to the Early Holocene humid phase and merges slightly into the Middle Holocene transitional phase:

3.3.1. Early Holocene humid phase (12000-7000 calBP)

During the Late Glacial and Early Holocene, the landscape was open with steppe and light, variable woodlands of pines especially at higher altitudes (e.g. Sierra de Baza/GR; CARRIÓN ET AL. 2010a, 462), oaks (*Quercus coccifera* and *ilex*; CARRIÓN ET AL. 2010a, 470; CARRIÓN ET AL. 2010b, 733; PÉREZ-OBIOL ET AL. 2011, 83) or junipers (GARCÍA PUCHOL ET AL. 2009, 239; for the Late Glacial substrate cf. RODRIGUEZ TARROSO GOMES 2007 or CARRIÓN ET AL. 2012). In the Early Holocene, the conditions became milder, the Alboran Sea surface temperature rose (CORTÉS-SÁNCHEZ ET AL. 2008, 2190) and THORNDYCRAFT and

BENITO (2006) registered high precipitation and "phases of increased frequency of large magnitude floods" between 10855-10230 and 9530-8780 calBP (cf. controversial JALUT ET AL. 2000: aridification phase around 10900-9700 calBP).

Within the Early Holocene climate optimum between 9000-6500 calBP and partly parallel to the African Humid Period, the weather became moderate and humid (Cádiz; LÓPEZ SÁEZ/PÉREZ DÍAZ/ALBA SÁNCHEZ 2011, 78 cf. BATHIANY/CLAUSSEN/FRAEDRICH n.d., Fig. 6) and oaks expanded from refugia in the Baetic Cordilleras (CARRIÓN ET AL. 2010a, 458). An evergreen oak forest covered parts of the working area. At mountainous fringes, birches also appeared whereas the coast was dominated by xerothermofilic macchia with *Pinales* (i.e. pollen evidence from Cueva Bajondillo/MA, Cueva de la Carigüela and Padul/GR; LÓPEZ SÁEZ ET AL. 2010, 216 cf. FERNÁNDEZ ET AL. 2007, 87 Fig. 8).

Around 8200 calBP the N Atlantic cooling event also affected the W Mediterranean with an abrupt climate deterioration, a certain cooling (temperature drop of approximately <1°C), hyper-aridification and remarkable climatic irregularities and subsequent deforestation (RODRÍGUEZ-ESTRELLA ET AL. 2011, 241; 247; CORTÉZ SÁNCHEZ ET AL. 2012, 227; BERGER/GUILAINE 2009, 41; LÓPEZ SÁEZ 2008, 81; JALUT ET AL. 2000: aridification between 8400-7600 calBP).

Between 7800 and 7300 calBP the aridity increased and the temperature and precipitation dropped (approximately 3°C and 50mm; CORTÉZ SÁNCHEZ ET AL. 2012, 227 cf. RIERA MORA 2006, 19, who observed since 7800 calBP a higher water availability than today in Almería), and at the same time, LÓPEZ SÁEZ ET AL. (2010, 216) observe first hints of anthropogenic interference: Settlers deforested the landscape by slash and burn and xerothermofilic macchia, scrub- and grasslands with *Olea, Pistacia, Cistaceae* and rosemarys spread (Cueva de Nerja/MA). Contemporaneously agricultural evidence was present (macrobotanical remains of domestic plants in Cueva de Nerja/MA; Los Castillejos/GR; LÓPEZ SÁEZ ET AL. 2010, 215; in summary ANTOLÍN/BUXÓ 2012).

Subsequently, at 7200 calBP, the climate turned humid again and floods became frequent, thus representing a phase of relative water stability with fewer shortages. (RODRÍGUEZ-ESTRELLA ET AL. 2011, 241; CORTÉS SÁNCHEZ ET AL. 2012, 227-228; YANES ET AL. 2011). The vegetation was dominated by plants adapted to moderate climate conditions (C3-vegetation; proxies from land snail shells from Los Castillejos/GR; YANES ET AL. 2011).

3.3.2. Middle Holocene transitional phase (7000-5500 calBP) and the beginning of the aridification phase (from 5500 calBP onwards)

From 7000 calBP onwards the current semi-arid conditions began to shape (PÉREZ-OBIOL ET AL. 2011, 90) under determining and increasing human influences (CARRIÓN ET AL. 2010a, 471; LÓPEZ SÁEZ ET AL. 2010, 216):

Parallel to the Neolithic between 6760 and 5900 calBP, the climate turned arid (RODRÍGUEZ-ESTRELLA ET AL. 2011, 242; 247), increasingly during the W Mediterranean "mid-Holocene rapid climate change interval 6-5ka calBP" (FLETCHER/ZIELHOFER in press) and repeated aridification phases (mid-Holocene 5900-5500 calBP and 5300-4200 calBP; CARRIÓN ET AL. 2010a, 467; PÉREZ-OBIOL ET AL. 2011, 83; JALUT ET AL. 2000). Changes in lake and fluvial levels, sediment transport and fire regimes followed (FLETCHER/ZIELHOFER in press; GIL-ROMERA ET AL. 2010a). The stage of most anthropogenic impact between 3000 and 1500 calBP corresponds with a maximum fire activity (CARRIÓN ET AL. 2010a, 470), and in that time burning events were caused by humans rather than by natural hazards (VANNIÈRE ET AL. 2011).

Thermo-mosophilic vegetation with pines and deciduous oaks dispersed (*Pinus nigra, Quercus faginea*) and alternated with xeric Mediterranean steppe and shrub vegetation (PÉREZ-OBIOL ET AL. 2011, 84; 90). Generally both the woodland coverage and the biodiversity fell and erosion increased (PÉREZ-OBIOL ET AL. 2011, 86; for the whole development cf. RIERA MORA 2006, 19-21).

3.3.3. Culture-environment interaction

These natural changes in the environment parallel the changes in the Epipaleolithic substrate as well as the Neolithization and provoke an interconnected process with feedback processes (LÓPEZ-SÁEZ ET AL. 2010, 216; PÉREZ-OBIOL ET AL. 2011, 86). The changing environment caused adapted exploitation patterns (RODRÍGUEZ-ESTRELLA ET AL. 2011, 241-242), which subsequently influenced the environment and further adaptation was required. These changes and difficult environmental conditinons could have supported the quick Neolithization of the area by creating a sense of a new era (cf. *pre-adaptation*; AURA TORTOSA ET AL. 2001, 34).

The Epipaleolithic appears parallel to the Holocene, and with the short term 8.2 ka calBP cold event, the Geometric Mesolithic became apparent in Valencia (GARCÍA PUCHOL ET AL. 2009, 239). Apart from this change, BERGER and GUILAINE (2009) observed frequent cultural gaps in the W Mediterranean between 8500 and 8000 calBP (cf. LÓPEZ SÁEZ/LÓPEZ MERINO/PÉREZ DÍAZ 2008, 82-83).

Since 7500/7000 calBP, the presence of humans and their impact on the environment became detectable through new settlement patterns, fire, slash and burn, adoption of agriculture and introduction of foreign plants and animals, pastoralism and modifications in the natural resource management in W Mediterranean pollen records (CARRIÓN ET AL. 2010a, 458; 471; PÉREZ-OBIOL 2011, 75; 86-87 cf. CARRIÓN ET AL. 2007, 1466 fig. 8). A contemporaneity of initial agricultural and climatic changes imply a relation with increasing anthropogenic impact due to disturbances, deforestation, influences on ecology and erosion (PÉREZ-OBIOL 2011, 86; 90; LÓPEZ SÁEZ ET AL. 2010, 216). But agriculture was not present everywhere contemporaneously and with the same intensity. Geographical barriers and harsh regional environmental conditions with fewer resources retarded the dispersal (LÓPEZ SÁEZ ET AL. 2010, 213). But even in remote sites, the human impact became evident in the record (ANDERSON ET AL. 2011).

These responses and/or proxies for the RCC interval between 6000 and 5000 calBP could be interconnected with the appearance of the Neolithic lifestyle in the area under question, i.e. abrupt declines in the pollen ratio of temperate and Mediterranean forest trees in marine core MD95-2043 and of deciduous trees from Lake Siles/S Spain accompanied by a sudden presence of microcharcoal particles around 7500 calBP (Lake Siles/S Spain; FLETCHER/ZIELHOFER in press). Also CORTÉS SÁNCHEZ ET AL. (2012, 221) highlight the coincidence of “population and economic turnover” and “major changes in the continental and marine ecosystems”. The subsistence strategies of the last hunter-gatherer populations were strongly interfered, and in some areas strategies would even be insufficient to react to these impacts, thus causing hiatuses.

Real “cultural [i.e. human-shaped] landscapes” appear from the Chalcolithic onwards (CARRIÓN ET AL. 2011, 468-469).

The coastal semiarid parts of Almeria may have remained unsettled due to arid, unfavorable conditions (CARRIÓN ET AL. 2010a, b). There was another obvious settlement gap in Epipaleolithic and Early Neolithic times between Granada and Almeria.

Additionally, seismic activities could have influenced the occupation of this region by hunter-gatherer and farming communities. At least for Pozo/MU, SÁNCHEZ-GÓMEZ ET AL. (2009) assumed a partial collapse of the shelter that disturbed the human occupation and might have caused abandonment around 5800-3700 calBP.

3.4. Paleoenvironmental contextualization of the sites

Sites occupied by settlers were mostly situated in the mesomediterranean climatic belt (CARRIÓN ET AL. 2010a, 469; 469 Fig. 11) in the arid and mountainous regions in the Betic Cordillera or in its foothills near the coast in limestone massifs. Inhabitants were affected by frequent water deficits and big fluctuations in the precipitation and thus the total water amount. Droughts and torrential rains could alternate.

Vegetation consisted less of trees such as pines and oaks but was dominated by macchia. The hilly, water and plant coverage conditions led to high erosion.

Several humid phases, e.g. between 9000-8200 calBP and 7200-7000 calBP could have been climatically favorable periods, whereas aridification and cooling events, e.g. around 8.2 ka calBP, between 7800-3300 calBP or around 7000/6800-5900 calBP, challenged the Epipaleolithic and thereafter the new Neolithic lifestyle and could lead to an abandonment of settlements (cf. GONZÁLEZ-SAMPÉRIZ ET AL. 2009 for the Central Ebro Basin). This could also be one reason for the very few Early Neolithic sites in the region: Due to the very small precipitation amounts (e.g. Murcia less than 250 mm; MARTÍNEZ ANDREU N.D., 62), sufficient agriculture to feed the whole community was impossible. Instead domesticates were used to a smaller extent (transhumance), accompanied by maintenance of exploiting the well-known resources from the sea and hunting and gathering. In contrast, ANTOLÍN/BUXÓ (2012, 99) assumed permanent agricultural crop land around Cast/GR.

During summer and in dry periods, lithic raw materials were easy available in the dried river beds with stream-worn cobbles. The location of the sites directly in sheltered bays and river inlets or within day trips to the sea provided marine food and ornamental resources.

Holocene coastal sites could have been overflowed during the Early Holocene sea level rise (HOFFMANN 1988, 76), but currently they are located slightly upcountry (ARTEAGA ET AL. 1988, 125). Besides immediate marine access for resources and waterways, their ancient location also provides shelter within the cleft coast. AL and CH/MU, CNP/AL and A6/MA are situated in immediate range of the coast: CNP/AL on a hilltop was located at the seasonally fluctuating, but permanently aquiferous Antas river mouth in a bay (CÁMALICH MASSIEU/MARTÍN SOCAS 1999, 392 Fig. 83 no. 155). A6/MA is located immediately next to the mouth of the small, not permanently water-bearing creek Totalán, which could have dissolved into a small cove where there is the beach today. CH/MU in the foothills of Cabezo del Horno was also located directly at the sea, facing the Bay of Mazarrón. AL/MU is situated in the foothills of the Sierra del Algarrobo within a one-to-two-hour-walking-distance from the coast. Existing remains of marine malacofauna confirm the exploitation of marine resources (RODRÍGUEZ-ESTRELLA ET AL. 2011, 247).

The remaining sites of the present study are located in the hinterland, several days' journey (approximately 1-3 days) away from the sea and coastal settlement area (cf. Car/GR, PELLICER 1964, 7) and provided only small amounts of marine malacofauna including particularly objects of personal adornment that illustrate contacts and exchange. Caves are located in the foot-hills (AM, CZ/both in MU) or in river valleys (CA/AL, Pozo/MU), while people settled in the open air on hill tops (Cast/GR, Du/MA). The sites are oriented in all directions, and their altitude increases the more they are in the interior (cf. **SITE GAZETTEER**). Thus, different locations with changing topographical conditions are known, but there is no substantial diachron difference.

4. Lithic assemblages

Previous to the actual descriptive analyses of the lithic inventories, introductory parts provide explanations of the recorded attributes (**4.1. Recorded attributes**) and present the dataset of lithic artifacts in general (**4.2. Correction and data set**). **4.3. Raw material** and **4.4.1. Approach** to **4.4.1.5. Discard** compile the raw materials and interpretation *opportunities* for the occurring, in the following evaluated attributes and accompanying issues. I approached the *chaîne operatoire* assemblage- and stage-wise and summarized it in **4.4.2. Cueva del Algarrobo/Murcia (AL/MU)** to **4.5. Comparative characterization of the reduction sequences**. Finally I evaluated the blank and tool assemblages statistically for chronological or regional differences in **4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra** and the results concerning the research questions (**1. Approach and research questions**) are summarized in **4.7. Conclusion: The lithic assemblages as indicators of the Neolithization process**.

4.1. Recorded attributes

For each lithic artifact, I recorded selected features of the system by DRAFEHN/BRADTMÖLLER/MISCHKA (2008) and the tool type by TIXIER (1963, 159-161) in a database (**Tab. 22**; available in NESPOS 2013 associated with the DOI 10.12853/RESDB.NESPOS.0001; cf. ASCHRAFI 2010, 31; 33 Tab. 3, LINSTÄDTER ET AL. 2012a).

Within this system, Jörg Linstädter and I recorded various sites of different time periods in SE Spain and NE Morocco in the frame of the project (see **Collaborative Research Center 806**). Thus, we ensure their comparability (cf. LINSTÄDTER ET AL. 2012a).

At first sight, the recording system appears objective and self-explanatory. Not only the recorded features are standardized but also the selectable options are fixed by unique codes (see ASCHRAFI 2010, 30). However, the descriptions in **Tab. 22** express certain complications, to some extent unfixed or varying "definitions", an existing range in each recorded characteristic and the necessity for additions for its application in this study.

The recording system by DRAFEHN/BRADTMÖLLER/MISCHKA (2008, 1) is a summary of several approaches and combines attributes to record artifacts of Upper Paleolithic to Bronze Age assemblages in various regions and thereby provides a broad comparability. For the Moroccan inventories, J. Linstädter recorded the features 1-16, 20-34, 36, 37, 59, 60, 67, 68, 76-94 for ground stone tools and 1-16, 20-34, 36, 37, 59, 60, 67, 68, 95-135 for adzes and axes. Such artifacts are rare or appear doubtful in Epipaleolithic and Early Neolithic contexts in SE Spain and are therefore only listed in the **SITE GAZETTEER**.

The tool definitions by TIXIER (1963, 159-161) represent the conventional typology for the Maghreb and are necessary for a comparison with the Moroccan tool assemblages and older works from this region (LINSTÄDTER ET AL. 2012a).

	N°	ATTRIBUTE	COMMENT
site related data	+	ID*	Identification number recorded for each single artifact (cf.**Tab. 25**).
	1	site	Abbreviation of site (cf. **Tab. 25**).
	2	year*$^{\Delta}$	Year of excavation.
	+	archaeologcial/geol. level*$^{\Delta}$	Levels to distinguish artifacts that are recorded from several layers of the same site and to simplify their identification.
	5	IN°*$^{\Delta}$	Individual number for each artifact corresponding to the excavation or museum inventory and labeling.
	7	square*$^{\Delta}$	Square of origin.
	+	museum	Museums in which the artifact is stored.
raw mat.erial	16	RM	Raw material. I entered generally 11 "indeterminable silex" for flint artifacts. Apart from that very few other materials were used (for a detailed description and discussion cf. **4.3.1. Varieties**).
	18	surface	Description of artificial surface: 1 to 4.
natural surface	20	cortex	Condition of cortex: 0 to 7, 9.
	22	rounding	Rounding of cortex or natural cleavage planes (0 to 3) and portion of cortex and natural cleavage planes: 0 to 4, 9. For natural cleave planes, theses features have to be completed, whereas 20 "cortex" is 0.
	23	portion	
heat	24	effect heat treatment	Effect and time of heat treatment: 0 to 9 and 0 to 7. I entered "after modification" for burned tools with intentional retouch, thus not in the case of retouches due to use, which do not influence the IGerM; except splintered pieces (possibly conflict with the *chaîne operatoire*, compare comment in "modification 1-6"). Blanks with traces of use get burned after the "removal of the blanks", but obviously such signs are hard to determine on burned artifacts. "Thermal fracture" does not automatically imply debris as a blank, e.g. if a regular blade is broken horizontally. "Heating of the raw material" was very hard to distinguish, appears very rarely or is meanwhile concealed by fire exposure. In some cases I identified a modification after the heating. Small changes in color or luster could be hints.
	25	timing heat treatment	
dimensions	36	length (L; mm)*	Measurements in the direction of percussion by flakes and blades (maximal, millimeter). For debris and cores, I entered the values declining in length down to thickness.
	37	width (WI; mm)*	Compare characteristics no. 27 and 28 "measurements in smallest encircling rectangular". The measuring in direction of percussion is used to maintain the comparability with other W Mediterranean assemblages.
	29	thickness (T; mm)*	Maximal thickness (millimeter).
	30	weight (WE; gram)*	Weight (gram).
blank	33	blank 1	Blanks: 0 to 5, 9; i.e. flakes, blades, artificial debris, cores or pebbles (for a definition see ZIMMERMANN 1988, 580-581). Artifical debris: Irregular blanks without recognizable ventral face, which could occur during reduction (ASCHRAFI 2010; 51 and citations therein), fire contact or other damaging. In the case of flakes from cores with several dorsal flake scars, I recorded only the flake-features and not the core attributes. Nodules with just single or irregular negatives were not recorded as core but seen as rejected nodules because of insufficient raw material conditions.
	34	blank 2	Further description of the blank 00-28, recorded only where reasonable. Very regular blanks with a width under 10mm were provisionally recorded as 03/bladelet. This differentiation has to be proved in each particular case after finishing the record with size ranges and differences in the *chaîne operatoire*. Plunging blanks were recorded as such (19) and 53/distal ending contains 07 or another ending as further description.
The recording of debris continues with 59/modifications and the recording of cores with the added characteristic +preservation/61 type of core.			
	35	preservation	Preservation in direction of percussion: 1 to 9
proximal ending	42	platform remnant: constitution	Constitution and form of platform remnant: 0 to 9, A to F (42; constitution) and 0 to 9, A to C. In other systems these two characteristics are often mixed.
	43	constitution and shape	
	47	DR	Dorsal reduction: 0 to 2, 9.
	48	lip	Lip underneath the platform remnant: 0 to 5, 9.
	50	bulb	Bulb: 0 to 7, 9.
	51	bulbar scar	Bulbar scar: 0 to 7, 9
	52	impact ring	Impact ring on the platform remnant: 0 to 4, 9.

Tab. 22 Recorded attributes (cf. DRAFEHN/BRADTMÖLLER/MISCHKA 2008) with available options (codes), changes (regarding SDS) and comments (*attributes have to be completed by numbers; $^{\Delta}$ attributes have to be entered only if necessary).

	N°	ATTRIBUTE	COMMENT
	53	distal ending	Constitution of distal ending: 00 to 09, 33, 44, 83 to 85. If it is a plunging flake or blade, it was also recorded in 347blank 2, otherwise the ending is just sagging. Hinges (*Angelbruch*) often appear, whereas step terminations are less common or rather an intermixture with hinges. Concerning the underrepresentation of distal endings compare SCHIMMELPFENNIG (2004, 59) and KRAHN (2006, 408).
dorsal	56	PDS	Preparation of the dorsal surface at crested flakes or blades as well as core tablets or flakes from the edge of a core (compare 347blank 2): 0 to 8.
	58	flake scars	Direction of the dorsal flake scars: 0 to 9 (w/o PDF, breaks, retouches and splintering). In this study bipolar is used *sensu latu* signifying parallel unidirectional and opposing dorsal flake scars that do not necessarily have to alternate.
mod.	59	modification (mod.) 1 to 6$^{\Delta}$	Modification as a tool that can be entered with the character of retouch (abrupt, plain, etc.): 00 to 17, 19, 20, 23, 27, 28, 30 to 35, 38, 39, 42, 44.
	60	order modifications*$^{\Delta}$	Order of modifications.
other	+	number of chips*	Complete artifacts (not fragments of blanks!) smaller than 1cm of one raw material were only counted and recorded together within one set with the attributes 1-7 and + museum. Chips could remain from production or modification (ASCHRAFI 2010, 40).
		IGerM	*Index Geräte Modifikation/tool modification index* for classification of a piece finally as *one* tool (or unmodified piece) hierarchical with the smallest index or according to the order/dominance of a modification (recorded for all artifacts apart from chips). I did not classify burins further in median, angle or transverse burin. 42 for burin spall was added.
	+	type according to TIXIER (1963)	Tool types. I recorded sickles, splintered pieces and hammer stones (*Klopfer*) as 112, whereas simple plain lateral retouches (modification 06N) are 105.
	+	completed	Dataset completed: yes/no.
	+	remarks*$^{\Delta}$	Remarks, notes ...
	+	figures*$^{\Delta}$	Literature references for figures of the artifact.
Subsequent to characteristics 1 to 34 I recorded the following characteristics for cores:			
cores	+	preservation core	Preservation of core: 0 incomplete 1 complete 2 n.s. A core is "incomplete" if it is broken, damaged due to heat or for other reasons or if it is strongly influenced in size because of its use as a hammer stone or the like. "Complete" describes a core with bulb-negatives, which suddenly was exposed from debitage for whatever reason. In this context, I did not evaluate the size.
	61	type of core	Type (mostly n.s.) and shape of core (in most cases conic [a cone upside down] or cylindrical with two opposed more or less similar shaped plains): 0 to 3 and 0 to 9.
	62	shape of core	
	70	platforms	Number and surface of the biggest platform: 0 to 6 (number) and 0 to 7.
	71	surface platform	
	72	reduction face*	Number and direction of debitage: 0 to 5 (direction). 73 comprises the direction of debitage concerning the whole core and not the direction of the biggest reduction face. Thus, it is detectable, whether the core was turned during the process of debitage.
	73	direction of reduction face	

Tab. 22 continued.

4.2. Correction and data set

The following paragraphs provide a short guideline for a consistency check and correction of the datasets: First queries can detect attributes that are left blank (as such, not marked with$^{\Delta}$ in **Tab. 22**). Furthermore, I obtained consistency by querying the interconnected characteristics listed in **Tab. 23**.

Tab. 24 lists incomplete and thus excluded datasets. So the datasets listed in column 'datasets DS' of **Tab. 25** are valid and sufficient datasets for this study (cf. **4.3.1. Varieties** and **Tab. 30**). Variances in the number of datasets and the numbers of artifacts are due to the chips that were also recorded in datasets (cf. also **SITE GAZETTEER**).

ATTRIBUTE	DEPENDENT ATTRIBUTES
If ….	Then …
Condition of cortex = 0	Rounding = 0 and Portion = 0
	→ no cortex nor cleavage planes.
Condition of cortex = 0	Rounding > 0 and Portion > 0
	→ cleavage planes exist.
Condition of cortex > 0	Rounding > 0 and Portion > 0
	→ cortex exists.
Effect heat = 0	Time heat = 0
Effect heat > 0	Time heat > 0
Measurements of cores and debris	length > width > thickness (L>Wi>T).
Blank 1 = 1	IGerM = 21 or tool IGerM ≠ 22-29
Blank 1 = 2	IGerM = 22 or tool IGerM ≠ 21, 23-29
Blank 1 = 3	IGerM = 24, 25 or tool IGerM m ≠ 22-29
Blank 1 = 4	IGerM = 26 or tool IGerM ≠ 21-25 and 27-29
Blank 1 = 5	IGerM = 23 or tool IGerM ≠ 21, 22, 24-29
	and entire documentation of core-features.
Blank 2 = 04	IGerM = 42
Blank 2 = 14	Effect/time heat > 0 and IGerM = 24
Blank 2 = 15	IGerM = 24
Blank 2 = 19	Distal ending > 00
Blank 2 = 27	PDF > 0
Preservation = 1, 5 (complete)	Platform remnant constitution > 0 und Distal ending > 02
Preservation = 2, 6 (proximal)	Platform remnant constitution = 0 und Distal ending < 03 or = 08, 09
Preservation = 3, 7 (distal)	Platform remnant constitution = 0 und Distal ending > 02
Preservation = 4, 8 (mideal)	Platform remnant constitution = 0 und Distal ending < 03 or = 08, 09
Platform remnant constitution = 0	Platform remnant shape = 0 and DR/lip/bulb/bulbar scar/impact ring = 1
Platform remnant constitution > 0	Platform remnant shape > 0 and DR/lip/bulb/bulbar scar/Impact ring = 0 or > 1
Modification 1 to 6	
< 8 or >11 and <16	IGerM > 0 and < 21 or > 29 or ≠ 34
or = 9, 45, 46, 60, 62, 63, 67, 70	
Modification 1 to 6 = 01	IGerM = 01
… a.s.o.	… a.s.o.
Modification 1 to 6 = 63	IGerM = 33
IGerM > 0 and < 21 or > 29	Tixiertype > 0
IGerM = 01 projectile point	Tixiertype =45 to 72 or 82 to 100 or 112
IGerM = 02 borer	Tixiertype = 12 to 16 or 112
IGerM = 03, 04 or 31 varnish/sickle	Tixiertype = 112
IGerM = 06 burin	Tixiertype = 17 to 33 or 44 or 112
IGerM = 07 truncation	Tixiertype = 58, 79, 80 or 81
IGerM = 08 end scraper	Tixiertype = 1 to 11or 43 or 44 or 112
IGerM = 09 lateral retouch	Tixiertype =105 or 34 to72 or 112
IGerM = 11 splintered piece	Tixiertype = 104 or 112
IGerM = 19 hammer/hammer stone	Tixiertype = 112
IGerM = 32 notched piece	Tixiertype = 73, 74, 76 or 79
IGerM = 33 denticulate	Tixiertype = 75, 77 or 79
IGerM = 21-29 or 42	Tixiertype = 0

(However, the assignment of the IGerM depends not only on the hierarchy of the modifications (see **Tab. 22**) and is not necessarily verifiable by queries).

Tab. 23 Consistent features in the recording system.

ID	SITE	REASON
2506	CH	Entered only until 16/raw material (rock crystal).
7596	Car	Measurements are missing (splintered piece).
8007	A6	Entered only until 16/raw material (flint).
8402	A6	Ground stone tool with grinding and pecking.
8403	A6	Ground stone tool (2 kg) with negatives.
8435	A6	Entered only until 16/raw material (quartzite).
8436	A6	Ground stone tool wit negatives.
8437	A6	Ground stone tool with red ocher and flake negative.
8470	A6	Entered only until 16/raw material (flint).
8471	A6	Entered only until 16/raw material (flint).
8545	A6	Entered only until 33/blank 1 and tool characteristics (59, IGerM, Tixiertype; truncation).
8660	A6	Entered only until 33/blank 1 and tool characteristics (59, IGerM, Tixiertype; splintered piece).
8699	A6	Flake of a ground stone tool.
85786	A6	Entered only until 16/raw material (flint).

Tab. 24 Datasets excluded from the present study.

N°	SITE	STAGE	TOTAL	SELECTION CRITERIA	DS	n	CHIPS
0	AL	EPI	648	Only "*Epipaleolítico, estrato 1*" (archaeological level) without "*Epipaleolítico, estrato ?*" and „*…, estrato 2*"	638	513	250
2	CH	EPI	894	Only "2004", "2005" and "2007" (year of excavation), not "0", "1979", "1986", "1987", "1989", "2001", "2002" and without ID 2506 (cf. **Tab. 24**)	298	257	85
3	Hoz	EPI	219	-	219	219	
5	AM	EPI	97	-	97	91	19
6	CZ	EPI	408	-	408	395	400
7	Car	E NEO	488	without ID 7596 (cf. **Tab. 24**)	487	483	
8	A6		1175	two assemblages:	1167		
		EPI	508	like „*Estrato 8*" – Epipaleolithic without ID 8007 and	507	491	4
		E NEO	667	like "*Estrato 7*" – Early Neolithic without ID 8435, 8437, 8470, 8471, 8545, 8660 and 85786 (cf. **Tab. 24**)	660	601	21
9	CA	EPI	1640	-	1640	1613	452
10	CNP	E NEO	250	-	250	246	9
Σ			5819	*see above*	5204	4409	1240

Tab. 25 Number of lithic datasets (DS) included in the present study. The number of DS is not equal to the number of lithic artifacts because of selection criteria, raw materials (cf. **4.3.1. Varieties** and **Tab. 30**) and due to the chips: Several chips were recorded in one DS.

4.3. Raw material

Generally the Betic Cordillera is one of the most abundant flint areas in Iberia with very variable resources (MORGADO RODRÍGUEZ/LOZANO RODRÍGUEZ/PELEGRIN 2011, 261; RAMOS MILLÁN 1998, 2002; concerning flint in its geological formation cf. AFONSO MARRERO 1993, 45-48). People had at least partly easy access to the raw material by outcrops (cf. e.g. LOZANO ET AL. 2010, 164 Fig. 1A) or when it was exposed to erosion and transported by rivers (MORGADO RODRÍGUEZ/LOZANO RODRÍGUEZ/PELEGRIN 2011, 264). A lack of raw material is unlikely.

So far various raw material sources are known in the working area, but in the majority of cases, single artifacts could not be assigned concretely to a source. MARTÍNEZ ANDREU (2002, 55-58 cf. **Tab. 26**) evaluated the specific raw material present in AL/MU, but a specification of flint sources is impossible. Effectively the chipped stone industry consists mostly of variable flints and related siliceous raw materials of different colors, textures, translucency and sources. Single rock crystal artifacts and some pieces of coarser raw materials are also occasionally present (**Tab. 27** and **Tab. 28**).

RM	DESCRIPTION	OCCURANCES	USE/RATIO
flint	large, indifferent group of different colored (black, grey, brown) and textured siliceous rocks (opaque or transparent) with variable cortex (amongst others chalky cortex)	mostly of foreign origin; People required only the flint of Viña de Raja/Roja (bluish, coarse-grained, small nodules) from a 2km distant outcrop.	most frequently used for blank production; Viña de Raja-flint is rare
quartz	several varieties: opaque white with conchoidal fracture to transparent (= rock crystal)	frequent in the surrounding and the littoral Murican mountain range	18-30% of the débitage per level
rock crystal (variety of quartz)	transparent with fracture similar to flint, very small nodules of initially 3-4cm		mostly microlithis due to the small size of the RM, but also exceptionally other tools
limonitas jaspoides/ jaspe limonitico	flint-like fracture; contains clay and other ferrous minerals (yellowish-brown to brown color)	in 3-30km distance around Mazarrón and La Unión (mining ?)	approximately 5% of the débitage
jasper	homogenous, fine-grained structure with excellent fracture properties, red (saffron), occurs in small cores	unidentified, foreign origin	large amount of the tools
red ocher	porous, earthy rocks with ferrous minerals as iron, limonite or clay	frequent in the surroundings	pigments; temper material
diaspore	opaque and monochrome (yellow) chalcedonies with excellent fracture	"exotic"; regional	rare: exploitation of one core in squares 10 and 11N
chalcedony	dark to light brown with excellent fracture properties	foreign RM; origin unknown	small amount of the débitage

Tab. 26 AL/MU (all levels: Magdalenian to Epipaleolithic). Raw materials (RM) summarized according to Martínez Andreu (2002, 57-58 cf. Martínez Andreu 1997b, 351 Fig. 3, 5; Martínez Andreu 1993, 38; Martínez Andreu 1991b, 92).

4.3.1. Varieties

So far, percentages of the various used raw materials and their definite provenance is – except for AL/MU – not available in previous studies.

Martínez Andreu (2002, 55-58) illustrates diversely available raw materials in Murcia. People of AL/MU had a broad knowledge about the sources and made use of diverse raw materials. Débitage shows that people unequivocally favored flint in AL/MU (**Tab. 26**). Many different flint varieties constitute the largest amount of artifacts. Martínez Andreu (2002, 58) cannot really specify the flint more precisely. Due to the internal variability, flint artifacts cannot be unequivocally assigned to one single source (pers. comm. M. Martínez Andreu). Furthermore, he stressed that even the general "flint"-category provides ambiguity: Probably also other raw materials were classified as "flint" (Martínez Andreu 2002, 58). Besides flint, Martínez Andreu (2002, 57-58) also determined other rocks occurring in the lithic assemblages of AL/MU (cf. **Tab. 26**). Flint, quartz, rock crystal and *"jaspe limonitico"* occur in the Epipaleolithic level 1 of AL/MU (Martínez Andreu 1989, 72 Fig. 36; 91 cf. 1991b). People of Ner/MA used apparently similar raw materials: flint, rock crystal, *jaspe*, quartz and metamorphic rocks (Aura Tortosa et al. 2001, 28-29).

Hunter-gatherers used quartzite, phylite, micashist as ground stone tools (Martínez Andreu 2002, 58 cf. Delgado Raack 2008 and Orozco Köhler 1998).

Generally the so-called „*jaspe limonitico*" is hardly distinguishable within the flint varieties. In the present study, it could only be identified in CH/MU by M. Martínez Andreu (pers. comm.). Thus, the raw material determination in the present study is still subject to considerable uncertainties. So far only general impressions about primary/secondary origins of the lithic supply based on the cortex conditions are possible (cf. **4.3.2. Indirect approach: Primary vs. secondary flint provenances** and **4.3.3. Local or regional flint availability**). But the raw material variants of the knapped stone industry are not analyzed here in detail. Although raw material dispersals hold great potential and could provide unique insights in mobility patterns or contacts, networks and exchange connections, this topic cannot be addressed in this study until further research is conducted.

Instead I consider, whether artifacts of different raw materials can compose a homogenous sample. The varying characteristics possibly required different knapping techniques: One could imagine that e.g. massive tools could have been processed out of coarse raw material, whereas people preferred excellent flint for accurate microliths. Thus, it is questionable, whether artifacts of "regular" and coarse materials can be evaluated together. Exemplarily I tested this using the assemblages of AL, CH/both in MU and A6/MA with relatively large amounts of coarse raw material:

	MU - RAW MATERIAL	*Σ (n)*	*%*	*Σ (g)*	*%*	*Ø g*
AL	flint/*"jaspe limonitico"*	483	79.4%	616.1	45.2%	1.3
	rock crystal	30	4.9%	30.6	2.2%	1.0
	other	95	15.6%	714.9	52.5%	7.5
	Σ (total assemblage)	608	100.0%	1361.6	100.0%	2.2
CH	flint	241	91.3%	416.1	90.8%	1.7
	rock crystal	4	1.5%	6.2	1.4%	1.6
	„jaspe limonitico"	9	3.4%	9.3	2.0%	1.0
	iron ore	3	1.1%	3.5	0.8%	1.2
	other	7	2.7%	23.3	5.1%	3.3
	Σ (total assemblage)	264	100.0%	458.4	100.0%	1.7

Tab. 27 Total numbers, weight and average weight (Ø) concerning used raw materials in AL (cf. MARTÍNEZ ANDREU 1989, 72 Fig. 36; 91 or AL in **SITE GAZETTEER**: **Cueva del Algarrobo/Murcia**) and CH/both in MU. Particular differences occur between the mean values of "fine" and other raw materials.

	A6 - RAW MATERIAL	*Σ (n)*	*%*	*Σ (g)*	*%*	*Ø g*
EPI	flint	491	97.2%	3021.2	82.4%	6.2
	other	14	2.8%	646.0	17.6%	46.1
	Σ (total assemblage)	505	100.0%	3667.2	100.0%	7.3
NEO	flint	599	92.2%	3709.7	80.5%	6.2
	rock crystal	2	0.3%	9.4	0.2%	4.7
	other	49	7.5%	886.4	19.2%	18.1
	Σ (total assemblage)	650	100.0%	4605.5	100.0%	7.1

Tab. 28 A6/MA. Total numbers, weight and average weight (Ø) of the used raw materials. Particular differences occur between the mean values of "fine" and other raw materials.

SITE	RAW MATERIAL	PROBABILITY (P)
AL/MU	flint and *"quarzo massivo"*	p-value < 2.2e-16
	"quarzo massivo" and rock crystal	p-value = 6.149e-06
A6/MA	flint and quartzite	p-value = 2.926e-06
	flint and milky quartz	p-value = 6.065e-05
AL/MU	flint and rock crystal	p-value = 0.2612
CH/MU	flint and "*jaspe limonitico*"	p-value = 0.8214

Tab. 29 Results of Wilcoxon rank sum test concerning artifact weights of fine (flint, rock crystal, "*jaspe limonitico*" and iron ore) vs. coarse ("*quarzo massivo"*, quartzite, milky quartz and n.s.) raw materials.

Varying mean values of the weight already illustrate differences between "fine" (flint, rock crystal, *"jaspe limonitico"*, iron ore) and "coarse" (*"quarzo massivo"*, quartzite and other [milky quartz or not specified]) raw materials (**Tab. 27** and **Tab. 28**). Furthermore, the Wilcoxon rank sum test (DULLER 2008, 165-169; WILCOXON 1945) clearly exposes differences between these two raw material groups. Basically the test checks the dissimilarity of two statistical dispersals (DULLER 2008, 165), i.e. the dispersal of weights of the artifacts of fine vs. coarse raw material. With a probability $p < 0.05$ the samples are displaced and belong to different weight dispersals (DULLER 2008, 165). I conducted the test with R (R DEVELOPMENT CORE TEAM 2011) and the package "exactRankTests" (HOTHRON/HORNIK 2011: *Wilcox.exact, pared=FALSE, alternative = "two.sided"*). A test of flint and rock crystal against *"quarzo massivo",* quartzite and milky quartz presents low probabilities (cf. **Tab. 29**), whereas flint, rock crystal and "*jaspe limonitico*" probably belong to one sample.

Finally I evaluate artifacts of flint, rock crystal, "*jaspe limonitico"* and the three similar accurate iron ore artifacts of CH/MU. **Tab. 30** lists the absolute artifacts numbers and weights that were finally analyzed within this study. In contrast, all artifacts of the coarse raw materials – analogously from the other sites as well – were excluded from the analyzed sample. It should be noted that all these pieces are non-modified. Some of these artifacts could even originate from the preparation of ground stone tools. Especially in A6/MA it seems that the transition to ground stone tools is fairly smooth: E.g. irregular flakes were knapped of quartzite-like bulky “cores” and flint pebbles were not (only) used for blank production but for polishing and so the pebbles were polished (cf. **4.4.10. Abrigo 6/Málaga (A6/MA)** with **Tab. 183** and **Tab. 197**).

site		*Σ number*	*Σ weight (g)*	*Ø (g)*	*SD*
CA	AL	1613	4859.3	2.5	3.786
A6 NEO	MA	601	3719.1	1.7	2.991
AL	MU	513	646.7	1.3	2.733
A6 EPI	MA	491	3021.2	4.7	10.131
Car	GR	483	7315.3	3.0	7.135
CZ	MU	395	528.7	2.1	4.182
CH	MU	257	435.0	1.8	3.074
CNP	AL	246	508.8	6.2	22.945
Hoz	MU	219	1037.0	6.2	9.651
AM	MU	91	223.1	1.3	3.031

Tab. 30 Number and weight (including mean weight (Ø) and standard deviation (SD) in gram) of the analyzed lithic assemblages ordered according to descending numbers.

4.3.2. Indirect approach: Primary vs. secondary flint provenances

The coverage with different cortex types indicates the sources. The presence of pebble and chalky cortex in all assemblages implies the exploitation of at least two sources in varying proportions (**Tab. 31; Fig. 6**). The Epipaleolithic and Early Neolithic assemblages of A6/MA with more than 90% pebble cortex are outstanding and display the dominant acquisition of a secondary, fluvial transported raw material. Epipaleolithic settlers of Ner/MA exploited predominantly secondary sources (dominance of pebble cortex; AURA TORTOSA ET AL. 2001, 28) and a pebble remained from the Early Neolithic (AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO 2011). Settlers of Car/GR obtained their nodules predominantly from river beds, too, but – due to 30% chalky cortex – also used primary outcrops. In CA/MA, Hoz and CH/both in MU, artifacts with chalky cortex slightly outweigh those covered with stream-worn cortex. The inhabitants of CNP/AL and of all remaining Murcian sites (AL, AM, CZ) supplied their needs by regular visits to different primary and secondary provenances.

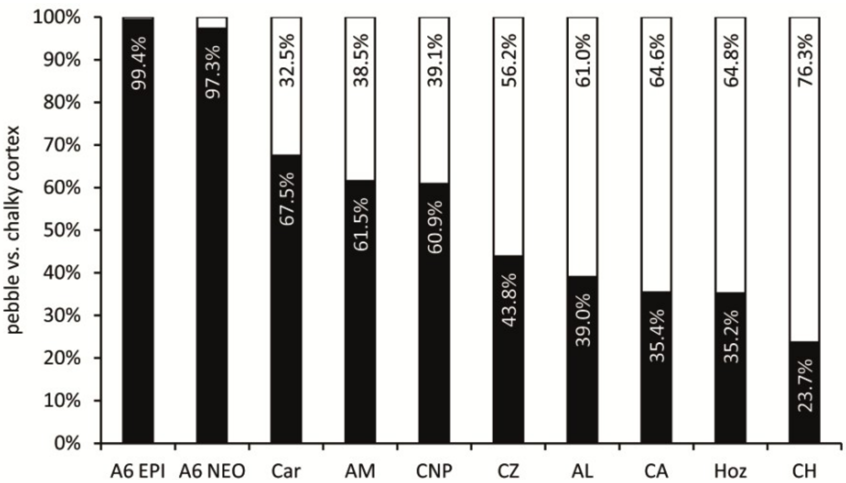


Fig. 6 Ratios of pebble (black) vs. chalky cortex (white; equivalent 0.6% for A6 EPI and 2.7% for A6 NEO/MA) of the analyzed assemblages.

CORTEX	A6 EPI		A6 NEO		AL		AM		CA		Car		CH		CNP		CZ		Hoz	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
pebble cortex	157	99.4%	216	97.3%	41	39.0%	8	61.5%	120	35.4%	83	67.5%	18	23.7%	14	60.9%	32	43.8%	19	35.2%
chalky cortex	1	0.6%	6	2.7%	64	61.0%	5	38.5%	219	64.6%	40	32.5%	58	76.3%	9	39.1%	41	56.2%	35	64.8%
total with cortex	158	100.0%	222	100.0%	105	100.0%	13	100.0%	339	100.0%	123	100.0%	76	100.0%	23	100.0%	73	100.0%	54	100.0%
n.s.*	12	7.1%	17	7.1%	31	22.8%	6	31.6%	86	20.2%	12	8.9%	10	11.6%	12	34.3%	23	24.0%	18	25.0%

Tab. 31 Amounts of cortex types : The preponderance of either chalky (majority in AL/MU, CA/AL, Hoz and CH/both in MU) or pebble cortex (A6/MA, Car/GR; cf. **Fig. 6**) implies a dominant exploitation of primary or secondary raw material provenances. Settlers of most sites (AL, AM, CZ, Hoz/all in MU and CNP/AL) satisfied their demands by mixed consultation of both types of sources (n. s. = not specified cortex refers to the total amount of artifacts within an assemblage cf. **Tab. 30**).

4.3.3. Local or regional flint availability

Apparently mostly local and regional sources satisfied the raw material needs of Epipaleolithic and Early Neolithic settlers. They received their raw materials from various origins nearby and less frequently from remote sites. Not only did the quality and characteristics of each raw material determine the exploitation, but the exploitation corresponded to the settler's requirements. Availability mattered, too, as people possibly obtained raw materials via exchange (MARTÍNEZ ANDREU 2002, 57 cf. **4.4.1.6. Exchange**) besides direct acquisition.

Hunter-gatherers staying in AL/MU preferred flint of foreign sources and exploited 30% of their flint from the Guadalentín valley (MARTÍNEZ ANDREU 2002, 58; 1989, 73; 147). Due to the internal variability, flint artifacts cannot be unequivocally assigned to one single source (pers. comm. M. Martínez Andreu). The hunter-gatherers took less advantage of the immediately local sources and exploited only one local, quasi irrelevant source (Viña Roja, cf. **Tab. 26**). "J*aspe limonitico"*, red ocher, quartz and other raw materials for ground stone tools originate from the nearby costal mountain range (MARTÍNEZ ANDREU 1997b, 351 Fig. 3, 5; MARTÍNEZ ANDREU 1993, 38; 1997b, 351 Fig. 3, 5; MARTÍNEZ ANDREU 1991b, 92; MARTÍNEZ ANDREU 1989, 148; MARTÍNEZ ANDREU 2002, 58). Only very few artifacts originate from sources at about 200km distance (MARTÍNEZ ANDREU 2002, 57).

Settlers of Hoz/MU visited mostly local but additionally, in particular cases, regional sources for their raw material supplies (in Hoz/MU, LILLO CARPIO/LILLO CARPIO 1982-1983, 9-10). Also people settling in Cast/GR gathered their flint mostly in the near surrounding of the site during pastoralism activities (SÁNCHEZ ROMERO 2000, 186; 198). The initial cortex removal and core preparation took place off-site (for details cf. **SITE GAZETTEER**: **Los Castillejos/Granada**). People from CNP/AL procured their principal flint demand from the Vélez region (CÁMALICH ET AL. 2004, 188) and added special products from foreign raw material sources (MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO 1999b, 245 cf. GOÑI QUINTEIRO ET AL. 1999, 169; RODRÍGUEZ RODRÍGUEZ 1999, 235). Flint artifacts of CA/AL originated from the surrounding area of a 30km radius (pers. comm. A. Suárez Marquez; RIPOLL LÓPEZ 1988, 590-595). MARTÍNEZ FERNÁNDEZ ET AL. (2006, 297) found that settlers of the modern day province of Granada (e.g. groups of Los Castillejos) had exploited the local flint raw material source of Los Gallumbares at least since the Middle Paleolithic. In younger periods, since the $4^{th}/3^{th}$ millennium calBC, the exploitation of flint intensified (AGUAYO/MORENO 1998). People mined flint and distributed it regularly over larger distances (MORGADO RODRÍGUEZ/LOZANO RODRÍGUEZ/PELEGRIN 2011, 152 FIG. 14; RAMOS MILLÁN 1998), but still preferred the exploitation and exchange within the near territory (MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 15 footnote 11).

Exhaustive exploitation, i.e. small cores, completely exhausted tools and recycled pieces demonstrate certain shortages in the raw material supply (cf. **Tab. 36**) as in AL/MU (MARTÍNEZ ANDREU 1997b, 351; MARTÍNEZ ANDREU 2002, 59; 61) or in CNP/AL (CÁMALICH ET AL. 2004, 188; GOÑI QUINTEIRO ET AL. 1999, 169). Early Neolithic settlers in Car/GR probably even re-used Middle Paleolithic artifacts (MARTÍNEZ FERNÁNDEZ 1985, 181-183; cf. **SITE GAZETTEER**: **Cueva de la Carigüela/Granada**).

Moreover, AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO (2011) detected raw material shortages in Málaga: Apparently no local raw materials were available for the Paleolithic, Epipaleolithic and Early Neolithic settlers of Ner/MA (cf. AURA TORTOSA ET AL. 2001, 29; 34): People had to import flints from at least 25 to 40km distant sources (25km/Periana, Alfarnate or Zafarraya; 39.6km/Benajarafe; 47.2km/Cútar; 47.4km/Sierra Gordo/GR). The few rock crystal artifacts stem presumably from a source around Motril/GR in 56km distance.

4.4. Descriptive analyses: Reconstruction of the reduction sequence (*chaîne operatoire*)

The reduction sequence was conducted to reconstruct concepts of the knapper and on-site activities. Environment, resource availability, technology, tradition, capability, preferences or other factors can influence or restrict the reduction sequence (cf. KRETSCHMER 2006, 20). Presence and absence identify actions and thus possible functions of the site. Comparable studies follow similar approaches (MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO 1998; AFONSO MARRERO 1993, 89 Fig. 4; SÁNCHEZ ROMERO 2000).

ASCHRAFI (2010, 27-29; 59-65; cf. LINSTÄDTER ET AL. 2012a) composed and adapted the stages of the reduction sequence (GENESTE 1985; cf. KRETSCHMER 2006, 20 and PASTOORS/TAFELMAIER 2010 with citations therein) – and its indicators to the project C2-working area (cf. **Tab. 32**).

4.4.1. Approach

To approach the stages 0 to 6, ideally the first step of recording should be a sorting according to raw materials and subsequently according to the stages of the reduction sequence. For the present study, I had to refrain from this approach due to time constraints and especially to maintain the museum-specific storage system. Alternatively, the stages can be approached by querying the according attributes of the lithic artifacts listed in **Tab. 32**, column 3.

E.g. remains of stage 0 are nodules, pebbles or tested specimens on-site. In the database these artifacts can be queried by blank 1 equaling 4 or IGerM equaling 25 or 26. Or e.g. the blank production (stage 3) produces regular flakes and blades without cortex. Due to their regularity, these artifacts generally became further processed into tools. For querying those artifacts, blank 1 equals 1/flake or 2/blade and the cortex = 0/without cortex. Additionally, the direction of the dorsal flake scars should be regular, i.e. equaling 1, 2 or 3 and the IGerM between 21 and 29 (tools).

In this manner, not only the presence and absence of stages can be deduced but the characteristics of the artifacts – as e.g. dimensions or impact marks within a distinct stage – also provide information. Thus, the character of the reduction sequence can be determined: E.g. preparation, blade-oriented or opportunistic reduction. A comparison between stages and similar stages of different assemblages is possible. So, regarding stages 0 – mentioned as examples before – one can assume larger and heavier, but also fewer artifacts. In contrast, stage 3-artifacts are frequent and should be fairly fine or lighter weight and more standardized.

STAGE	PRODUCTS	ATTRIBUTES
0 RM PROCUREMENT + TESTING	nodules/pebbles (possibly tested with single removal negatives)	blank 1 = 4 or IGerM = 25, 26
1 CORTEX REMOVAL; PREP. CORE PLATFORM + REDUCTION FACE	flakes with ≥ 2/3 cortex coverage of dorsal surface simple flakes with few dorsal flake scars	blank 1 = 1 and cortex > 0 and < 9 and cortex amount = 3, 4
2 CORE PREPARATION	crested flakes + blades lateral core flakes	blank 2 = 18, 27
3 BLANK PRODUCTION	blades w/o cortex	blank 1 = 2 and cortex = 0
	regular flakes + blades	blank 1 = 1, 2 and dorsal flake scars = 1, 2, 3 and cortex = 0 or blank 2 = 02, 03
	processed flakes + blades	blank 1 = 1, 2 and IGerM < 21 and > 29
4 RE-PREPERATION CORE	core tablets	blank 2 = 07 or 17 or PDS > 0
	plunging flakes + blades	blank 2 = 19 (or distal ending = 07)
5a INTENTIONAL MODIFICATION	tools	IGerM < 10 and > 29
	burin spalls	IGerM = 42
5b USE	tools	IGerM < 10 and > 29
	pieces with use traces	Mod 1 to 6 = 09-16, 27, 31-33, 39, 42, 44, 52, 53 or IGerM = 03, 04, 11, 19, 20, 31, 41
5c RESHARPENING	tools with additional modifications	IGerM < 10 and > 29 and Mod. 1-6 with at least one additional tool modification (01-07, 09, 12, 13, 15, 45, 62-63) unequal to the IGerM modification (e.g. IGerM = burin and Mod. 2 = end scraper)
6 DISCARD	reduced cores w/o modification	blank 1 = 5 and preservation = 0, 2 and Mod. 1 = 0 or blank 2 = 11, 12, 13, 15 or IGerm = 23
	burned tools (burned after modification)	IGerM < 21 or > 29 and time heat = 3, 4
	burned blanks w/o usage (burned after blank removal)	IGerM > 20 and < 30 and time heat = 2, 3

Tab. 32 Simplified stages and products of the adopted reduction sequence compiled and modified from ASCHRAFI (2010, 27-29; 59-65 cf. LINSTÄDTER ET AL. 2012a) with corresponding attributes for queries cf. **Tab. 22** (RM = raw material; PREP = preparation) .

		REDUCTION SEQUENCE	number Σ (n)	number %	weight Σ (g)	weight %	weight Ø (g)	weight SD
MURCIA	AL	0 RM procurement						
		1 cortex removal	20	3.9%	34.7	5.4%	1.7	1.789
		2 core preparation	29	5.7%	46.7	7.2%	1.6	1.990
		3 blank production	282	55.0%	212.6	32.9%	0.8	2.375
		4 re-preparation	20	3.9%	29.0	4.5%	1.5	0.943
		5 tools&use	172	33.5%	273.5	42.3%	1.5	2.244
		6 discard	126	24.6%	144.5	22.3%	1.2	1.600
		reference amount	513	100.0%	646.7	100.0%	1.3	3.031
	AM	0 RM procurement						
		1 cortex removal	1	1.1%	2.7	1.2%	2.7	
		2 core preparation	5	5.5%	40.7	18.2%	8.1	4.762
		3 blank production	52	57.1%	54.0	24.2%	1.0	1.402
		4 re-preparation	4	4.4%	13.2	5.9%	3.3	2.780
		5 tools&use	50	54.9%	171.1	76.7%	3.4	4.562
		6 discard	17	18.7%	23.8	10.7%	1.4	1.992
		reference amount	91	100.0%	223.1	100.0%	2.5	3.786
	CH	0 RM procurement						
		1 cortex removal	11	4.3%	18.3	4.2%	1.7	1.780
		2 core preparation	15	5.8%	23.1	5.3%	1.5	1.590
		3 blank production	125	48.6%	122.0	28.0%	1.0	1.099
		4 re-preparation	9	3.5%	15.2	3.5%	1.7	1.381
		5 tools&use	89	34.6%	254.5	58.5%	2.9	4.548
		6 discard	43	16.7%	88.7	20.4%	2.1	2.928
		reference amount	257	100.0%	435.0	100.0%	1.7	2.991
	CZ	0 RM procurement	3	0.8%	7.1	1.3%	2.4	2.376
		1 cortex removal	7	1.8%	6.3	1.2%	0.9	0.981
		2 core preparation	22	5.6%	49.8	9.4%	2.3	3.578
		3 blank production	221	55.9%	161.1	30.5%	0.7	0.890
		4 re-preparation	15	3.8%	14.9	2.8%	1.0	0.910
		5 tools&use	133	33.7%	206.1	39.0%	1.5	2.091
		6 discard	195	49.4%	319.1	60.4%	1.6	3.426
		reference amount	395	100.0%	528.7	100.0%	1.3	2.733
	Hoz	0 RM procurement						
		1 cortex removal	3	1.4%	13.5	1.3%	4.5	3.205
		2 core preparation	25	11.4%	117.5	11.3%	4.7	5.080
		3 blank production	128	58.4%	197.7	19.1%	1.5	1.965
		4 re-preparation	20	9.1%	73.2	7.1%	3.7	4.198
		5 tools&use	149	68.0%	538.1	51.9%	3.6	5.096
		6 discard	51	23.3%	400.6	38.6%	17.6	3.418
		reference amount	219	100.0%	1037.0	100.0%	4.7	10.131

		REDUCTION SEQUENCE	number Σ (n)	number %	weight Σ (g)	weight %	weight Ø (g)	weight SD
ALMERÍA	CA	0 RM procurement						
		1 cortex removal	51	3.2%	242.3	5.0%	4.8	6.979
		2 core preparation	70	4.3%	343.2	7.1%	4.5	5.149
		3 blank production	942	58.4%	1203.3	24.8%	1.3	2.513
		4 re-preparation	47	2.9%	114.8	2.4%	2.4	2.564
		5 tools&use	285	17.7%	978.6	20.1%	3.4	6.544
		6 discard	704	43.6%	2746.1	56.5%	3.9	8.919
		reference amount	1613	100.0%	4859.3	100.0%	3.0	7.135
	CNP	0 RM procurement						
		1 cortex removal	3	1.2%	6.7	1.3%	2.3	3.092
		2 core preparation	14	5.7%	32.4	6.4%	2.3	2.313
		3 blank production	171	69.5%	154.5	30.4%	0.9	1.165
		4 re-preparation	8	3.3%	13	2.6%	1.6	1.296
		5 tools&use	149	60.6%	248.8	48.9%	1.7	2.945
		6 discard	128	52.0%	334.7	65.8%	2.6	5.218
		reference amount	246	100.0%	508.8	100.0%	2.1	4.182

Tab. 33 Amounts of artifacts assigned to the stages of the reduction sequence per assemblage (cf. **Tab. 32**).

		REDUCTION SEQUENCE	*number* Σ (n)	*%*	*ratio (% Σn)* 0% – 100%	*weight* Σ (g)	*%*	Ø (g)	SD	*ratio (% Σg)* 0% – 100%
GRANADA	Car	0 RM procurement								
		1 cortex removal	7	1.4%		133.9	1.8%	19.1	28.333	
		2 core preparation	36	7.5%		600.9	8.2%	16.7	17.051	
		3 blank production	219	45.3%		2129.0	29.1%	9.7	11.15451	
		4 re-preparation	12	2.5%		104.0	1.4%	8.7	4.803	
		5 tools&use	235	48.7%		3817.3	52.2%	16.2	24.314	
		6 discard	285	59.0%		4206.3	57.5%	14.8	22.121	
		reference amount	483	100.0%		7315.3	100.0%	15.1	22.515	

		REDUCTION SEQUENCE	*number* Σ (n)	*%*	*ratio (% Σn)* 0% – 100%	*weight* Σ (g)	*%*	Ø (g)	SD	*ratio (% Σg)* 0% – 100%
MALAGA	A6 EPI	0 RM procurement	5	1.0%		732.9	24.3%	146.58	173.3857	
		1 cortex removal	38	7.7%		206.0	6.8%	5.4	3.667	
		2 core preparation	38	7.7%		281.8	9.3%	7.4	19.305	
		3 blank production	248	50.5%		568.4	18.8%	2.3	2.230	
		4 re-preparation	16	3.3%		84.9	2.8%	5.3	7.261	
		5 tools&use	190	38.7%		1189.8	39.4%	6.3	32.577	
		6 discard	336	68.4%		1809.2	59.9%	5.1	10.408	
		reference amount	491	100.0%		3021.2	100.0%	6.2	22.945	
	A6 NEO	0 RM procurement	15	2.5%		675.2	18.2%	45.0	25.512	
		1 cortex removal	44	7.3%		302.4	8.1%	6.9	5.736	
		2 core preparation	24	4.0%		159.8	4.3%	6.7	7.431	
		3 blank production	220	36.6%		669.4	18.0%	3.0	2.764	
		4 re-preparation	31	5.2%		159.8	4.3%	5.2	4.655	
		5 tools&use	214	35.6%		1410.1	37.9%	6.6	9.605	
		6 discard	440	73.2%		2482.0	66.7%	5.7	6.794	
		reference amount	601	100.0%		3719.1	100.0%	6.2	9.651	

Tab. 33 continued.

Furthermore, the numbers of these indicators show how many artifacts could have been assigned to each stage (**Tab. 33**). But pieces could pass several stages (e.g. 3 – 5 – 6) and consequently occur multiple times. The presence/absence of stages and artifacts imply actions that were conducted on- or off-site before occupation or after leaving. Besides that, obviously all artifacts belong *sensu stricto* to stage 6. However, those ratios (cf. **Tab. 33**) are not absolute and cannot serve for numeral comparison within different stages or allow strict evaluation of dominant stages/actions that took place in situ. E.g. assuming that 5% of the artifacts from one assemblage originate from raw material procurement and 10% of the same inventory is débitage, these ratios show a great disproportion requiring further explanation as during the different stages various amounts of products accumulated. Many blanks appeared within only one cycle of stage 3, whereas other stages produced inherently only few remains, e.g. a core could possibly be re-prepared by reducing only one core tablet. Standardized ratios are required to evaluate the dominance of a certain stage and thus action on-site.

Another issue arises when approaching the reduction sequence with standardized queries. Results of those are obviously somehow artificial and cannot take account of exceptional artifacts as a foregoing sorting by hand possibly can. E.g. with the options in column 3 of **Tab. 32** a query concerning stage 3-artifacts of the blank production requires a certain regularity of the semi-finished products. The regular directions of the dorsal flake scars (unidirectional, opposing or bipolar) are, to a certain degree, immanent. In this case, an evaluation of the dorsal flake scars requires caution as far as circular argumentation is concerned.

4.4.1.1. Raw material and core initialization

Especially pieces assigned to stage 0 and 1 allow conclusions concerning the consulted raw material sources, the size of nodules and pebbles or the import of decortified pre-cores. The more accurate the cortex removal in stage 1 was, the less cortex covered artifacts occured in the subsequent stages and the less core preparation was necessary in stage 2.

4.4.1.2. Blanks

Besides the main blank types as e.g. blades, more specialized categories such as bladelets are also available in the recording system. Small, regular blades appear in the studied inventories, but they were not evaluated as separated blank-type because blades and bladelets merge smoothly into one another (as indicated by dimension diagrams). There are no indicators for another specialized reduction sequence (e.g. for bladelets) apart from blades and flakes.

blanks			flakes			blades			cores			art. debris			pebbles*	Σ
			unm.	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm./Σ*	
MU	AL	*n*	216	55	271	147	44	191	12	3	15	30	6	36		513
		%	79.7%	20.3%	52.8%	77.0%	23.0%	37.2%	80.0%	20.0%	2.9%	83.3%	16.7%	7.0%		100%
	AM	*n*	49	10	59	24	4	28				2	2	4		91
		%	83.1%	16.9%	64.8%	85.7%	14.3%	30.8%				50.0%	50.0%	4.4%		100%
	CH	*n*	116	20	136	64	21	85	3	5	8	25	3	28		257
		%	85.3%	14.7%	52.9%	75.3%	24.7%	33.1%	37.5%	62.5%	3.1%	89.3%	10.7%	10.9%		100%
	CZ	*n*	206	29	235	75	27	102	8		8	43	4	47	3*	395
		%	87.7%	12.3%	59.5%	73.5%	26.5%	25.8%	100.0%		2.0%	91.5%	8.5%	12.7%	0.8%	100%
	Hoz	*n*	53	25	78	94	29	123	5	3	8	6	4	10		219
		%	67.9%	32.1%	35.6%	76.4%	23.6%	56.2%	62.5%	37.5%	3.7%	60.0%	40.0%	4.6%		100%
AL	CA	*n*	910	75	985	393	49	442	53	12	65	111	10	121		1613
		%	92.4%	7.6%	61.1%	88.9%	11.1%	27.4%	81.5%	18.5%	4.0%	91.7%	8.3%	7.5%		100%
	CNP	*n*	80	23	103	89	37	126	6	3	9	6	2	8		246
		%	77.7%	22.3%	41.9%	70.6%	29.4%	51.2%	66.7%	33.3%	3.7%	75.0%	25.0%	3.3%		100%
GR	Car	*n*	240	85	325	60	30	90	15	15	30	33	5	38		483
		%	73.8%	26.2%	67.3%	66.7%	33.3%	18.6%	50.0%	50.0%	6.2%	86.8%	13.2%	7.9%		100%
MA	A6	*n*	251	28	279	118	26	144	7	3	10	51	2	53	5	491
	EPI	*%*	90.0%	10.0%	56.8%	81.9%	18.1%	29.3%	70.0%	30.0%	2.0%	96.2%	3.8%	10.8%	1.0%	100%
	A6	*n*	344	65	409	55	23	78	15	3	18	64	18	82	14	601
	NEO	*%*	84.1%	15.9%	68.1%	70.5%	29.5%	13.0%	83.3%	16.7%	3.0%	78.0%	22.0%	13.6%	2.3%	100%

Tab. 34 Unmodified (unm.) and modified (mod.) blanks of the analyzed assemblages (unmod./mod. blanks refer to Σ of blank type; blank type refers to total number of artifacts per assemblage; *natural debris in CZ/MU is unm.; the pebbles of A6 are not intentionally modified to tools but were partly used for polishing or treating red ocher cf. **4.4.10.1. Epipaleolithic assemblage of A6/MA** and **4.4.10.2. Early Neolithic assemblage of A6/MA**).

For the blank fragments, one could assume an intentional fragmentation of blades in proximal, medial and distal fragments allowing the use of medial fragments as standardized tool inserts (LÖHR ET AL. 1977, 202; cf. e.g. **Tab. 43** and **Tab. 44** and equivalent tables of other assemblages).

4.4.1.2.1. Dimensions and preservation

Usually pebbles and cores are the largest blanks, the blank type with the highest mean weights. Subsequently artificial debris, flakes and blades follow with decreasing values. Small non-modified flakes and artificial debris with irregular dimensions are considered as discarded débitage (cf. **Tab. 36**). It is assumed that people did not usually use them because these blanks were too little and/or irregular. However, if those blanks were to hand and fit the tasks to be completed, people could have used them in exceptional, opportunistic cases.

In contrast, assuming that foremost regular, standardized blades were taken as insets for tools, modified specimens should be characterized by uniform widths and thicknesses and low standard deviations. However, the interpretation of the standard deviation value is delicate (see **4.4.1.2.1.1. Descriptive statistical values**). The values of fragments of modified blades added together could give indications or aspired, ideal blades.

Furthermore, one can pay attention to the values of the cores, whether their edge length fit to the present débitage and how long people adhered to a single core removing blanks and reducing the core size, and with it the size of the removed blanks. Relatively big cores on-site indicate sufficient evasion-raw material or other initiated cores, allowing cores to be discarded early. Additionally, people did not need small flakes and blades. In contrast, the presence of small cores could imply that people needed small flakes and blades to haft them. Alternatively, they might have had to remove blanks until the core was totally exploited. This would show a raw material shortage.

4.4.1.2.1.1. Descriptive statistical values

These considerations concerning blank dimensions are plausible and offer opportunities to compare and interpret the dimensions. Manifold ways for evaluation are provided by various, variable statistical values – as minimum and maximum values, mean, standard deviation, quartile, skewness, kurtosis etc. Compare therefore studies in which authors used the present recording system as e.g. ZIMMERMANN (1988) or recently BUHS (2012 and studies between). But this diversity aggravates the selection of appropriate values, and a comparison could become very confusing and extensive. Due to my previous work with the recording system (MEDVED 2009), I decided to consult only minimum and maximum values, mean and SD.

Specific values concerning Gaussian distribution as skewness and kurtosis are disregarded, althoug the dimension-dispersals of the artifacts in this study are left-skewed distributions and therefore cause standard deviation (SD)-problems: Values of SD are denoted in millimeter as the minimum, maximum and mean values concerning length, width and thickness. Despite equal units of measure (mm), values of SD of length, width and thickness are quasi incomparable as values could not immanently spread similarly around divergent mean values: E.g. flakes could be up to 80mm long, but are mostly less than 10mm thick. However, the skewed distributions of the dimensions cause real issues as an average flake is e.g. 1.4±2.8mm thick. Additionally, one has to keep in mind that a comparison of SD concerning mean length, width or thickness in contrast to the SD of mean weights is obviously invalid, as the SD concerning weights is denoted in grams. Because of these issues, other statistical values (as quantiles, coefficient of variation etc.) would be more suitable. Thus, values of SD have to be compared and interpreted carefully, if at all. SD is named in this study only due to convention and to accompany the mean value.

4.4.1.2.1.2. Dimensions of cores

Based on the products of stages 2 to 4 and their dimensions (maximum lengths, mean values), the core length in different stages can be estimated. The length of the removed blanks decreases continuously during the reduction and re-preparation of cores. With the dimensions of core tablets and plunging flakes and blades, one can estimate the approximate core edge length before and during the re-preparation stadium of stage 4. Finally, smallest blanks imply roughly the sizes of exploited cores.

4.4.1.2.1.3. Heat treatment

Artifacts can be burned because of non-intentional fire damage, i.e. artifacts came into contact with fire after their discarding, or to melt the glue and disconnect the inserts from their hafting (ROTH 2000, 120). In addition, in S Spanish Neolithic lithic inventories, tempering was frequently identified and documented to facilitate pressure technique (AFONSO MARRERO 1993, 18; 474; MARTÍNEZ FERNÁNDEZ ET AL. 2010, 165 and citations therein).

TECHNIQUE		HSP hard stone percussion	SSP soft stone percussion	OP organic percussion	punch/indirect technique
tool		hard rock, e.g. silex	soft rock	hardwood, bone, antler	bone, antler, hardwood (≥10cm)
aim		preparation, cortex removal		blade production	
products		large, thick pieces		fine, thin pieces	
indicators	dorsal reduction	likely to be present			
	platform remnant	thick and wide	fine, linear or point-shaped	pointed oval	
	lip			likely to be present	
	bulb	pronounced		w/o or diffuse	pronounced
	bulbar scar	only slight "splintering"	likely to be present	likely to be present	small
	impact ring	likely to be present			

Tab. 35 Reduction and percussion techniques and characteristics on the lithic artifacts (compiled from MAIER 2012; PELEGRIN 2000; WEINER 1981).

However, I often observed strong material alteration with cracks and fractures and a degradation of the material characteristics in the studied assemblages (cf. ASCHRAFI 2010, 43 and citations therein). Additionally, thermal changes occur frequently on dorsal and ventral surfaces on flakes and blades, so the heat treatment obviously took place after blank removal. But tempering would tend to cause slight thermal changes (no visible alterations) due to low and specific heat application on the outer surface of the core. Thus, the dorsal faces of flakes and blades should be in the original, non-heated condition. Probably the observed strong thermal effects covered prior tempering (cf. **4.4.1.5. Discard**).

4.4.1.3. Reduction and percussion technique

The reduction technique refers to the way people prepared their cores previous to the blank production. This fact means that core shapes and the number and surface of the striking platforms provide valuable information. Additionally, one can draw conclusions from the surface of the platform remnant as part of the former core platform. E.g. plain platforms and platform remnants imply (re-)preparation by removing core tablets. A further preparation of the core edges could prevent the removal of only short out-jutting-parts in favor of larger blanks (MAIER 2012). This procedure leaves dorsal reductions on flakes and blades and could indicate hard stone percussion (cf. **Tab. 35**).

Subsequently the removal of blanks from the cores took place in a certain direction and with distinct tools according to a certain percussion technique. Therefore, the direction of the dorsal flake scars on flakes and blades displays preferred removal directions during all stages of the blank production. The dorsal flake scars are designated as 'bipolar *sensu lato'* in this study, when parallel unidirectional and opposing flake scars occur. These flakes scars do *not* strictly alternate. As far as the percussion direction towards the end of the blank production is concerned, a comparison of the flake scars on the reduction faces of cores could point to re-orientations of the cores. These re-orientations can indicate a general or temporary opportunistic blank removal, e.g. during the final core exploitation. Thus, in favor of the production of a few more blanks before the core discard, the irregularity of the latest blanks was accepted.

Impact marks and the shape of the platform remnant could serve combined as hints for the percussion tool used (**Tab. 35**). One can expect different percussion techniques in stage 2 and 3 (ASCHRAFI 2010, 61-62).

Regarding the re-preparation of the core, the dorsal flake scars of the core tablets represent the former core platform. Thus, the directions of these dorsal flake scars show how the tablet was removed in relation to the platform and where its point of percussion was situated on the core. Generally, stage 4-artifacts on-site show an exploitation of the raw material and no previous discarding.

4.4.1.4. Tools

Stage 5 comprises tools, their diversity, use, exploitation, resharpening or reworking. Splintered pieces dominate several assemblages. People could have used these for multiple purposes e.g. to process bone, antler or other hard organic remains or lithic material. A use as punch in indirect percussion is unlikely, as they are comparably brittle and too short (MAIER 2012). Generally various tool types, especially end scrapers, truncations, borers or burins, frequent macroscopically visible use traces, and intensively used tools with additional modifications are indicators of broad handcrafting on-site. In contrast, projectiles discarded on-site remain from the replacements of these inserts in arrows, and thus tool repairing took place on-site, too.

The "primary" modification of tools serves today for the tool type designation. Tools with additional modifications can indicate simply their use as a combined tool or a subsequent additional modification due to a secondary use of the piece. People could have used the piece for other activities or resharpened it. Apparently the artifact was used intensely.

The variability of the tool assemblage can be calculated using the Simpson diversity index: "$D = \sum n(n-1)/\, N(N-1)$ where *n* is the amount of specimens within a single tool class, and *N* is the total amount of tools in an assemblage" (HEIDENREICH 2012, 164 and citations therein). The diversity of the present tool assemblages is high when there is a broad spectrum of tools. This is represented by a low index close to 0 (cf. **Fig. 36**). In contrast, assemblages with an index close to 1 are very uniform and imply a specialization of activities with only few tool types needed. Indices can be comprehensively compared amongst the sites. The inventories compared in this study show a positive correlation of assemblage size and increasing index (i.e. decreasing diversity; cf. **Fig. 36**; cf. SHOTT 1989, 2010; HEIDENREICH 2012, 365). But indices here are generally very low and fluctuate between 0.1-0.2. Thus, this issue should be addressed within a sample of more variable indices that covers a broader range between 0-1.

Immanent issues that cannot be eliminated in the archaeological contexts of mobile groups are multiple visits and occupations of sites that are not clearly detectable from the record. These cause a palimpsest (detailed described by HEIDENREICH 2012, 169-170) and assumingly a bigger diversity and less specialization: People could have conducted different on-site-actions during every periodical visit. However, today it is generally assumed that hunter-gatherers frequented their camps in various locations repetitively to exploit the various, locally limited available resource in and throughout the turns of a year. Thus, simplified and leaving aside probable irrational non-approachable human decision-making, one can expect similar activities and organization on and in the surrounding of the site during each of these repeated visits. People occupied the site every time for the same reasons (e.g. simplified to exploit one concrete resource). And furthermore, one can assume even reuse and consolidation of present, non-mobile structures such as hearths during each seasonal occupation. In this case, several visits would not significantly change the components of an inventory, but would rather be reflected by a growing number of similar finds and probably intensification of features. But in the end, changes in resource exploitation and on-site activities for whatever archaeologically unverifiable reasons are also conceivable, and the effect of palimpsest could not be generally evaluated or even dismissed. So the issue of palimpsests has to be judged for every individual assemblage and site. For the sites in this study, I assume predominantly repeated occupations within one relative chronological period that result in the present assemblages (cf. **3.1.2.5. Evaluated sites and archaeological characterization**).

Another difficulty in interpreting the diversity index arises when a site is not completely excavated. The excavation area could detect potentially only special task-areas and single concentrations; whereas other activity fields remain undiscovered (cf. ASCHRAFI 2010, 58). Either way, the meaning of the diversity index is certainly tentative.

4.4.1.5. Discard

In sensu stricto the whole assemblage was discarded on-site. Nevertheless, one can evaluate how people finally handled discarded artifacts. In most cases, settlers did not mind a further destruction by fire exposure. Of course such terminal unintentional heating could conceal intentional heat treatment (ASCHRAFI 2010, 63).

4.4.1.6. Exchange and mobility

Blanks and their attributes can provide indications of flint exchange, as elaborated for the Rhenish Linear Pottery Culture (ZIMMERMANN 1988) and the systematic flint exchange system (ZIMMERMANN 1995). The state of a settlement within this hierarchical network can be detected. Although the exchange system is based on the regionally frequented raw material source in the Netherlands and the availability of this flint for the sedentary Rhenish Linear potters, the indicators of on-site-blank production and ex- and import of various products can be transferred to the inventories analyzed in this study – *without* directly assuming an exchange system. Instead mobility of the group(s), their occupation and abandonment rhythms could have caused the composition of an assemblage. Of course, it must be kept in mind that most sites lack a complete excavation of the whole settlement area. Distinct activity areas could lie outside of the excavation section. Therefore, activity areas could remain undiscovered and thus a spectrum of activities could be missing and not reflected in the assemblage. But, on the basis of the present record, it can be assumed that e.g. people did blank production on a site, leaving behind lots of non-modified trimming flakes, before they moved to another site with semi-finished end products and possibly initiated further cores. Subsequently they discarded the cores there etc. Apart from that, products could have reached the site even in advanced states as cores (as also assumed for Cast/GR; SÁNCHEZ ROMERO 2000 and cf. **SITE GAZETTEER**: **Los Castillejos/Granada**), semi-finished blanks or as end products, i.e. tools. Thus, if parts of the reduction sequence are dominant on-site as non-modified blanks *or* tools (cf. previous examples), one can assume that these characteristics can be at least partly interpreted as listed in **Tab. 36**: A surplus of tools in one assemblage indicates an import of tools in addition to those produced on-site. In contrast, assemblages with a surplus of non-modified blanks miss the very tools that can be expected compared to the large amount of production waste. These indicators do not exclude each other but do indicate tendencies.

ATTRIBUTES	EXPRESSION	INTERPRETATION
nodules	present	raw material import/dissection and production on-site
	absent	raw material procurement and initialization off-site
cortex covered pieces	present/large amount	cortex removal/core preparation on-site
	absent	import of decortified/prepared cores
non-modified flakes	present/large amount	production waste, core preparation/blank production on-site
artifical debris	present/large amount	production waste, core preparation/blank production on-site
cores	present	preparation/blank production on-site
pre-prepared cores	present	import of semi-finished products
blades	large amount	import of (semi-finished) target products
proximal frags. of blades	present/predominating	reduction and fragmentation of blanks on-site
medial frags. of blades	present/predominating	import of target products
tools	large amount	import of target products
	secondary use	exploitation/long-term utilization of target products

Tab. 36 Simplified assortment of indicators interpreted in the context of the Rhenish Linear Pottery exchange system (KEGLER-GRAIEWSKY 2004, LÖHR ET AL. 1977, ZIMMERMANN 1998, ZIMMERMANN 1995). These indicators are taken in account as mobility-indicators in this study (cf. sections above).

Several authors assume raw material dispersal systems even though indications for direct access of the raw material source or exchange are missing (cf. also **5.3.1.2. Temper types and raw material origins** in this study; MARTÍNEZ ANDREU 2002, 59 for AL/MU; MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO 1999b, 245 for CNP/AL; LILLO CARPIO/LILLO CARPIO 1982-1983, 9-10 for Hoz/MU). MARTÍNEZ ANDREU (2002, 59), MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO (1999b, 245) and LILLO CARPIO/LILLO CARPIO (1982-1983, 9-10) even consider mining.

MARTÍNEZ ANDREU (2002, 57) suggests a raw material exchange as one option of how people of AL/MU acquired their lithic raw material needs (cf. **4.3.1. Varieties** and **4.3.2. Indirect approach: Primary vs. secondary flint provenances**). AFONSO MARRERO (1993, 470 and RESUMEN, p. 4) also mentioned the possibility of an exchange or direct acquisition from the source to receive the lithic tools, blanks or raw material: If people exploited the raw material directly by visiting the source, they could have initiated the reduction sequence there or in nearby ephemeral camps and continued the lithic production on-site. Contemporaneously, single pieces of differing sizes and techniques indicate a regional or supra-local production and thus an exchange system (cf. La Molaina/GR, El Polideportivo/Jaén and El Cerro de San Cristóbal/GR): Small blades are present in the assemblage, whereas the production of large blanks and all previous reduction stages took obviously place off-site, possibly at the raw material source – thus implying probable divergent exchanges. Lithic assemblages of younger ages prove an exchange of semi-finished products (cf. MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 15 footnote 11).

BERNABEU AUBÁN (2012, 105-106) suggests an increasing exchange of various products within a complex adaptive system and hierarchically structured networks. Raw materials circulated and information and technology were disseminated. People could have exchanged down the line, and thus with increasing distance, the raw material amount decreased. Thus, the effects of these exchanges could be comparable to the occurrences in the Linear Pottery lithic exchange (cf. **Tab. 36**).

VERA RODRÍGUEZ and MARTÍNEZ FERNÁNDEZ (2012) detected supra-local networks for jewelry. Coastal groups exploited marine resources and exchanged shells with settlements in the hinterland (cf. **3.4. Paleoenvironmental contextualization of the sites**) based on balanced reciprocity. People accepted distances of 70-100km for cinnabar/cinnabarite exchange in Málaga and Granada. ANTOLÍN/BUXÓ (2012, 99) think about crop exchange (cf. **2.3. The Neolithization of the W Mediterranean in its**

European context). During the later Neolithic and Chalcolithic exchanges became more evident (AGUAYO DE HOYOS/MARTÍNEZ FERNÁNDEZ/MORENO JIMENEZ 1989-90; RAMOS MILLÁN 1998). However, of course this dispersal of goods can be due to mobility and – keeping in mind the short-term camps (cf. **3.1.2.5. Evaluated sites and archaeological characterization**) – I tend to interpret it this way as in **Tab. 36**.

4.4.2. Cueva del Algarrobo/Murcia (AL/MU)

Apart from stage 0-artifacts of raw material procurement, indicators of all other stages are present.

4.4.2.1. AL/MU: Stage 1 – Cortex removal and preparation of core platform and reduction face

AL STAGE 1	flakes + cortex *n*	*%*	ratio on dorsal surface *≥ 2/3*	*complete*
pebble cortex	10	55.6%	7	3
chalky cortex	8	44.4%	7	1
Σ	18	100.0%	14	4
n.s.*	2	10.0%	2	

Tab. 37 AL/MU. Artifacts from stage 1 of the reduction sequence: Flakes with more than 2/3 cortex-ratio on the dorsal surface (n.s. = cortex not specified *refers to all stage 1-artifacts Σ=20).

Stage 1 is represented by 10 flakes with pebble cortex and eight are covered with chalky cortex (**Tab. 37**). Thus, the cortex removal of at least two different raw materials, one originating from a river and another from a primary source were decortified on-site. The majority of pieces with about two thirds cortex on their dorsal surface stem from a later cortex removal-stage. A quarter of the artifacts is completely covered with cortex on dorsal surface and represents the initial cortex removal.

Considering all artifacts with cortex remains, approximately a quarter of the inventory consists of artifacts at least partly covered with cortex (26.5%; **Tab. 38**) and amongst these the amount of pebble to chalky cortex is 2:3 with a dominance of approximately 60% with chalky cortex (cf. **Tab. 31** and **Fig. 6**). Cortex amounts decrease from flakes and blades to the other blanks. 34.7% of the flakes and only 15.7% of the blades – mostly non-modified blanks – have remains of cortex on their dorsal surfaces.

CORTEX/HEAT TREATMENT		flakes *unm.*	*mod.*	*Σ*	blades *unm.*	*mod.*	*Σ*	cores *unm.*	*mod.*	*Σ*	art. debris *unm.*	*mod.*	*Σ*	Σ*	
with cortex	*n*	78	16	94	23	7	30	2		2	8	2	10	136	
	%	83.0%	17.0%	69.1%	76.7%	23.3%	22.1%	100.0%		1.5%	80.0%	20.0%	7.4%	100%	26.5%
w/o cortex	*n*	138	39	177	124	37	161	10	3	13	22	4	26	377	
	%	78.0%	22.0%	46.9%	77.0%	23.0%	42.7%	76.9%	23.1%	3.4%	84.6%	15.4%	6.9%	100%	73.5%
with heat treatment	*n*	49	14	63	40	16	46	4	2	6	5		5	120	
	%	77.8%	22.2%	52.5%	87.0%	34.8%	38.3%	66.7%	33.3%	5.0%	100.0%		4.2%	100%	23.4%
w/o heat treatment	*n*	167	41	208	107	28	145	8	1	9	25	6	31	393	
	%	80.3%	19.7%	52.9%	73.8%	19.3%	36.9%	88.9%	11.1%	2.3%	80.6%	19.4%	7.9%	100%	76.6%

Tab. 38 AL/MU. Cortex coverage and heat treatment of unmodified (unm.) and modified (mod.) blanks (Σ* refers to the total assemblage n=513).

4.4.2.2. AL/MU: Stage 2 – Core preparation

4.4.2.2.1. Crested pieces and lateral core flakes

Stage 2 is similarly scarcely represented in the inventory with 16 crested flakes and blades and 13 lateral core flakes. Nine of the 16 crested flakes and blades remain from primary preparation of a ridge to initialize a reduction sequence (**Tab. 39B**).

The majority of lateral core flakes (nine pieces) is covered at least partly with cortex, thus indicating an initial stadium of core preparation. Whereas two have also a preparation of the dorsal surface, implying that this ridge preparation was insufficient to build sufficient convexities for blank production. This was corrected twice by reducing lateral core flakes.

DIRECTION DORSAL FLAKE SCARS	lat. core flakes *n*	*%*
parallel, unidirectional	8	72.7%
parallel, opposing	2	18.2%
transverse	1	9.1%
Σ	11	100.0%
*w/o**	*2*	*15.4%*

A

PREP. DORSAL SURFACE	crested pieces *n*	*%*
primary	9	60.0%
secondary	6	40.0%
Σ	15	100.0%
n.s.*	1	6.3%

B

Tab. 39 AL/MU. Artifacts from stage 2 of the reduction sequence: **A** – direction of dorsal flake scars of lateral core flakes (*reference amount: total of lateral core flakes Σ=13) and **B** – crested pieces with primary and secondary preparation of the dorsal surface (*reference amount: total of crested pieces Σ=16).

Most of the remaining lateral core flakes have regular dorsal flake scars (**Tab. 39A**) and remain from an initial phase of core reduction or preparation. In contrast the flake scars of one lateral core flake are transverse caused by the re-orientation of the core for further reduction and a later stadium in the sequence.

4.4.2.2.2. Cores and reduction technique

The cores present in AL/MU are mostly – as in all other Murcian and almost all other studied assemblages – shaped like a cone with a pointed base (**Tab. 40**). About two thirds of the cores in AL/MU have only one platform (**Tab. 55**). Most platforms only show one flake scar (**Tab. 71**) of the (re-)preparation with core tablets (cf. **4.4.2.4. AL/MU: Stage 4 – Re-preparation of the core**). But, as indicated by five cores with a platform that shows more than one flake scar, a removal of several flakes was obviously also conducted.

Cores are generally very small (**Tab. 44** cf. **Fig. 33**). The maximum edge length of 39mm is far below the values of the largest flakes and blades, thus showing a maintained removal of blanks and late discard of cores. Also, very few cores were modified to tools. These were probably too small.

CORE SHAPE	AL *n*	*%*	CH *n*	*%*	CZ *n*	*%*	Hoz *n*	*%*
conical	10	83.3%	3	60.0%	4	57.1%	5	62.5%
cylindrical			1	20.0%	1	14.3%	3	37.5%
irregular	2	16.7%	1	20.0%	2	28.6%		
Σ	12	100%	5	100%	7	100%	8	100%
n.s.*	3	20.0%	3	37.5%	1	12.5%		

Tab. 40 MU. Core shapes (*reference amount for the cores with shape not further specified (n.s.) is the total amount of cores in each assemblage AL=15; CH=8; CZ=8 and Hoz=8). In AM/MU no cores are present.

Besides several flakes and blades with rests of natural surfaces on the platform remnants, most flakes and blades are obviously removed from cores with plain striking platforms (**Tab. 41A**). A remarkable large amount of artifacts with a facetted platform remnant (16.5% of the flakes and 15.4% of the blades) show an additional preparation of the striking platform previous to blank reduction. The platform remnants of natural surface may stem from the initial core preparation and the preparation of the actual plain striking platform, i.e. these are trimming flakes. The artifacts with plain and facetted platform remnants show a regular preparation and creation of a striking platform previous to the removal of target products.

PLATFORM REMNANT TYPE	flakes *n*	flakes %	blades *n*	blades %
type determined	181	78.0%	91	65.5%
natural**	16	8.8%	4	4.4%
plain**	121	66.9%	68	74.7%
primary facetted**	2	1.1%		
secondary facetted**	16	8.8%	8	8.8%
facetted (n.s.)**	12	6.6%	6	6.6%
crushed**	14	7.7%	5	5.5%
w/o	51	22.0%	48	34.5%
Σ	232	100%	139	100%
n.s.*	39	14.4%	52	27.2%

A

PLATFORM REMNANT SHAPE	flakes *n*	flakes %	blades *n*	blades %
shape determined	219	81.1%	142	74.7%
oval**	86	39.3%	41	28.9%
point**	20	9.1%	37	26.1%
linear**	72	32.9%	40	28.2%
triangular**	20	9.1%	15	10.6%
rectangular**	2	0.9%	3	2.1%
irregular**	14	6.4%	3	2.1%
scarred (ventral)**	1	0.5%		
winged/wavy**	2	0.9%	2	1.4%
trapezoid**	2	0.9%	1	0.7%
w/o	51	18.9%	48	25.3%
Σ	270	100%	190	100%
n.s.*	1	0.4%	1	0.5%

B

Tab. 41 AL/MU. Types (**A**) and shapes (**B**) of platform remnants present on flakes and blades (*reference amount of the type/shape not specified (n.s.) is the total amount of flakes=271 and blades=191; the type and shape attributes refer to flakes and blades with type/shape determined).

DORSAL REDUCTION	flakes *n*	flakes %	blades *n*	blades %
with DR	79	35.9%	49	34.3%
w/o DR	141	64.1%	94	65.7%
Σ	220	100%	143	100%

Tab. 42 AL/MU. Flakes and blades with and without (w/o) dorsal reduction (DR).

In 35% of the cases blank removal required a slight reduction of the core and platform edges in advance and left a dorsal reduction on flakes and blades (**Tab. 42**). The reduction points to a hard hammer (cf. **Tab. 35**) and probably trimming pieces.

Two flakes and one core that were obviously heated previous to the removal (cf. **Tab. 52**) are probable signs of intentional heat treatment.

4.4.2.3. AL/MU: Stage 3 – Blank production

About 55% of the assemblage consists of very regular flakes and blades and originate obviously from stage 3 *sensu stricto* (according to the attributes in **Tab. 32**). 282 flakes and blades have no cortex and scanty further modification or use traces.

The whole blank assemblage consists of 52.8% flakes and 37.2% blades (**Tab. 34**). The index of flakes divided by the number of blades is 1.4 or a ratio of 3:2. These ratios indicate a reduction on-site and no additional import of blades as semi-finished products. Approximately 80% of the blanks remained non-modified (cf. **Tab. 34**) and most blanks are completely preserved: 53.1% of the flakes and 41.9% of the blades (**Tab. 43**). Besides the complete blanks, a quarter of flakes and blades consist of proximal fragments and indicate their reduction on-site. Distal and medial parts are underrepresented. Especially the rare amount of medial fragments could imply their application as insets for composite tools, which were taken off-site.

Removed blanks range in length between 4.5cm long blanks to less than 1cm , the latter of which are mostly small terminal blanks (cf. minimum/maximum values in **Tab. 44**, **Fig. 7** and **Fig. 8**). Thus, at least the terminal stage of the blank reduction sequence seems to be present on-site. Taking the maximum lengths of the products as starting point, cores with edge lengths of at least about 6cm were reduced. Whether this took place on-site or if the solitary large blank was imported, remains questionable. The latter seems more probable because of the gap in the histogram of lengths (**Fig. 7**).

Apparently, bigger flakes and blades were more frequently selected for modification (**Tab. 44** cf. **Tab. 49B**). Non-modified blanks are smaller in all dimensions. The mean length of modified blades is almost 0.5cm longer than non-modified flakes. Concerning other dimensions, modified blades are fairly fine with smaller mean values of width, thickness and weight. The variance in width is a general characteristic of flakes and blades in this inventory: Flakes and blades vary considerably (**Fig. 8**). Flakes (with a maximum width of 3-4cm) are much wider than blades. Blades measure less than 2cm in width. Generally blades are slightly longer, but most pieces of both blank types are 1-3cm long and 0.1-1cm thick.

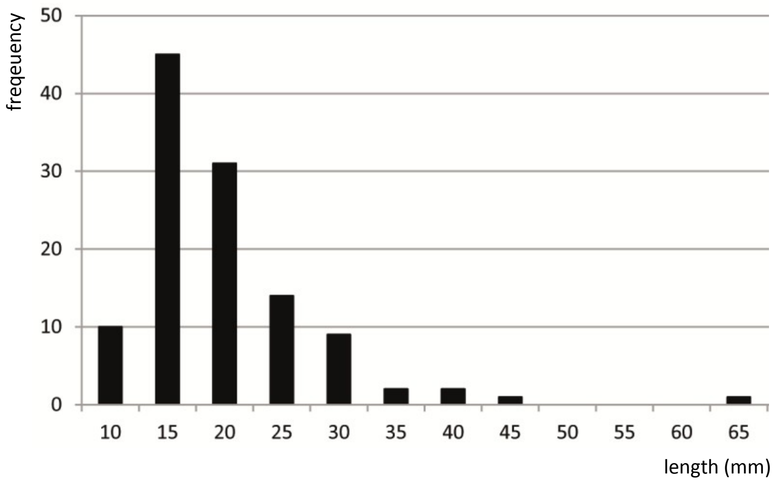


Fig. 7 AL/MU. Length of complete, regular flakes and blades (Σ=115) in 5mm-ranges (from 5-10mm, to 15 etc.).

BLANK FRAGMENTS	flakes						blades						Σ	
	unm.		*mod.*		*Σ*		*unm.*		*mod.*		*Σ*			
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
complete	125	57.9%	19	34.5%	144	53.1%	72	49.0%	8	18.2%	80	41.9%	224	48.5%
proximal	59	27.3%	17	30.9%	76	28.0%	44	29.9%	19	43.2%	63	33.0%	139	30.1%
distal	23	10.6%	5	9.1%	28	10.3%	15	10.2%	5	11.4%	20	10.5%	48	10.4%
medial	9	4.2%	14	25.5%	23	8.5%	16	10.9%	12	27.3%	28	14.7%	51	11.0%
Σ	216	79.7%	55	20.3%	271	100.0%	147	77.0%	44	23.0%	191	100.0%	462	100.0%

Tab. 43 AL/MU. Preservation of the unmodified (unm.) and modified (mod.) flakes and blades. The complete blanks consist also of 5 flakes and 4 blades that are incomplete in their width because of a modification.

DIMENSIONS	*n*	length (mm)				width (mm)				thickness (mm)				weight (g)			
		MIN	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*
flakes	271	7	63	16.8	6.789	2	38	14.3	5.578	1	20	4.4	2.560	0.1	36.8	1.4	2.826
unmod.	216	7	63	16.5	6.821	5	38	14.0	5.541	1	15	4.1	2.265	0.1	36.8	2.0	2.805
complete	125	7	63	17.1	7.649	5	38	14.8	6.274	1	15	4.2	2.376	0.1	36.8	1.4	3.575
mod.	55	9	43	18.0	6.576	2	28	15.7	5.568	1	20	5.7	3.195	0.1	19.0	2.1	2.824
complete	19	10	30	19.2	5.540	5	28	17.4	6.094	2	11	6.2	2.455	0.2	4.4	2.0	1.355
blades	191	5	54	19.0	6.598	3	20	7.4	3.126	1	24	3.2	2.524	0.1	9.0	0.6	0.977
unmod.	147	5	40	18.4	5.871	3	18	7.2	2.812	1	24	3.1	2.556	0.1	3.9	0.5	0.631
complete	72	12	39	19.8	5.986	3	18	7.2	3.038	1	24	3.2	2.877	0.1	3.9	0.5	0.681
mod.	44	7	54	20.8	8.433	4	20	8.3	3.926	1	12	3.7	2.391	0.1	9.0	1.0	1.631
complete	8	17	54	28.9	13.527	4	20	9.0	6.071	1	12	4.5	3.441	0.1	9.0	2.2	3.330
cores	15	10	39	23.4	7.576	9	31	16.1	6.151	7	30	12.8	5.685	1.1	44.0	7.3	10.674
unmod.	12	10	39	23.3	7.808	10	31	16.6	6.215	7	30	13.1	6.052	1.1	44.0	8.0	11.769
mod.	3	18	33	23.7	8.145	9	22	14.3	6.807	8	17	11.7	4.726	1.5	10.4	4.8	4.875
art. debris	36	10	39	18.5	6.470	5	38	12.7	6.118	2	13	5.6	2.181	0.2	8.5	1.6	1.853
unburned	26	10	39	18.0	6.779	5	38	12.7	6.833	2	13	5.7	6.833	0.2	8.5	1.6	2.116
burned	10	11	33	20.0	5.637	8	21	12.5	3.979	4	8	5.5	1.650	0.4	3.3	1.3	0.910

Tab. 44 AL/MU. Dimensions of unmodified (unmod.) and modified (mod.) blanks.

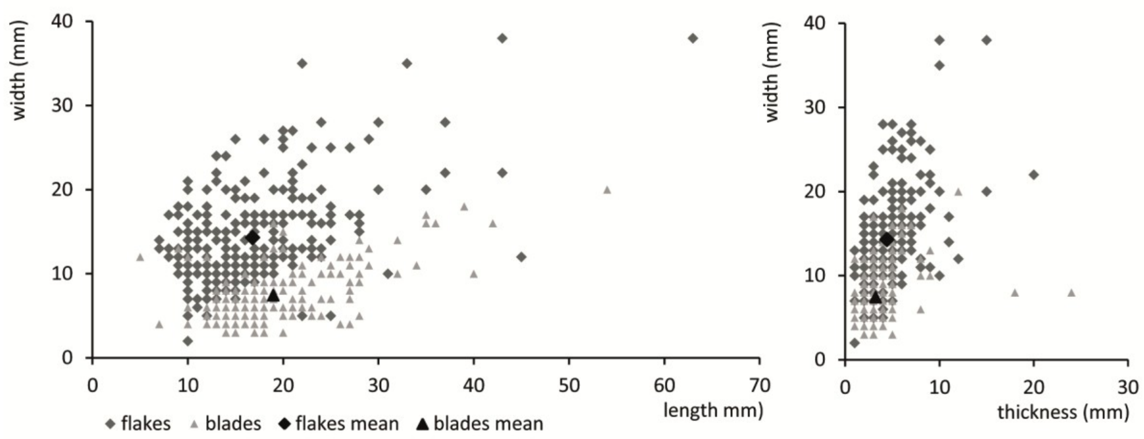


Fig. 8 AL/MU. Dimensions of all flakes and blades with mean values.

4.4.2.3.1. Percussion technique

The dominant amount of flakes and especially of blades is removed in a parallel, unidirectional way (**Tab. 45**). About 95% of the blades with dorsal flake scars determinable are regularly removed in parallel or bipolar directions. Only 5% indicate a turning of the core in a later stadium of the reduction sequence or a disordered removal. In contrast about 25% of the flakes are removed irregularly originating from a (re-)preparation or the ending core reduction.

The small cores obviously stem from the end or a late stage of the reduction sequence. They are characterized by at least two and up to five reduction faces (**Tab. 87**) and thus indicate a blank removal from all core faces. Additionally, they mostly show several directions of reduction (**Tab. 102**) and 21.4% even have a second, additional platform right-angled to the other platform (cf. **Tab. 55**).

Thus, after an initial regular, systematic removal of target products, the cores were turned during the final reduction stage to elongate the reduction process. As a result, several more, even though small, irregular blanks were gained.

DIRECTION DORSAL FLAKE SCARS	flakes *n*	flakes *%*	blades *n*	blades *%*
dorsal flake scars determined	231	86.2%	175	92.6%
parallel, unidirectional**	149	64.5%	146	83.4%
parallel,opposing**	15	6.5%	5	2.9%
bipolar *sensu lato***	9	3.9%	15	8.6%
unidirectional-transverse**	16	6.9%	3	1.7%
opposing-transverse**	2	0.9%	1	0.6%
transverse**	23	10.0%	3	1.7%
concentric**	1	0.4%		
other**	16	6.9%	2	1.1%
w/o	37	13.8%	14	7.4%
Σ	268	100%	189	100%
n.s.*	3	1.1%	2	1.0%

Tab. 45 AL/MU. Direction of dorsal flake scars of flakes and blades (*blanks with dorsal flake scars not specified (n.s.) refer to the total amount of flakes=271 and blades=191; **directions refer to blanks with dorsal flake scars determined).

IMPACT MARK	flakes *n*	flakes *%*	blades *n*	blades *%*
with impact ring	7	3.2%		
w/o impact ring	213	96.8%	142	100%
Σ	220	100%	142	100%
n.s.*			1	0.7%
with lip	15	6.8%	11	7.5%
w/o lip	205	93.2%	132	90.4%
Σ	220	100%	146	100%
with bulbar scar	53	24.1%	17	11.9%
w/o bulbar scar	167	75.9%	126	88.1%
Σ	220	100%	143	100%
with bulb	147	66.8%	77	53.8%
pronounced**	*35*	*23.8%*	*10*	*13.0%*
double**	*2*	*1.4%*		
diffuse**	*109*	*74.1%*	*65*	*84.4%*
splintered**	*1*	*0.7%*	*2*	*2.6%*
w/o bulb	73	33.2%	66	46.2%
Σ	220	100%	143	100%

Tab. 46 AL/MU. Impact marks on flakes and blades (*blanks with not further specified (n.s.) characteristics refer to the total amount of flakes/blades with proximal ending Σ=220/143; **bulb attributes refer to all blanks with bulb).

Amongst the impact marks, almost 70% of the flakes and more than 50% of the blades have a bulb and about 24% vs. 12% a bulbar scar (**Tab. 46**). Lip and impact ring are minor present.

The presence of dorsal reduction (cf. **Tab. 42**), pronounced bulbs on 23.8% of the flakes with bulb, bulbar scars and even impact rings on single flakes imply a removal of the corresponding artifacts with hard hammer percussion (cf. **Tab. 35**). Additionally, the presence of artifacts from stages 1 and 2 of the reduction sequence and the blanks with natural platform remnants (cf. **Tab. 41A**) are diagnostic of hard stone percussion and indicate a preparation and cortex removal on-site.

Besides these indicators, the large amount of diffuse bulbs, the few artifacts with lips, the bulbar scars and the large amount of fine, pointed, pointed-oval or linear platform remnants (54.3% of the blades with platform remnant and 42% of the flakes; **Tab. 41B**) furthermore implies a removal of target products with soft or even organic hammer (cf. **Tab. 35**).

4.4.2.4. AL/MU: Stage 4 – Re-preparation of the core

Nineteen plunging flakes and blades and one core tablet prove core re-preparation on-site. Although nothing concrete about the raw material origins and availability can be said, the pebbles originated likely from the proximity and were good accessible in river beds (cf. **Tab. 37** and **4.4.2.1. AL/MU: Stage 1 – Cortex removal and preparation of core platform and reduction face**). Nevertheless, stage 4-artifacts present on-site indicate an exploitation of the raw material and *no* preliminary discarding.

The directions of dorsal flake scars of plunging flakes and blades have various directions and show a decreasing regularity in the reduction compared to the blanks of stage 3 (cf. **Tab. 47A** and **Tab. 45**). Only ca one third of the dorsal flake scars of plunging flakes and blades are dispersed in an unidirectional way. Besides this dispersal, several other directions are present and imply that the core was already re-oriented previous to the re-preparation. Thus, the blank productions (stage[s] 3) aimed at the removal of as many blanks as possible previous to a re-preparation.

DIRECTION DORSAL FLAKE SCARS	plunging pieces *n*	*%*
parallel, unidirectional	7	36.8%
parallel, opposing	2	10.5%
bipolar *sensu lato*	2	10.5%
unidirectional-transverse	2	10.5%
opposing-transverse	1	5.3%
other	5	26.3%
Σ	19	100.0%

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	17.9	5.363	10	28
width	14.8	5.418	5	26
thickness	6.0	2.103	3	11
weight	1.5	0.943	0.3	3.4

B

Tab. 47 AL/MU. Artifacts from stage 4 of the reduction sequence: **A** – direction of flake scars on the dorsal surfaces of plunging flakes and blades and **B** – dimensions of core tablets *and* plunging flakes and blades.

The single core tablet was removed parallel to the former platform; i.e. the dorsal flake scars of the core tablet are parallel and unidirectional. The presence of only one core tablet is striking, while core platforms of the reduced cores are mostly plain and remained consequently from only one flake removal (**Tab. 71** and cf. **4.4.2.2.2. Cores and reduction technique**). Thus, these striking platforms could remain from the primary core preparation in stage 2 or arrived in AL/MU in an already re-prepared state.

A comparison of stage 3-blanks to core tablets and plunging flakes (**Tab. 47B**) shows a decreasing core length of ca 1.5-3cm during blank production in stage 3. Small cores at about 3cm length were re-prepared for another reduction sequence. However, no gaps occur in the frequencies of length ranges of the target products. No single reduction cycles with re-preparation phases in between can be identified (cf. **Fig. 7**).

4.4.2.5. AL/MU: Stage 5 – Modification and use

Of 108 tools approximately 25% have an additional intentional modifications (**Tab. 51**). Furthermore, 64 unmodified pieces show macroscopically visible use traces. Thus, these artifacts were probably used on-site and people repaired tools and exchanged lithic inserts.

4.4.2.5.1. 5a – Intentional modification

A total of 108 pieces (21.1% of the artifacts) is intentionally modified into tools (**Tab. 48**). Splintered pieces, end scrapers and projectiles are predominant and indicate the processing of goods (e.g. hide) and tool maintenance (projectile point replacement). The seven burins were likely imported to AL, because burin spalls are missing and do not proof the processing of burins in situ. The low Simpson index (D) implies a high diversity of tool types.

TOOL TYPES	n	%	0 ratio % 40
projectiles	20	18.5%	
borers	2	1.9%	
burins	7	6.5%	
truncations	9	8.3%	
end scrapers	27	25.0%	
lateral retouches	10	9.3%	
splintered pieces	29	26.9%	
notched pieces	1	0.9%	
denticulates	1	0.9%	
others	2	1.9%	
Σ n	108	100%	
% tools/assemblage		*21.1%*	D = 0.182

Tab. 48 AL/MU. Tools: Absolute number, amount of each tool type, tool ratio referring to the total assemblage and Simpson diversity index (D).

The tools consist of 62 modified, regular flakes and blades of stage 3, 24 flakes and blades with irregular or without (visible) direction of the dorsal flake scars, 13 flakes and blades with cortex, six artificial chunks partly with cortex and three cores. Among the tools modified flakes predominate slightly over blades (55 vs. 44; cf. **Tab. 34**). But despite this majority of flakes and blades (90%), several tools apparently demanded opportunistic forms as artificial debris or cores. Or these pieces were possibly randomly picked for tools to deal with resources or goods righ away. They were by chance available in time and fitted more or less to the intended function.

DIRECTION DORSAL FLAKE SCARS	tools n	%
parallel, unidirectional	51	60.7%
parallel, opposing	7	8.3%
bipolar *sensu lato*	9	10.7%
unidirectional-transverse	4	4.8%
opposing-transverse	1	1.2%
transverse	7	8.3%
other	5	6.0%
Σ	84	100.0%
*w/o**	*15*	*15.2%*

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	19.4	7.453	7	54
width	12.6	6.027	2	28
thickness	5.1	3.286	2	20
weight	1.7	2.557	0.1	19.0

B

Tab. 49 AL/MU. Artifacts from stage 5a of the reduction sequence: **A** – direction of dorsal flake scars of the tools (*reference amount: tools made of flakes and blades Σ=99) and **B** – dimensions all 108 tools.

Unidirectional dorsal flake scars occur on 60% of the tools (made of flakes or blades). In comparison to all flakes and blades with an amount of 73%, the amount of tools with unidirectional dorsal flake scars is relatively low (**Tab. 49** cf. **Tab. 45**). This difference indicates that not all tools necessarily require absolute regular blanks in our current sense.

USE TRACES	use traces	other mod.	Σ (n pieces) n	%	*reference amount*
flakes	19	4	23	10.7%	216
blades	38	2	40	27.2%	147
art. debris					30
cores	1		1	8.3%	12
1x ut.	58	6	**64**	15.8%	405
2x ut.	13	3	16		
Σ (n ut.)	71	9	80		

Tab. 50 AL/MU. Macroscopically visible use traces (ut.) on pieces without intentional tool modification. The artifacts are listed according to the blank type and refer to unmodified blanks in the assemblage. Several pieces show additional use traces (2x ut. = with two ut.; reference amount = all unmodified pieces Σ=405).

4.4.2.5.2. 5b – Use

In addition to the 108 tools, 64 pieces show fine, macroscopically visible use traces (**Tab. 50**). 172 artifacts or 33.5% of the assemblage were used. I recorded 80 use traces on 64 pieces. These traces unfold a slightly dominant use of non-modified blades (27.2% with use traces) prior to flakes (10.7%; **Tab. 50Tab. 50**).

Macroscopically, these use traces cannot be assigned to specific activities.

4.4.2.5.3. 5c – Resharpening

About 25% of the tools have one to three additional modifications (**Tab. 51**). Especially most of the burins are combined tools with one additional modification that is (besides additional burin blows) a truncation, splintered piece or denticulation. A few pieces with a lateral retouch are present (cf. Σ** in **Tab. 51**), but tools with another "main"-modification were often (13 times) additionally laterally retouched.

TOOL TYPES	ADDITIONAL MODIFICATIONS 1	2	3	*Σ n*	*%**	*%***	*Σ***	burins	truncations	end scrapers	lateral retouches	splintered pieces	denticulates
projectiles							20						
borers							2						
burins	5			5	18.5%	71.4%	7	2	1			1	1
truncations	3		1	4	14.8%	44.4%	9		1	1	4		
end scrapers	5	1	1	7	25.9%	25.9%	27		2	1	6	1	
lateral retouches	2	2		4	14.8%	40.0%	10		1		3	2	
splintered pieces	5	1		6	23.1%	20.7%	29					7	
notched pieces							1						
denticulates							1						
others							2						
Σ n	20	4	2	**26**	100%	24.1%	108	2	5	2	13	11	1
%	76.9%	15.4%	7.7%	100%									

Tab. 51 AL/MU. Tools and additional modifications (*referring to total amount of tools with additional modifications Σ=26; **referring to total number of each tool type Σ**).

Thus, at least a quarter of the tools was re-modified and intensively (re-)used.

The explicit modification or resharpening of burins cannot be confirmed in situ, because burin spalls are lacking (cf. **4.4.2.5.1. 5a – Intentional modification**).

4.4.2.6. AL/MU – Stage 6 – Discard

126 pieces are exhausted cores without modifications, burned unused blanks and burned damaged tools (cf. **Tab. 32** and **Tab. 32**).

A quarter of the inventory is burned (cf. **Tab. 42**). Color changes and heat pitting as well as the combination of both with fissures are most frequent (**Tab. 53**). The contact with fire took mostly place after flakes and blades were removed from the core or after their modification to tools, i.e. when they were discarded (**Tab. 52**).

TIME HEAT TREATMENT	flakes *n*	flakes *%*	blades *n*	blades *%*	cores *n*	cores *%*	art. debris *n*	art. debris *%*	Σ *n*	Σ *%*
raw material heated	2	3.3%			1	33.3%			3	2.8%
heated after blank removal	40	66.7%	21	63.6%	2	66.7%			63	59.4%
thermal fracture	6	10.0%	4	12.1%			8	80.0%	18	17.0%
heated after modification	12	20.0%	8	24.2%			2	20.0%	22	20.8%
total with heat treatment	60	100.0%	33	100.0%	3	100.0%	10	100.0%	106	100.0%

Tab. 52 AL/MU. Time of heat treatment on blank types.

EFFECT HEAT TREATMENT	MURCIA								ALMERÍA						GRANADA		MÁLAGA			
	AL		AM		CH		CZ		Hoz		CA		CNP		Car		A6 EPI		A6 NEO	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
color change	21	20.4%	2	13.3%	4	11.8%	11	5.8%	6	12.5%	128	19.3%	18	13.8%	71	24.8%	58	16.2%	76	16.1%
fissures	11	10.7%	2	13.3%	1	2.9%	10	5.3%	7	14.6%	7	1.1%			2	0.7%	4	1.1%	7	1.5%
heat pitted	21	20.4%	1	6.7%	8	23.5%	13	6.9%	2	4.2%	64	9.7%	5	3.8%	14	4.9%	21	5.8%	14	3.0%
color change and fissures	10	9.7%	3	20.0%	4	11.8%	19	10.1%	11	22.9%	51	7.7%	9	6.9%	16	5.6%	25	7.0%	31	6.6%
color change and heat pitted	8	7.8%	1	6.7%	6	17.6%	17	9.0%	1	2.1%	281	42.4%	49	37.7%	100	35.0%	117	32.6%	135	28.7%
fissures and heat pitted	17	16.5%	1	6.7%	4	11.8%	26	13.8%	6	12.5%	15	2.3%	3	2.3%	4	1.4%	6	1.7%	5	1.1%
color change, fissures, heat pitted	15	14.6%	5	33.3%	7	20.6%	83	43.9%	15	31.3%	104	15.7%	21	16.2%	72	25.2%	82	22.8%	153	32.5%
gloss							10	5.3%			13	2.0%	25	19.2%	7	2.4%	46	12.8%	50	10.6%
total with heat treatment	103	100.0%	15	100.0%	34	100.0%	189	100.0%	48	100.0%	663	100.0%	130	100.0%	286	100.0%	359	100.0%	471	100.0%
n.s.	3	2.8%	1	6.3%							1	0.2%			1	0.3%			1	0.2%

Tab. 53 Effects of heat treatment in the assemblages.

4.4.2.7. AL/MU – Summary: Reconstruction of the reduction sequence

The assemblage of AL is fairly large. However, no nodules indicate a direct acquisition of the raw materials. The few artifacts associated with stage 1 and 2 prove the initial cortex removal and core preparation in small proportions. Especially the preparation of core shape, platforms, reduction faces and ridges with crested flakes and blades and dorsal reduction took definitively place *in situ*. Cortex removal could have taken place off-site.

Most artifacts are obviously rests from the blank removal. But the dimensions indicate foremost the reduction of small initial cores or of already reduced cores of less than 4.5cm edge length. Possibly, hunter-gatherers brought already initiated, reduced cores for further reduction to the site. Alternatively, the larger blanks, which are missing, could have been modified and taken off-site. The small blanks, useless for further modification, were discarded on-site.

Most blanks were removed in a regular way, but reduction sequences were elongated by turning and total exploitation of the cores in various removal directions. Both indicators of soft and also for hard hammer are present in the inventory and indicate an application adapted to the purposes.

Subsequently, reduced cores at about 3cm edge length were re-prepared and show re-orientations during this process. Thus, the exploitation of the core was extended and an additional reduction stage started. This does not mandatorily imply a shortage, but parsimony in raw material use is indicated.

In total 33.5% of the artifacts in level 1 of AL/MU were used as intentionally modified tools (108) and as blanks with macroscopically visible use traces (64 pieces). 24.1% of the tools show more than one modification. This indicates intense use or resharpening on-site. After all, the tools imply tool production on-site and in addition various handcraft-activities on-site. Furthermore, the discarded tools indicate the repair and replacement of lithic insets in composite tools.

4.4.3. Abrigo del Monje/Murcia (AM/MU)

4.4.3.1. AM/MU: Stage 1 – Cortex removal and preparation of core platform and reduction face

In this small assemblage only one flake (ID 5832) with approximately two thirds chalky cortex on the dorsal surface could represent stage 1. It shows a previous cortex removal off-site. This artifact was modified into a burin and rounded ridges imply usage. Assumingly, this tool was carried on-site and, consequently, this piece can *not* serve as an indicator for stage 1. The cortex removal and initial core preparation is also absent in AM. Prepared cores were possibly imported.

Generally 20.9% of the artifacts show cortex coverage (**Tab. 54**). Pebble cortex (61.5%) slightly dominates compared to chalky cortex (38.5%; cf. **Tab. 31** and **Fig. 6**). But the cortex type could not be specified at a third of the artifacts with cortex. Cortex remained mostly on non-modified flakes and blades (**Tab. 54**).

CORTEX/HEAT TREATMENT		flakes			blades			art. debris			Σ*	
		unm.	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*		
with cortex	*n*	10	4	14	4	1	5					19
	%	71.4%	28.6%	73.7%	80.0%	20.0%	26.3%				100%	20.9%
w/o cortex	*n*	39	6	45	20	3	23	2	2	4		72
	%	86.7%	13.3%	62.5%	87.0%	13.0%	31.9%	50.0%	50.0%	5.6%	100%	79.1%
with heat treatment	*n*	9	2	11	4	1	5					16
	%	81.8%	18.2%	68.8%	80.0%	20.0%	31.3%				100%	17.6%
w/o heat treatment	*n*	40	8	48	20	3	23	2	2	4		75
	%	83.3%	16.7%	64.0%	87.0%	13.0%	30.7%	50.0%	50.0%	5.6%	100%	82.4%

Tab. 54 AM/MU. Cortex coverage and heat treatment of unmodified (unm.) and modified (mod.) blanks. The Σ* of artifacts with or without cortex or heat treatment refers to the total assemblage n=91.

4.4.3.2. AM/MU: Stage 2 – Core preparation

4.4.3.2.1. Crested pieces and lateral core flakes

A crested flake (ID 5908, 15.4g), a crested, plunging blade (ID 5903) and three lateral core flakes (IDs 5274, 10.2g; 5277; 5278) indicate core preparation on-site. The high mean weight of the five pieces (Ø=8.1g) implies a rough preparation of the core. Both crested pieces have a primary preparation of the dorsal surface. The dorsal flake scars of the plunging blade are regular unidirectional, whereas the flake is additionally covered with irregular dorsal flake scars with other removal directions. These flake scars came from a slightly later stadium of the reduction, when the core was already re-oriented during blank removal. Or this piece with multi-directional dorsal flake scars indicates an irregular core preparation.

The two lateral core flakes with cortex coverage stem from an earlier phase of the core preparation. One lateral core flake with unidirectional dorsal flake scars also has a partial primary preparation that remained from a ridge preparation and initiation of a reduction sequence as in AL/MU (cf. **4.4.2.2. AL/MU: Stage 2 – Core preparation**).

PLATFORMS (n)	AL		CH		CZ		Hoz	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*
with platform	14	93.3%	6	85.7%	8	100%	8	100%
1**	9	64.3%	5	83.3%	2	25.0%	7	87.5%
2 opposing**	1	7.1%			1	12.5%		
2 right-angled**	3	21.4%	1	16.7%	2	25.0%	1	12.5%
> 2**	1	7.1%			3	37.5%		
0	1	6.7%	1	14.3%				
Σ	15	100%	7	100%	8	100%	8	100%
n.s.*			1	12.5%				

Tab. 55 *(on the previous page!)* MU. Core platforms (*reference amount for the cores in CH with platform not further specified (n.s.) is the total amount of cores CH=8; **platform numbers and attributes refer to cores with platform). No cores remain from AM/MU.

4.4.3.2.2. Cores and reduction technique

Crested and plunging pieces, lateral core flakes and core tablets prove that cores must have existed once in AM/MU. Considering a low amount of 2% cores as in CZ/MU (cf. **Tab. 34**), one could expect one or two cores. The lack of cores is likely owed to the small inventory. Alternatively, the cores were possibly taken to another site for continued reduction or as tools.

However, the platform remnants of flakes and blades are mostly plain (**Tab. 56A**) and indicate a (re-)preparation of the core with one trimming flake or core tablet. Faceting of the striking platform was also common: 19.5% of the flakes and 22.2% of the blades have facetted platform remnants.

PLATFORM REMNANT TYPE	flakes		blades	
	n	*%*	*n*	*%*
type determined	36	70.6%	9	50.0%
natural**	1	2.8%		
plain**	28	77.8%	7	77.8%
secondary facetted**	4	11.1%	1	11.1%
facetted (n.s.)**	2	5.6%		
natural+secondary facetted**	1	2.8%	1	11.1%
w/o	15	29.4%	9	50.0%
Σ	51	100%	18	100%
n.s.*	8	13.6%	10	35.7%

A

PLATFORM REMNANT SHAPE	flakes		blades	
	n	*%*	*n*	*%*
shape determined	43	74.1%	19	67.9%
oval**	9	20.9%	5	26.3%
point**	3	7.0%	4	21.1%
linear**	15	34.9%	8	42.1%
triangular**	2	4.7%	1	5.3%
irregular**	7	16.3%		
rhombic**	2	4.7%		
winged/wavy**	2	4.7%	1	5.3%
trapezoid**	3	7.0%		
w/o	15	25.9%	9	32.1%
Σ	58	100%	28	100%
n.s.*	1	1.7%		

B

Tab. 56 AM/MU. Types (**A**) and shapes (**B**) of platform remnants of flakes and blades (*reference amount of the type/shape not specified (n.s.) is the total amount of flakes=59 and blades=28; **the type and shape attributes refer to flakes and blades with type/shape determined).

DORSAL REDUCTION	flakes		blades	
	n	*%*	*n*	*%*
with DR	26	59.1%	16	84.2%
w/o DR	18	40.9%	3	15.8%
Σ	44	100%	19	100%

Tab. 57 AM/MU. Flakes and blades with and without (w/o) dorsal reduction (DR).

Dorsal reduction is present on approximately 60% of the flakes and 85% of the blades (**Tab. 57**) and provides one indicator for a hard stone percussion (cf. **Tab. 35**).

5.4.2.3. AM/MU: Stage 3 – Blank production

64.8% of the 91 artifacts of AM are flakes and 30.8% are blades (**Tab. 34**). Flakes dominate blades by a ratio of 2:1 (index: 2.1). Fifty-two artifacts thereof are very regularly removed and do not have cortex remains (cf. **Tab. 32**, column 3).

Blank fragments are dominated by complete and proximal parts (**Tab. 58**). Medial fragments were possibly used as insets into a haft.

BLANK FRAGMENTS	flakes						blades						Σ	
	unm.		*mod.*		*Σ*		*unm.*		*mod.*		*Σ*			
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
complete	22	44.9%	1	10.0%	23	39.0%	8	33.3%			8	28.6%	31	35.6%
proximal	16	32.7%	5	50.0%	21	35.6%	9	37.5%	2	50.0%	11	39.3%	32	36.8%
distal	7	14.3%	1	10.0%	8	13.6%	4	16.7%			4	14.3%	12	13.8%
medial	4	8.2%	3	30.0%	7	11.9%	3	12.5%	2	50.0%	5	17.9%	12	13.8%
Σ	49	83.1%	10	16.9%	59	100.0%	24	85.7%	4	14.3%	28	100.0%	87	100.0%

Tab. 58 AM/MU. Preservation of the unmodified (unm.) and modified (mod.) flakes and blades. The complete blanks consist amongst others of 2 non-modified flakes that are complete in length (in direction of percussion) but incomplete in their width.

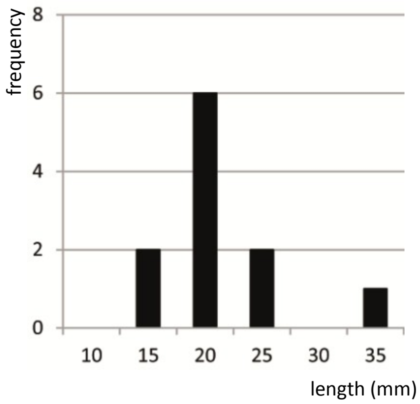


Fig. 9 AM/MU. Lengths of complete and regular flakes and blades in 5mm-ranges (from 5-10mm, to 15 etc.; Σ=11).

The lengths of the blank types are similar. Weights and width of the blank types are more diverse: Flakes are larger than blades. Modified flakes and blades are generally larger than their non-modified counterparts (**Tab. 59**). But, considering only complete blanks, they have the largest mean values. The width ranges very widely (**Fig. 10**). Flakes have a larger span in length and thickness, whereas blades are more clustered.

The maximum values of flakes and blades are fairly small. Flakes and blades must stem from small cores (cf. **Fig. 9**). One can assume that the cores were smaller possibly caused by smaller starting nodules or the cores came to AM in an already reduced status and consequently the initial reduction sequence had taken place off-site. The underrepresentation of stage 1-artifacts supports that (**4.4.3.1. AM/MU: Stage 1 – Cortex removal and preparation of core platform and reduction face** and stage 4 **4.4.3.4. AM/MU: Stage 4 – Re-preparation core**). On-site, people continued the reduction of small blanks. Alternatively, larger blanks could have been carried away to a subsequent camp. So far the estimated maximal edge length of cores is at about 3.5-4cm.

DIMENSIONS	*n*	length (mm)				width (mm)				thickness (mm)				weight (g)			
		MIN	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*
flakes	59	5	60	21.8	11.057	5	49	20.3	10.165	1	12	5.5	3.207	0.1	20.5	3.3	4.361
unmod.	49	7	60	21.1	10.481	5	49	19.6	9.947	1	12	5.2	3.248	0.1	20.5	3.0	4.268
complete	22	8	60	24.6	12.861	9	49	21.4	10.536	2	12	5.9	3.629	0.3	20.5	4.1	5.603
mod.	10	5	53	25.2	13.645	12	47	23.7	11.076	2	10	6.6	2.875	0.1	15.4	5.1	4.617
complete	1	32	32	32.0		19	19	19.0		9	9	9.0		4.5	4.5	4.5	
blades	28	10	65	21.5	10.963	3	16	7.8	3.128	1	6	2.6	1.370	0.1	6.6	0.7	1.244
unmod.	24	10	65	21.3	11.407	5	16	8.0	2.851	1	6	2.7	1.435	0.1	6.6	0.7	1.341
complete	8	13	65	25.3	16.935	5	14	8.3	3.536	1	6	3.3	2.121	0.1	6.6	1.3	2.202
mod.*	4	15	35	22.8	9.032	3	14	7.0	4.967	1	3	2.3	0.957	0.1	0.7	0.5	0.252
art. debris**	4	14	24	18.8	4.992	4	20	11.5	6.609	3	12	7.3	3.686	0.1	3.7	1.7	1.543

Tab. 59 AM/MU. Dimensions of unmodified (unmod.) and modified (mod.) blanks. *All modified blades are incomplete and **all pieces of artificial debris are not burned.

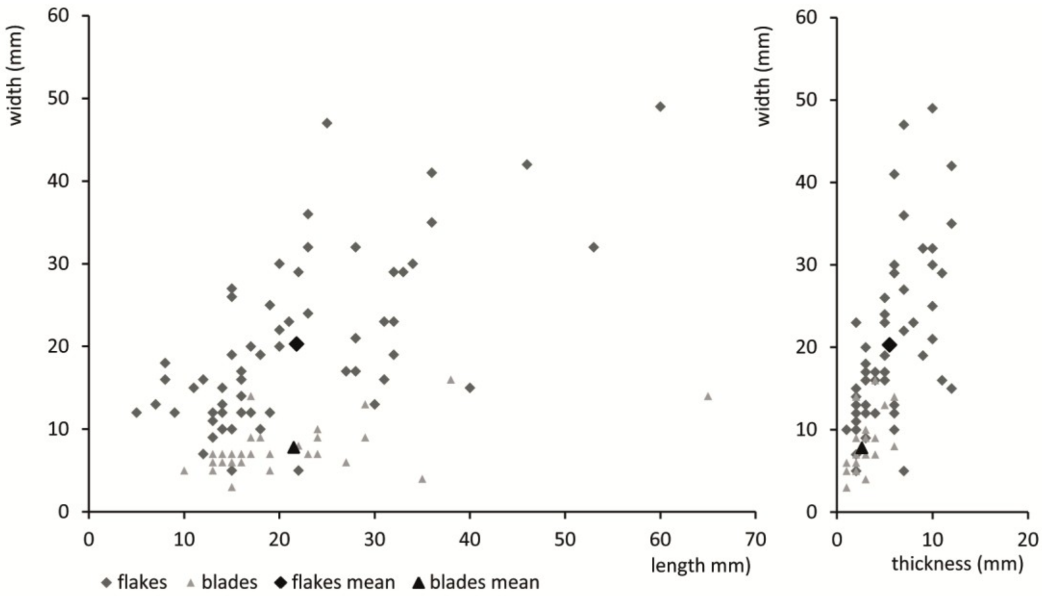


Fig. 10 AM/MU. Dimensions of flakes and blades.

4.4.3.3.1. Percussion technique

DIRECTION DORSAL FLAKE SCARS	flakes		blades	
	n	*%*	*n*	*%*
dorsal flake scars determined	58	98.3%	27	96.4%
parallel, unidirectional**	32	55.2%	23	85.2%
parallel,opposing**	1	1.7%		
bipolar sensu lato**	3	5.2%	4	14.8%
unidirectional-transverse**	12	20.7%		
opposing-transverse**	1	1.7%		
transverse**	4	6.9%		
other**	5	8.6%		
w/o	1	1.7%	1	3.6%
Σ	59	100%	28	100%

Tab. 60 AM/MU. Direction of dorsal flake scars of flakes and blades (**directions refer to blanks with dorsal flake scars determined).

62.1% of the flakes were regularly removed in a parallel or bipolar way (**Tab. 60**). The rest of almost 40% was irregularly removed in changing directions. In contrast, all blades were regularly removed without exception. The irregular flakes possibly stem from preparation processes. Alternatively, these pieces could have been removed during a later state of the reduction sequence, when the core had to be re-oriented.

Large amounts of flakes and blades have bulbs, impact lips or bulbar scars (**Tab. 61**). Most bulbs are diffuse. In combination with the other previously mentioned characteristics and the many pointed, pointed-oval and linear fine platform remnants (**Tab. 56B**), these attributes could result from the use of a soft hammer, i.e. a soft stone or even an organic hammer (cf. **Tab. 35**).

IMPACT MARKS	flakes		blades	
	n	*%*	*n*	*%*
with impact ring	3	6.8%		
w/o impact ring	41	93.2%	19	100%
with lip	16	36.4%	9	47.4%
w/o lip	29	65.9%	10	52.6%
with bulbar scar	9	20.5%	7	36.8%
w/o bulbar scar	35	79.5%	12	63.2%
with bulb	26	59.1%	14	73.7%
pronounced**	*5*	*19.2%*	*1*	*7.1%*
diffuse**	*20*	*76.9%*	*12*	*85.7%*
splintered**	*1*	*3.8%*	*1*	*7.1%*
w/o bulb	18	40.9%	5	26.3%

Tab. 61 AM/MU. Impact marks on flakes and blades (refer to the total amount of flakes/blades with proximal ending Σ=44/19; **bulb attributes refer to all blanks with bulb).

But, of course, indicators of preparation and cortex removal by hard hammers also occur: Dorsal reduction is frequent, pronounced bulbs exist, wide, partly irregular platform remnants and even very few impact rings could imply the percussion with a hard stone.

4.4.3.4. AM/MU: Stage 4 – Re-preparation core

DIMENSIONS	*L*	*W*	*T*	*We (g)*
core tablet (5282)	22	8	6	0.9
core tablet (5828)	17	12	6	1.1
core tablet (5878)	40	15	12	4.6
plunging blade (5903)	65	14	6	6.6
Ø	36.0	12.3	7.5	3.3
SD	21.710	3.096	3.000	2.780

Tab. 62 AM/MU. Dimensions of artifacts remaining from stage 4 of the reduction sequence (ID bracketed; LxWxT in mm).

Three core tablets and one plunging blade with parallel unidirectional dorsal flake scars remain from stage 4. The core tablets were removed parallel or transversal to the former platform (unidirectional and transversal dorsal flake scars).

Within the whole assemblage and compared with the pieces from stage 3 (cf. **Tab. 59** and **Tab. 62**), these artifacts are extraordinary large – especially the plunging blade with 6.5cm length (**Tab. 62**). Thus, larger nodules and cores as starting points for the initial reduction are likely.

TOOL TYPES	*n*	%
projectiles	3	18.8%
burins	2	12.5%
truncations	3	18.8%
end scrapers	1	6.3%
lateral retouches	1	6.3%
splintered pieces	5	31.3%
denticulates	1	6.3%
Σ n	16	100%
% tools/assemblage		*16.8%*

D = 0.142

Tab. 63 AM/MU. Tools: Absolute number, amount of each tool type, tool ratio referring to the total assemblage and Simpson diversity index (D).

One can assume that the cortex removal and preparation of cores and the first blank production process took place off-site at the previous camp: Several already reduced cores were brought to AM/MU. These pieces had already passed stages 1-3. On-site, they were re-prepared to start a secondary and continued reduction sequences. Thus, larger pieces originate from a re-preparation and the blanks of the subsequent reduction were smaller.

4.4.3.5. AM/MU: Stage 5 – Modification and use

55% of the total amount of artifacts were intentionally retouched or irregular, fine traces demonstrate the use beside the usual modification. Approximately half of the tools have more than one tool ending. Thus, most artifacts were intensely used for various handcrafts. Repairing of tools also took place on-site.

4.4.3.5.1. 5a – Intentional modification

The tool amount is comparatively low in the assemblage of AM/MU (16.8%; **Tab. 63**). As in many of the other assemblages, splintered pieces are also the dominant tool type in AM/MU. Second most frequent are projectiles and truncations with three pieces each. Despite the two burins, no burin spall remained. Thus, some handcraft activity such as hide scraping can be assumed. Congruently, the observation of a few red ocher traces supports this hypothesis (**4.4.3.5.2. 5b – Use**; **Tab. 65**). Projectiles imply the repeated repairing of arrows by exchanging inserts.

Despite the low amount of tools, eight tool categories are present (**Tab. 63**). The high diversity of the inventory, which is expressed by the Simpson index, is surely skewed by the small assemblage.

In comparison to the regular flakes of stage 3 (**Tab. 59** and **Tab. 60**), the variance in the tool dimensions exceeds (**Tab. 64**). The tools have larger mean and maximum values than non-modified blanks. Apparently, the tools that were discarded in AM originated from initial reductions of large blanks that took place off-site. These large inserts were exchanged on-site.

DIRECTION DORSAL FLAKE SCARS	tools n	%
parallel, unidirectional	9	69.2%
unidirectional-transverse	2	15.4%
other	2	15.4%
Σ	13	100.0%
*w/o**	*1*	*7.1%*

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	23.9	11.610	5	53
width	17.9	11.795	3	47
thickness	5.6	3.010	3	10
weight	3.5	4.190	0.1	15.4

B

Tab. 64 AM/MU. Artifacts from stage 5a of the reduction sequence: **A** – direction of dorsal flake scars of the tools (*reference amount: total of tools Σ=14) and **B** – dimensions of the tools.

The 16 tools were predominantly made of flakes. In addition to the five regular flakes and blades (cf. **5.4.2.3. AM/MU: Stage 3 – Blank production**), several other flakes and blades (cf. **Tab. 64**) with cortex and chunks were modified. 16.9% of the flakes and 14.3% of blades are modified (**Tab. 34**).

4.4.3.5.2. 5b – Use

Around 50% of the artifacts were possibly used: Besides 16 tools, 34 artifacts have use traces: Large amounts of 42.9% of the non-modified flakes and 54.2% of the non-modified blades (**Tab. 65**) were used. Fine traces are macroscopically visible on the edges. Two pieces have traces of red ocher showing a treatment of pigments and once a polished section.

USE TRACES	red ocher traces	use traces	other mod.	polish	Σ (n pieces) *n*	*%*	*reference amount*
flakes		18	3		21	42.9%	49
blades		13			13	54.2%	24
art. debris							2
1x ut.		31	3		**34**	45.3%	75
2x ut.	1	6	1	1	9		
3x ut.	1				1		
Σ (n ut.)	2	37	4	1	44		

Tab. 65 AM/MU. Macroscopically visible use traces (ut.) on pieces without intentional tool modification. The artifacts are listed according to the blank type and refer to unmodified blanks in the assemblage. On nine pieces, more than one specific use trace remain (2x ut. etc.; mod. = modification). The reference amount is all unmodified pieces.

4.4.3.5.3. 5c – Resharpening

Six tools of the small tool assemblage have more than one modification and possibly imply resharpening (**Tab. 66**).

4.4.3.6. AM/MU: Stage 6 – Discarding

17 flakes and blades were damaged by fire: Changes in color of and thermal fissures on the artifacts occur (**Tab. 53**). The exposure to fire occured after blank production or after modification (**Tab. 67**). Another two pieces are beyond repair because of Siret breaks.

4.4.3.7. AM/MU – Summary: Reconstruction of the reduction sequence

Effectively, pieces assigned to the initial stages 0-2 of the reduction sequence are missing. This lakc is probably caused by the small inventory. Amongst several crested pieces, a flake with multiple dorsal flake scars implies a re-orientation of the core during the advanced reduction processes.

Seemingly, people camped in the rock shelter of AM and brought cores in an advanced reduction status and tools with them. The reduction on-site started with the re-preparation of cores. The remains from the core re-preparation are the largest products of the assemblage: A core (re-)preparation is implied by a few crested flakes, plunging pieces, core tablets and dorsal reduction on flakes and blades. Thereafter, during a secondary reduction sequence blanks were removed from cores with edge lengths of 4-1.5cm. Attributes imply variable percussion techniques during these processes.

Tools are relatively large and were possibly imported. Besides the repair of tools, macroscopic traces also indicate the use of non-intentionally modified artifacts and the processing of goods on-site. One third of the tools have one or more additional modification implying resharpening and intense use.

TOOL TYPES	ADDITIONAL MODIFICATIONS 1	2	3	Σ n	%*	%**	Σ**	burins	lateral retouches	splintered pieces
projectiles							3			
burins	1	1		2	33.3%	100%	2	1		2
truncations							3			
end scrapers	1			1	16.7%	100%	1			1
lateral retouches							1			
splintered pieces	1	1		2	33.3%	40.0%	5			3
denticulates			1	1	16.7%	100%	1		1	2
Σ n	3	2	1	**6**	100%	37.5%	16	1	1	8
%	50.0%	33.3%	16.7%	100%						

Tab. 66 AM/MU. Tools and additional modifications (*refer to the total amount of tools with one to three additional modifications Σ=6; **refer to total number of each tool type Σ**).

TIME HEAT TREATMENT	flakes n	flakes %	blades n	blades %	Σ n	Σ %
heated after blank removal	6	54.5%	4	80.0%	10	62.5%
thermal fracture	3	27.3%			3	18.8%
heated after modification	2	18.2%	1	20.0%	3	18.8%
total with heat treatment	11	100.0%	5	100.0%	16	100.0%

Tab. 67 AM/MU. Time of heat treatment on blank types.

4.4.4. Cueva de la Higuera/Murcia (CH/MU)

No nodules are preserved.

4.4.4.1. CH/MU: Stage 1 – Cortex removal and preparation of core platform and reduction face

CH STAGE 1	flakes + cortex n	flakes + cortex %	ratio on dorsal surface ≥ 2/3	ratio on dorsal surface complete
pebble cortex	6	54.5%	3	3
chalky cortex	5	45.5%	4	1
Σ	11	100.0%	7	4

Tab. 68 CH/MU. Artifacts from stage 1 of the reduction sequence: Flakes with more than 2/3 cortex-ratio on the dorsal surface.

The cortex removal and initial core preparation is represented by 11 pieces with dorsal surfaces that are to more than two thirds covered with cortex. Pebble and chalky cortex indicate at least two different raw material sources.

Generally a relatively large amount (33.5%) of artifacts has remains of cortex (**Tab. 69**). Cortex remained predominantly on flakes. Especially non-modified flakes obviously stem from preparation stages. Four pieces with complete cortex coverage on the dorsal surface imply initial cortex removal. 75% chalky cortex indicate a preferential exploitation of a primary raw material source (cf. **Tab. 31**).

CORTEX/HEAT TREATMENT		flakes *unm.*	*mod.*	*Σ*	blades *unm.*	*mod.*	*Σ*	cores *unm.*	*mod.*	*Σ*	art. debris *unm.*	*mod.*	*Σ*	Σ*	
with cortex	*n*	44	4	48	19	3	22	2	2	4	10	2	12	86	
	%	91.7%	8.3%	55.8%	86.4%	13.6%	25.6%	50.0%	50.0%	4.7%	83.3%	16.7%	14.0%	100%	33.5%
w/o cortex	*n*	72	16	88	45	18	63		3	4	15	1	16	171	
	%	81.8%	18.2%	51.5%	71.4%	28.6%	36.8%		75.0%	2.3%	93.8%	6.3%	9.4%	100%	66.5%
with heat treatment	*n*	12	1	13	6	3	9		1	1	11		11	34	
	%	92.3%	7.7%	38.2%	66.7%	33.3%	26.5%		100.0%	2.9%	100.0%	0.0%	32.4%	100%	13.2%
w/o heat treatment	*n*	104	19	123	58	18	76		4	7	14	3	17	223	
	%	84.6%	15.4%	55.2%	76.3%	23.7%	34.1%		57.1%	3.1%	82.4%	17.6%	7.6%	100%	86.8%

Tab. 69 CH/MU. Cortex coverage and heat treatment of unmodified (unm.) and modified (mod.) blanks. The sum of artifacts with or without cortex or heat treatment (Σ*) refer to the total assemblage n=257.

4.4.4.2. CH/MU: Stage 2 – Core preparation

4.4.4.2.1. Crested pieces and lateral core flakes

PREPARATION DORSAL SURFACE	crested pieces *n*	*%*
primary	7	58.3%
secondary	5	41.7%
Σ	12	100.0%
n.s.*	1	7.7%

Tab. 70 CH/MU. Crested pieces with primary and secondary preparation of the dorsal surface from stage 2 of the reduction sequence (*reference amount: total of crested pieces Σ=13).

Fifteen artifacts remain from the core preparation: Two small lateral core flakes have once parallel, unidirectional dorsal flake scars and the other one with unidirectional and transversal dorsal flake scars also has rests of cortex. The four crested flakes and nine crested blades are mostly primary dorsally prepared and initiated the blank production (**Tab. 70**). They are partly covered with cortex (7:6 w/o cortex). The ridges were partly prepared immediately after cortex removal and partly in later reduction stages, when the cortex was completely removed.

4.4.4.2.2. Cores and reduction technique

Eight cores remained on-site. The majority (three cores) is shaped like a cone with a pointed base (**Tab. 40**) and one striking platform on top (**Tab. 55**). The platform was prepared in various ways with one or several flake scars remaining or is even formed like a ridge (**Tab. 71**). One core was even reduced without preparing a platform in advance, i.e. the platform is still covered with cortex.

PLATFORM SURFACE	AL *n*	*%*	CH *n*	*%*	CZ *n*	*%*	Hoz *n*	*%*
with platform	14	93.3%	7	87.5%	7	100%	8	100%
1 negative**	8	57.1%	2	28.6%	6	85.7%	4	50.0%
> 1 negative**	5	35.7%	3	42.9%			4	50.0%
cortex/natural**	1	7.1%	1	14.3%				
ridge**			1	14.3%	1	14.3%		
w/o platform	1	6.7%	1	12.5%				
Σ	15	100%	8	100%	7	100%	8	100%
n.s.*					1	12.5%		

Tab. 71 MU. Surfaces of the core platforms (reference amount for the cores in CH with platform surface not further specified (n.s.) is the total amount of cores CH=8). No cores remained from AM/MU.

The cores are similar small as the specimens of AL/MU (**Fig. 33**). The small size indicates an ongoing reduction of small flakes and blades. Thus, either a need of small flakes and blades or a raw material limitation can be assumed. Maximal lengths are ca 2cm smaller than the longest flakes and blades (**Tab. 75**). Blanks were obviously initially removed from larger cores.

The blank's platform remnants are predominantly plain (**Tab. 72A**) and indicate a common (re-) preparation of the core's striking platform by removing only one flake or a core tablet. A few artifacts show other preparations of the striking platform. Very few platform remnants with natural surfaces imply that these pieces were trimming flakes.

PLATFORM REMNANT TYPE	flakes		blades	
	n	*%*	*n*	*%*
type determined	93	83.0%	44	62.9%
natural**	5	5.4%	3	6.8%
joint plane**	1	1.1%		
plain**	80	86.0%	35	79.5%
secondary facetted**	4	4.3%	3	6.8%
facetted (n.s.)**	2	2.2%		
crushed**	1	1.1%	3	6.8%
w/o	19	17.0%	26	37.1%
Σ	112	100%	70	100%
n.s.*	24	17.6%	15	17.6%

A

PLATFORM REMNANT SHAPE	flakes		blades	
	n	*%*	*n*	*%*
shape determined	113	85.6%	57	68.7%
oval**	30	26.5%	15	26.3%
point**	18	15.9%	16	28.1%
linear**	34	30.1%	17	29.8%
triangular**	9	8.0%	5	8.8%
rectangular**	2	1.8%	1	1.8%
irregular**	10	8.8%	3	5.3%
rhombic**	1	0.9%		
winged/wavy**	7	6.2%		
trapezoid**	2	1.8%		
w/o	19	14.4%	26	31.3%
Σ	132	100%	83	100%
n.s.*	4	2.9%	2	2.4%

B

Tab. 72 CH/MU. Types (**A**) and shapes (**B**) of platform remnants of flakes and blades (*reference amount of the type/shape not specified (n.s.) is the total amount of flakes=136 and blades=85; **the type and shape attributes refer to flakes and blades with type/shape determined).

DORSAL REDUCTION	flakes		blades	
	n	*%*	*n*	*%*
with DR	53	45.3%	25	43.1%
w/o DR	64	54.7%	33	56.9%
Σ	117	100%	58	100%
n.s.			1	1.7%

Tab. 73 CH/MU. Flakes and blades with and without (w/o) dorsal reduction (DR; *blades with DR not specified (n.s.) refer to the total amount of blades=59).

In addition to the preparation of a striking platform, the edges of the core were also slightly reduced aiming at a removal of larger blanks (**Tab. 73**): Almost 45% of flakes and blades have a dorsal reduction and point to a hard hammer (cf. **Tab. 35**).

4.4.4.3. CH/MU: Stage 3 – Blank production

The inventory consists of 52.9% flakes and 33.1% blades (**Tab. 34**). Three times as many flakes as blades exist (ratio 3:1) and the flake-blade index is 1.6. Thus, *no* additional import of semi-finished blanks (i.e. blades) is indicated by the blank ratios. 125 pieces (ca 50% of the inventory) are very regular without any cortex representing the amount of blank production in **Tab. 33**.

Flakes and blades are mostly complete (**Tab. 74**). Another quarter consists of proximal endings. Especially medial fragments are severely underrepresented because of their possible insertion in hafts.

Flakes and blades renge between 1-4cm (**Fig. 11** and **Fig. 12**). Blades are strikingly long with a mean and maximum value larger than the equivalent values of flakes (**Tab. 75**). Flakes have bigger width (between 1-3cm; **Fig. 12**). Thickness of both blank types is fairly similar ranging under 1cm. Additionally, a piece of 6cm length implies large cores (cf. maximum lengths in **Tab. 75**). Large semi-finished products of the initial blank removal are apparently missing and could thus have been exported. This option seems more likely in CH, because cortex removal and core preparation are present on site. In contrast, the small blanks in AM/MU were seemingly reduced from small imported cores (cf. **4.4.3.7. AM/MU – Summary: Reconstruction of the reduction sequence**).

BLANK FRAGMENTS	flakes						blades						Σ	
	unm.		*mod.*		*Σ*		*unm.*		*mod.*		*Σ*			
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
complete	77	66.4%	5	25.0%	82	60.3%	39	60.9%	3	14.3%	42	49.4%	124	56.1%
proximal	25	21.6%	10	50.0%	35	25.7%	10	15.6%	7	33.3%	17	20.0%	52	23.5%
distal	12	10.3%	3	15.0%	15	11.0%	4	6.3%	3	14.3%	7	8.2%	22	10.0%
medial	2	1.7%	2	10.0%	4	2.9%	11	17.2%	8	38.1%	19	22.4%	23	10.4%
Σ	116	85.3%	20	14.7%	136	100.0%	64	75.3%	21	24.7%	85	100.0%	221	100.0%

Tab. 74 CH/MU. Preservation of the unmodified (unm.) and modified (mod.) flakes and blades. The complete blanks consist among others of 8 non-modified, 2 modified flakes and 1 modified blade that are complete in length (in direction of percussion) but incomplete in their width.

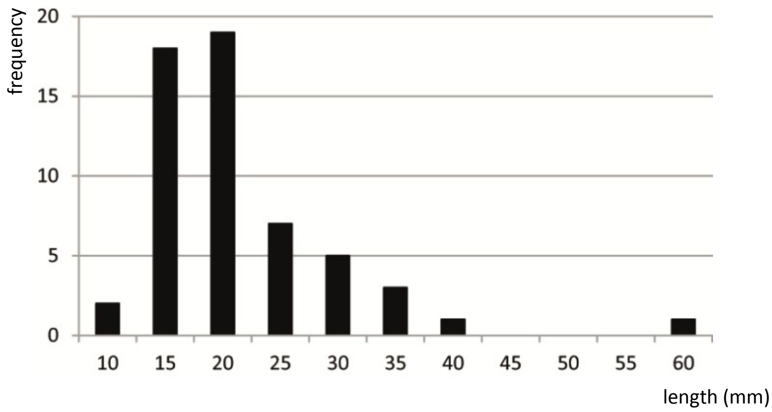


Fig. 11 CH/MU. Frequency of the y-axis of present lengths in 5mm-ranges (from 5-10mm, to 15 etc.) on the x-axis of complete and regular flakes and blades (Σ=56).

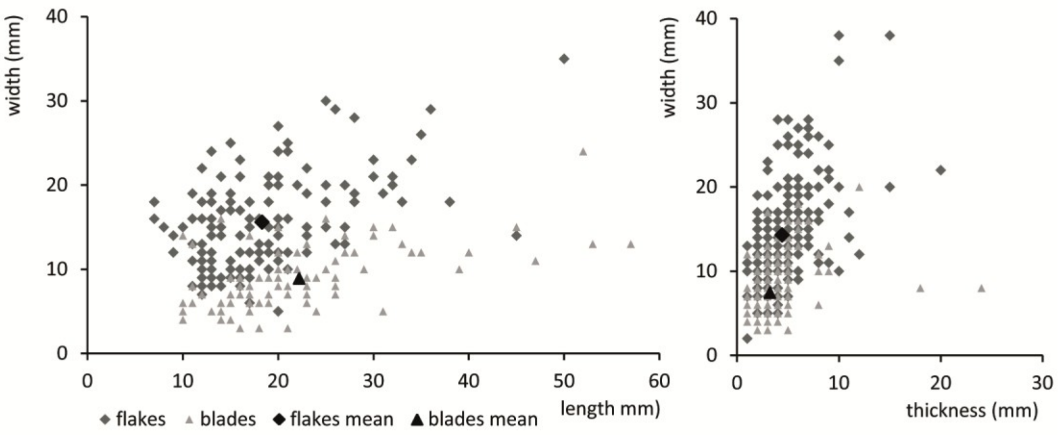


Fig. 12 CH/MU. Dimensions of flakes and blades.

DIMENSIONS	n	length (mm)				width (mm)				thickness (mm)				weight (g)			
		MIN	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*
flakes	136	7	50	18.3	7.336	5	35	15.6	5.592	1	12	4.7	2.228	0.1	15.9	1.5	1.884
unmod.	116	7	38	17.5	6.475	5	30	15.4	5.524	1	12	4.6	2.206	0.1	7.6	1.3	1.422
complete	77	7	38	17.8	6.729	5	29	15.7	5.399	1	11	4.5	2.156	0.1	7.6	1.3	1.469
mod.	20	12	50	23.2	9.980	8	35	16.9	5.958	2	12	5.3	2.337	0.1	15.9	2.6	33.392
complete	5	15	50	24.6	14.536	12	35	20.0	8.775	3	12	6.0	3.674	0.4	15.9	4.1	6.612
blades	85	10	57	22.2	9.817	3	24	8.9	3.806	1	14	3.4	2.031	0.1	16.0	1.0	1.902
unmod.	64	10	40	20.3	6.592	3	16	8.3	3.065	1	7	3.1	1.416	0.1	3.6	0.6	0.648
complete	39	13	40	21.4	6.056	3	16	7.9	3.012	1	7	3.3	1.608	0.1	3.6	0.7	0.730
mod.	21	10	57	27.8	14.966	3	24	10.6	5.201	1	14	4.3	3.136	0.1	16.0	2.2	3.458
complete	3	14	57	29.7	23.756	3	13	6.7	5.508	1	4	2.3	1.528	0.1	3.2	1.1	1.788
cores	8	15	36	25.3	6.671	14	36	21.8	7.459	7	23	15.0	4.781	0.9	29.0	10.8	8.457
unmod.	3	15	25	19.7	5.033	14	19	16.7	2.517	7	15	11.3	4.041	0.9	7.8	4.5	3.460
mod.	5	23	36	28.6	5.273	18	36	24.8	7.950	12	23	17.2	3.962	8.4	29.0	14.6	8.458
art. debris	28	13	43	19.1	7.315	5	27	12.3	4.429	4	18	7.4	3.225	0.2	15.4	2.0	3.319
unburned	17	13	43	20.2	9.155	5	27	12.8	5.126	4	18	8.3	3.619	0.2	15.4	2.7	4.143
burned	11	14	22	17.4	2.203	6	18	11.5	3.110	4	11	6.1	1.973	0.4	2.2	0.9	0.524

Tab. 75 CH/MU. Dimensions of unmodified (unmod.) and modified (mod.) blanks.

4.4.4.3.1. Percussion technique

DIRECTION DORSAL FLAKE SCARS	flakes		blades	
	n	*%*	*n*	*%*
dorsal flake scars determined	127	93.4%	82	96.5%
parallel, unidirectional**	75	59.1%	71	86.6%
parallel,opposing**	6	4.7%	4	4.9%
bipolar sensu lato**	5	3.9%	3	3.7%
unidirectional-transverse**	18	14.2%	1	1.2%
opposing-transverse**	2	1.6%		
bipolar-transverse**			1	1.2%
transverse**	8	6.3%	1	1.2%
other**	13	10.2%	1	1.2%
w/o	9	6.6%	3	3.5%
Σ	136	100%	85	100%

Tab. 76 CH/MU. Direction of dorsal flake scars of flakes and blades (**directions refer to blanks with dorsal flake scars determined).

Blades are predominantly removed very regular in a parallel or bipolar way (95.2%; **Tab. 76**). Only single blades have irregular directions of their dorsal flake scars, whereas 32.3% of the flakes have several dispersals of dorsal flake scars or the dorsal flake scars are irregularly dispersed.

Beside the regular initial blank production, the core preparation or the more opportunistic terminal blank removal from a small, almost exploited core is also visible. During the latter described processes, the core had to be frequently re-oriented.

The core's surfaces as indicators of the terminal blank removal mostly show two to four reduction faces (**Tab. 87**). Thus, during the late reduction, blanks were removed all around the core. But even though, the existing cores are obviously in their final reduction stage, four were removed in a regular way until the end.

Up to approximately 60% of the artifacts have a diffuse bulb (**Tab. 77**). In addition to other characteristics such as fine platform remnants (60% of the blades; **Tab. 72B**), 20-25% blanks with impact lips and 15-25% blanks with bulbar scar, diffuse bulbs could indicate organic or soft stone percussion (cf. **Tab. 35**) during the systematic blank production.

A few flakes with pronounced bulbs and wider platform remnants and the occurance of one impact ring could stem from preparation. This assumption is supported by a strikingly large amount of pieces with dorsal reduction (**Tab. 73**).

IMPACT MARKS	flakes		blades	
	n	*%*	*n*	*%*
with impact ring	1	0.9%		
w/o impact ring	116	99.1%	59	100%
Σ	117	100%	59	100%
with lip	24	20.5%	15	25.4%
w/o lip	93	79.5%	44	74.6%
Σ	117	100%	59	100%
with bulbar scar	19	16.2%	14	23.7%
w/o bulbar scar	98	83.8%	45	76.3%
Σ	117	100%	59	100%
with bulb	64	55.2%	37	62.7%
pronounced**	*7*	*10.9%*		
diffuse**	*54*	*84.4%*	*36*	*97.3%*
splintered**	*3*	*4.7%*	*1*	*2.7%*
w/o bulb	52	44.8%	22	37.3%
Σ	116	100%	59	100%
n.s.*	1	0.9%		

Tab. 77 CH/MU. Impact marks on flakes and blades (*blanks with not further specified (n.s.) characteristics refer to the total amount of flakes/blades with proximal ending Σ=117/59; **bulb attributes refer to all blanks with bulb).

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	22.7	8.170	13	40
width	13.3	5.895	5	20
thickness	6.0	2.646	3	11
weight	1.7	1.381	0.2	4.0

Tab. 78 CH/MU. Dimensions of artifacts from stage 4 of the reduction sequence.

4.4.4.4. CH/MU: Stage 4 – Re-preparation of the core

Six plunging flakes and blades and three core tablets remain from stage 4. Five of the plunging flakes and blades have unidirectional dorsal flake scars. Thus, immediately previously removed blanks were regularly reduced. Only one plunging piece is with dorsal flake scars in other directions, which indicate a more opportunistic previous removal of blanks.

The maximum value of the length of core tablets and plunging flakes and blades indicates a reduction of the core and blanks of ca 2cm during the blank production (**Tab. 78** cf. equivalent values in **Tab. 75**).

4.4.4.5. CH/MU: Stage 5 – Modification and use

Fourty-nine intentionally modified tools and 40 pieces with use traces remained abraded on-site. Amongst the tools, nine have modifications in addition to the type-determining retouches.

4.4.4.5.1. 5a – Intentional modification

Fourty-nine tools are present in CH/MU that equals an amount of 19.1% tools in the assemblage (**Tab. 80**). 80% of the tools were made of flakes and blades. Blades are slightly dominant: 21 blades and 20 flakes are intentionally modified, i.e. 24.7% of the blades and 14.7% of the flakes have a tool ending. Additionally, five cores were modified into tools. Eleven 11 tools are partly covered with cortex.

Varying dimensions show modifications of large and small blanks (cf. **4.4.4.3. CH/MU: Stage 3 – Blank production**). Nevertheless, modified flakes, blades and cores are generally larger than the non-modified blanks (cf. **Tab. 75**): Modified blades are on average 1g heavier, 1cm longer, but 5mm narrower and slightly thinner. Amongst the 49 tools no standardization is visible, but regularity is visible by the mostly unidirectionally dispersed dorsal flake scars (**Tab. 79**). 15% tools have opposing dorsal flake scars. A slightly opportunistic use of blanks as tools can be assumed.

DIRECTION DORSAL FLAKE SCARS	tools	
	n	*%*
parallel, unidirectional	29	74.4%
parallel, opposing	6	15.4%
bipolar *sensu lato*	2	5.1%
unidirectional-transverse	1	2.6%
opposing-transverse	1	2.6%
Σ	39	100.0%
*w/o**	*2*	*4.9%*

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	26.0	12.133	10	57
width	15.2	7.380	3	36
thickness	6.6	5.115	3	23
weight	4.1	5.765	0.1	29.0

B

Tab. 79 CH/MU. Artifacts from stage 5a of the reduction sequence: **A** – direction of dorsal flake scars of the tools (*reference amount: Σ of tools = 41) and **B** – dimensions of the tools.

TOOL TYPES	n	%
projectiles	5	10.2%
borers	4	8.2%
truncations	3	6.1%
end scrapers	8	16.3%
lateral retouches	15	30.6%
splintered pieces	9	18.4%
denticulates	2	4.1%
other	3	6.1%
Σ n	49	100%
% tools/assemblage		*19.1%*

D = 0.163

Tab. 80 CH/MU. Tool spectrum and Simpson diversity index (D).

USE TRACES	use traces	Σ (n pieces) *n*	*%*	*reference amount*
flakes	18	18	15.5%	116
blades	22	22	34.4%	64
art. debris				25
cores				3
1x ut.	40	**40**	19.2%	208
2x ut.	12	12		
Σ (n ut.)	52	52		

Tab. 81 CH/MU. Macroscopically visible use traces (ut.) on pieces without intentional tool modification. The artifacts are listed according to the blank type and refer to unmodified blanks/pieces in the assemblage. On several pieces, more than one specific use trace remain (2x ut.; mod. = modification). The reference amount is all unmodified pieces.

Neither burin spalls nor burins are present. Pieces with lateral retouch dominate the tool inventory (**Tab. 80**). Splintered pieces and end scrapers also are frequent. The low Simpson index implies a high tool diversity.

4.4.4.5.2. 5b – Use

In addition to the 49 tools, 40 pieces have use traces. Thus, the amount of used artifacts is large (34.6%).

Unmodified flakes and blades have several macroscopically visible, fine, irregular retouches on the edges that cannot be assigned to a concrete activity (**Tab. 81**). 34.4% of the otherwise non-modified blades and at least 15.5% of the non-modified flakes also have little macroscopically visible use traces. Additionally, after reduction, even the majority of cores (62.5%; five of eight) were used as tools.

4.4.4.5.3. 5c – Resharpening

Approximately 20% of the tool assemblage have one or two additional intentional modifications (**Tab. 82**).

4.4.4.6. CH/MU: Stage 6 – Discarding

Forty-three pieces are burned (amongst others thermal debris), finally reduced and destroyed (e.g. Siret breaks).

Only 13.2% of all artifacts were exposed to fire (**Tab. 69**) and show changes in color and pits caused by thermal treatment (**Tab. 53**). The time of the heat treatment implies a non-intentional fire exposure after discarding: Heating mostly took place after blank removal or even causes thermal fractures (**Tab. 83**).

4.4.4.7. CH/MU – Summary: Reconstruction of the reduction sequence

Despite the absence of nodules, cortex removal obviously took place on-site. Cortex rests persist at least up on artifacts of stage 3 and indicators for the use of hard hammers are present. Hard percussion tools could have been used during the early stages of the reduction sequence.

Flakes and blades are very small. However, one can assume a selection, use and finally export of larger, excellent – meanwhile – modified and used blanks with dimensions between 6-4cm, especially because artifacts of stages 1-2 and single large artifacts are present.

After the primary, regular reduction by probably soft stone percussion, the cores were re-prepared to start another blank reduction sequence. Thereafter the core was irregularly exploited by opportunistic blank removal. Re-preparation and irregular final exploitation show economic handling.

The tools are hardly standardized and in addition 20% of the otherwise unmodified artifacts were also used for not further definable activities. One fifth of the tools have more than one intentional modification and imply an intense use and resharpening on-site.

TOOL TYPES	n ADDITIONAL MODIFICATIONS 1	2	Σ n	%*	%**	Σ**	lateral retouches	splintered pieces	notched pieces
projectiles						5			
borers		1	1	11.1%	25.0%	4			2
truncations	1		1	11.1%	33.3%	3	1		
end scrapers	2	1	3	33.3%	37.5%	8	2	2	
lateral retouches	4		4	44.4%	26.7%	15	3	1	
splintered pieces						9			
denticulates						2			
other						3			
Σ n	7	2	**9**	100%	18.4%	49	6	3	2
%	77.8%	22.2%	100%						

Tab. 82 CH/MU. Tools and additional modifications (*refers to total amount of tools with additional modifications Σ=9; **refers to total number of each tool type/Σ**).

TIME HEAT TREATMENT	flakes n	flakes %	blades n	blades %	cores n	cores %	art. debris n	art. debris %	Σ n	Σ %
heated after blank removal	9	69.2%	7	77.8%					16	47.1%
thermal fracture	4	30.8%					5	45.5%	9	26.5%
heated after modification			2	22.2%	1	100.0%	6	54.5%	9	26.5%
total with heat treatment	13	100.0%	9	100.0%	1	100.0%	11	100.0%	34	100.0%

Tab. 83 CH/MU. Time of heat treatment of blanks.

4.4.5. Cueva de los Zagales/Murcia (CZ/MU)

In the neighboring site of AM/MU three artifacts are indicators of stage 0 on-site (IDs 6103, 6157, 6202). These pieces of natural debris imply an import of raw material. These debris pieces were of low quality and were thus neither processed nor sufficient for any other use. Thus, most of the raw material was probably already decortified at the raw material source or at another camp and mostly pre-prepared cores arrived in CZ. Alternatively, the raw material could have been completely used, which would have previously required a careful quality test and estimation of the raw material necessities.

4.4.5.1. CZ/MU: Stage 1 – Cortex removal and preparation of core platform and reduction face

CZ STAGE 1	flakes + cortex n	%	ratio on dorsal surface ≥ 2/3	complete
pebble cortex	4	66.7%	3	1
chalky cortex	2	33.3%	2	
Σ	6	100.0%	5	1
n.s.	1	14.3%	1	

Tab. 84 CZ/MU. Artifacts from stage 1 of the reduction sequence: Flakes with more than 2/3 cortex-ratio on the dorsal surface (n.s. = cortex not specified *refers to all stage 1 artifacts Σ=7).

Seven flakes with large cortex amounts on the dorsal surfaces are rests of stage 1 and show at least partly cortex removal and initial core preparation on-site. However, the major parts of cortex removal took probably place off-site (**Tab. 84**).

In the whole inventory, the amount of cortex-covered artifacts is mediocre (24.3%; **Tab. 85**). Most of these artifacts with cortex remains are (non-modified) flakes. Medium amounts of chalky (56.2%) and pebble cortex (43.8%) indicate the frequentation of primary and secondary sources and probably river sources nearby (cf. **Tab. 31**).

CORTEX/HEAT TREATMENT		flakes unm.	flakes mod.	flakes Σ	blades unm.	blades mod.	blades Σ	cores unm.**	art. debris unm.	art. debris mod.	art. debris Σ	Σ*	
with cortex	n	53	7	60	17	1	18	3	14	1	15	96	
	%	88.3%	11.7%	62.5%	94.4%	5.6%	18.8%	3.1%	93.3%	6.7%	15.6%	100%	24.3%
w/o cortex	n	153	22	175	58	26	84	5	29	3	32	296	
	%	87.4%	12.6%	59.1%	69.0%	31.0%	28.4%	1.7%	90.6%	9.4%	10.8%	100%	74.9%
with heat treatment	n	105	11	116	32	11	43	1	30	2	32	192	
	%	90.5%	9.5%	60.4%	74.4%	25.6%	22.4%	0.5%	93.8%	6.3%	16.7%	100%	48.6%
w/o heat treatment	n	101	18	119	43	16	59	7	13	2	15	200	
	%	84.9%	15.1%	59.5%	72.9%	27.1%	29.5%	3.5%	86.7%	13.3%	7.5%	100%	50.6%

Tab. 85 CZ/MU. Cortex coverage and heat treatment of unmodified (unm.) and modified (mod.) blanks (w/o natural debris). The Σ* of artifacts with or without cortex or heat treatment refers to the total assemblage n=395.**All cores are non-modified.

4.4.5.2. CZ/MU: Stage 2 – Core preparation

4.4.5.2.1. Crested pieces and lateral core flakes

DIRECTION DORSAL FLAKE SCARS	lat. core flakes n	%
parallel, unidirectional	3	37.5%
parallel, opposing	1	12.5%
unidirectional-transverse	1	12.5%
opposing-transverse	2	25.0%
other	1	12.5%
Σ	8	100.0%

Tab. 86 CZ/MU. Direction of dorsal flake scars of lateral core flakes from stage 2 of the reduction sequence.

Twenty-two artifacts remain from the core preparation. The eight lateral core flakes bear various directions of dorsal flake scars (**Tab. 86**), which could indicate opportunistic core preparation. Alternatively, the crested pieces could stem from a later stadium of the reduction sequence: The core was possibly already re-oriented during blank removal and previously a ridge preparation took place to initiate a re-newed reduction sequence.

Three lateral core flakes also have primary preparations of the dorsal surfaces. Thus, these lateral core flakes were connected with the beginning of the core preparation by a ridge to start the reduction of blanks. The ridge was obviously not sufficient to start a reduction of blanks and thus, the whole core flank was intentionally removed or was reduced by accident. 14 crested flakes and blades have nine times primary dorsal preparation and five times secondary preparation.

4.4.5.2.2. Cores and reduction technique

Conical cores also predominate amongst the few cores in CZ/MU (**Tab. 40**). Nevertheless, the number of core platforms is very variable (**Tab. 55**): Three cores have more than two striking platforms, two cores have two right-angled platforms and two cores have only one platform. These variations are probably due to changes within the reduction sequence and by the ending blank removal.

REDUCTION FACES (n)	AL n	AL %	CH n	CH %	CZ n	CZ %	Hoz n	Hoz %
1			2	25.0%	2	25.0%	4	50.0%
2	4	26.7%	4	50.0%	2	25.0%	1	12.5%
3	5	33.3%	1	12.5%	2	25.0%	2	25.0%
4	5	33.3%	1	12.5%	2	25.0%	1	12.5%
5	1	6.7%						
Σ	15	100%	8	100%	8	100%	8	100%

Tab. 87 *(on the previous page!)* MU. Number of core reduction faces. No cores remained from AM/MU.

The cores are small similar to those occurring in the assemblages of AL and CH/MU (**Fig. 33**). The maximum dimensions are lower than the highest values of flakes or blades. Only the mean values are higher than the mean values of flakes and blades (cf. **Tab. 91**). The edge length of former/initial cores can be estimated to ca 4cm, which is a similar value as in the other Murcian sites, but a minor value in comparison to sites from the other provinces with cores lengths of 6-7cm. So we can assume a previous reduction of these cores off-site and a subsequent import of already reduced cores. Evidence allowes a similar assumption for the neighboring AM/MU, where most cores arrived apparently already partly decortified (cf. **5.4.2.3. AM/MU: Stage 3 – Blank production** and **4.4.3.1. AM/MU: Stage 1 – Cortex removal and preparation of core platform and reduction face**). Alternatively, raw material sources that provide only smaller pebbles could have been exploited (cf. **Tab. 84**).

However, cores were obviously (re-)preparaed with single flakes or core tablets until the final core exploitation: Only one flake scar remains on most striking platforms and the platform remnants of flakes and blades are also predominantly plain (**Tab. 88A**). 10% of the blades have facetted platform remnants.

PLATFORM REMNANT TYPE	flakes		blades	
	n	*%*	*n*	*%*
type determined	120	56.6%	40	46.0%
natural**	6	5.0%	1	2.5%
plain**	102	85.0%	32	80.0%
primary facetted**	1	0.8%		
secondary facetted**	3	2.5%	3	7.5%
facetted (n.s.)**	2	1.7%	1	2.5%
crushed**	4	3.3%	2	5.0%
natural+secondary facetted**	2	1.7%	1	2.5%
w/o	92	43.4%	47	54.0%
Σ	212	100%	87	100%
n.s.*	23	9.8%	15	14.7%

A

PLATFORM REMNANT SHAPE	flakes		blades	
	n	*%*	*n*	*%*
shape determined	142	60.7%	55	53.9%
oval**	38	26.8%	14	25.5%
point**	8	5.6%	7	12.7%
linear**	39	27.5%	23	41.8%
triangular**	21	14.8%	5	9.1%
rectangular**	4	2.8%		
irregular**	14	9.9%	6	10.9%
rhombic**	4	2.8%		
winged/wavy**	10	7.0%		
trapezoid**	4	2.8%		
w/o	92	39.3%	47	46.1%
Σ	234	100%	102	100%
n.s.*	1	0.4%		

B

Tab. 88 CZ/MU. Types (**A**) and shapes (**B**) of platform remnants of flakes and blades (*reference amount of the type/shape not specified (n.s.) is the total amount of flakes=235 and blades=102; **the type and shape attributes refer to flakes and blades with type/shape determined).

Besides the preparation of the striking platform, the core edges were also reduced: A dorsal reduction remains on more than 50% of flakes and blades (**Tab. 89**).

4.4.5.3. CZ/MU: Stage 3 – Blank production

DORSAL REDUCTION	flakes		blades	
	n	*%*	*n*	*%*
with DR	77	53.8%	28	50.9%
w/o DR	66	46.2%	27	49.1%
Σ	143	100%	55	100%

Tab. 89 CZ/MU. Flakes and blades with and without (w/o) dorsal reduction (DR).

221 regular flakes and blades with predominantly parallel, unidirectional dorsal flake scars remain from the regular blank production (**Tab. 33**). The inventory consists of 59.5% flakes and 25.8% blades (**Tab. 34**) in a ratio of 7:3 or nearly 2:1 and a flake/blade-index of 2.3.

Relative similar amounts of complete, proximal and medial fragments of flakes and blades are striking (**Tab. 90**). These amounts are totally different than in other assemblages and possibly imply a different concept (cf. corresponding tables of other sites).

Dimensions of blanks decrease from flakes to blades (cf. e.g. mean weights in **Tab. 91**). Lengths and widths of flakes and blades are concentrated underneath 2cms, but "outliers" exist (**Fig. 13** cf. **Fig. 14**). Blades are comparably long, but all other values depict these as fine blank type (cf. also **Fig. 13**).

BLANK FRAGMENTS	flakes						blades						Σ	
	unm.		*mod.*		*Σ*		*unm.*		*mod.*		*Σ*			
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
complete	78	37.9%	1	3.4%	79	33.6%	24	32.0%	2	7.4%	26	25.5%	105	31.2%
proximal	49	23.8%	15	51.7%	64	27.2%	21	28.0%	8	29.6%	29	28.4%	93	27.6%
distal	34	16.5%	3	10.3%	37	15.7%	14	18.7%	4	14.8%	18	17.6%	55	16.3%
medial	45	21.8%	10	34.5%	55	23.4%	16	21.3%	13	48.1%	29	28.4%	84	24.9%
Σ	206	87.7%	29	12.3%	235	100.0%	75	73.5%	27	26.5%	102	100.0%	337	100.0%

Tab. 90 CZ/MU. Preservation of the unmodified (unm.) and modified (mod.) flakes and blades. The complete blanks consist amongst others of 12 non-modified, 1 modified flake and 2 modified blades that are complete in length (in direction of percussion) but incomplete in width.

DIMENSIONS	n	length (mm)				width (mm)				thickness (mm)				weight (g)			
		MIN	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*
flakes	235	5	37	15.8	6.017	5	50	14.3	5.427	1	15	4.4	5.427	0.1	16.7	1.2	1.658
unmod.	206	5	37	15.7	5.891	5	50	14.2	5.602	1	15	4.3	2.340	0.1	16.7	1.1	1.704
complete	78	6	37	17.5	6.260	7	50	15.2	7.108	1	15	4.4	2.452	0.1	16.7	1.4	2.302
mod.	29	7	34	16.9	6.870	8	23	15.0	3.959	2	10	5.1	2.059	0.3	5.2	1.5	1.273
complete	1	15	15	15.0		9	9	9.0		2	2	2.0		0.3	0.3	0.3	
blades	102	8	43	19.0	6.039	2	16	7.8	2.895	1	8	3.2	1.514	0.1	3.9	0.5	0.591
unmod.	75	8	43	18.3	5.638	3	15	7.9	2.488	1	7	3.3	1.505	0.1	2.3	0.5	0.448
complete	24	11	31	20.1	4.827	4	14	7.8	2.413	1	6	3.3	1.359	0.1	1.9	0.5	0.444
mod.	27	13	39	20.9	6.782	2	16	7.4	3.846	1	8	2.9	1.528	0.1	3.9	0.6	0.878
complete	2	17	26	21.5	6.370	6	13	9.5	4.950	2	2	2.0	0.000	0.2	0.8	0.5	0.424
cores*	8	15	39	28.9	9.094	13	39	24.4	8.782	6	26	15.9	6.490	1.7	33.4	13.4	10.508
art. debris	47	11	32	18.9	5.401	23	5	11.8	4.133	2	14	6.6	2.923	0.1	10.5	1.8	2.208
unburned	16	12	32	20.3	5.768	6	23	11.7	4.498	2	14	6.3	3.296	0.2	8.0	2.1	2.515
burned	31	11	31	18.2	5.162	5	23	11.8	4.009	3	14	6.8	2.750	0.1	10.5	1.7	2.063
nat. debris	3	17	22	18.7	2.887	9	17	14.0	4.359	4	11	7.0	3.606	0.8	5.1	2.4	2.376

Tab. 91 CZ/MU. Dimensions of unmodified (unmod.) and modified (mod.) blanks. *All cores are non-modified.

4.4.5.3.1. Percussion technique

94.2% of the blades were removed in a very regular, parallel or bipolar way (**Tab. 92**). In comparison 22.2% of the flakes were irregularly removed in several combined directions. So the blades and the amount of regularly removed flakes (77.8%) originate from the systematical reduction of semi-finished target products. The rest remains from the core (re-)preparation or from the final, more irregular and opportunistic core exploitation.

The cores were also re-oriented during the reduction sequence (cf. also **4.4.5.2.2. Cores and reduction technique**). Varying numbers of core reduction faces (**Tab. 87**) support this impression: To similar amounts cores with only one, with two, with three and with four reduction faces exist. Blanks were removed from all around the core. Three of these cores were exploited parallel and bipolar in a regular way (**Tab. 102**). The other four cores were transversally exploited and attest an advanced exploitation.

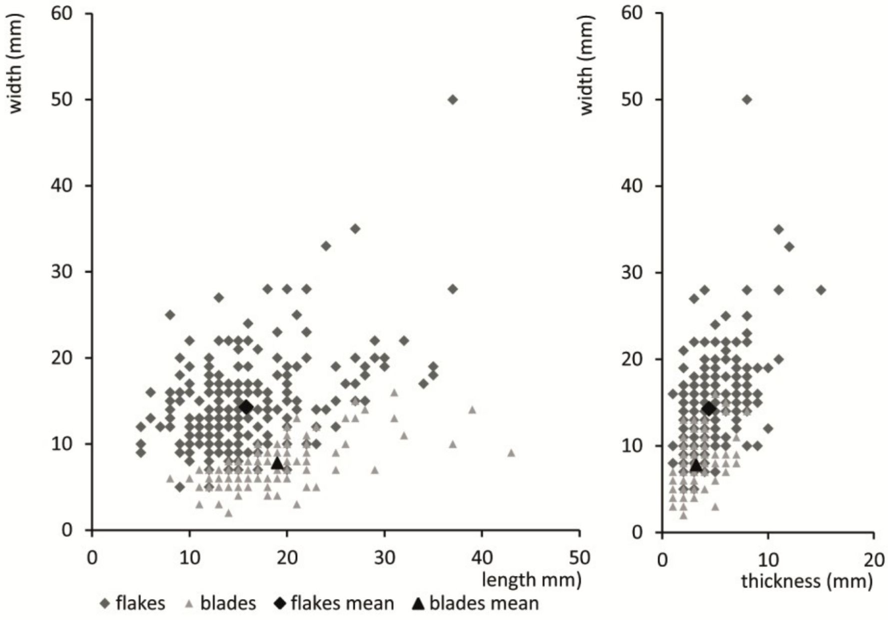


Fig. 13 CZ/MU. Dimensions of flakes and blades.

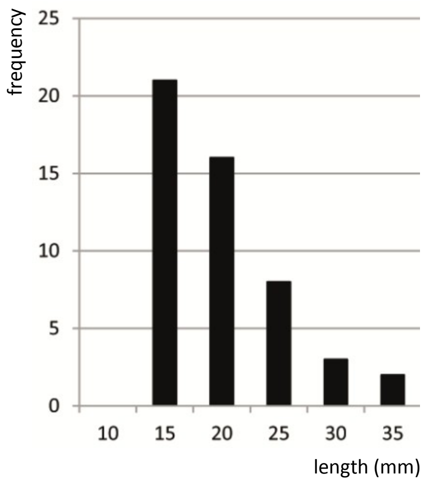


Fig. 14 CZ/MU. Frequency on the y-axis of present lengths in 5mm-ranges (from 5-10mm, to 15 etc.) on the x-axis of complete, regular flakes and blades (Σ=50).

DIRECTION DORSAL FLAKE SCARS	flakes *n*	flakes *%*	blades *n*	blades *%*
dorsal flake scars determined	230	97.9%	102	100%
parallel, unidirectional**	173	75.2%	94	92.2%
parallel,opposing**	4	1.7%		
bipolar sensu lato**	2	0.9%	2	2.0%
unidirectional-transverse**	15	6.5%	4	3.9%
opposing-transverse**	3	1.3%	1	1.0%
bipolar-transverse**	2	0.9%		
transverse**	20	8.7%		
other**	11	4.8%	1	1.0%
w/o	5	2.1%		
Σ	235	100%	102	100%

Tab. 92 CZ/MU. Direction of dorsal flake scars of flakes and blades (**directions refer to blanks with dorsal flake scars determined).

Thus, flakes and blades provide, first of all, indicators for a fairly irregular preparation and, moreover, for a regular blank removal. Furthermore, flakes, blades and cores imply a percussion technique adapted to the progressing exploitation: Subsequent to the initial regular systematic reduction of semi-finished target products, the cores were finally exploited by opportunistic removal with core re-orientations.

Diffuse bulbs are the dominant impact mark (**Tab. 93**). Impact lips also appear strikingly frequently. Together with the occurances of bulbar scars and fine pointed-oval platform remnants (**Tab. 88B**), an organic percussion is likely (cf. **Tab. 35**).

However, linear platform remnants are the most frequent platform remnant shape, especially amongst blades. This could indicate soft rock percussion. Whereas the platform remnants of flakes provide various and more wider forms, that could originate from hard stone percussion.

IMPACT MARKS	flakes		blades	
	n	*%*	*n*	*%*
with impact ring	4	2.8%		
w/o impact ring	139	97.2%	55	100%
with lip	72	50.3%	29	52.7%
w/o lip	74	51.7%	26	47.3%
with bulbar scar	24	16.8%	6	10.9%
w/o bulbar scar	119	83.2%	49	89.1%
with bulb	109	76.2%	34	61.8%
pronounced**	*8*	*7.3%*	*2*	*5.9%*
double**	*1*	*0.9%*		
diffuse**	*98*	*89.9%*	*32*	*94.1%*
splintered**	*2*	*1.8%*	*2*	*5.9%*
w/o bulb	34	30.1%	21	38.2%

Tab. 93 CZ/MU. Impact marks on flakes and blades (referring to the total amount of flakes/blades with proximal ending Σ=143/55; **bulb attributes refer to all blanks with bulb).

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	19.7	6.914	10	35
width	11.9	4.470	7	22
thickness	4.9	1.870	2	8
weight	1.0	0.910	0.2	3.7

Tab. 94 CZ/MU. Dimensions of artifacts from stage 4 of the reduction sequence.

4.4.5.4. CZ/MU: Stage 4 – Re-preparation of the core

The dorsal flake scars of the 11 plunging flakes and blades indicate a predominantly regular, parallel, unidirectional previous blank reduction (eight pieces; in addition one with bipolar and one with unidirectional-transverse and one without dorsal flake scars). The four core tablets were removed parallel (two pieces with unidirectional dorsal flake scars) and transversal (two pieces with transversal dorsal flake scars) from the core.

Thus, the dimensions of both types of artifacts reveal similarities with the conditions in AM/MU (cf. **4.4.3.4. AM/MU: Stage 4 – Re-preparation core**): Minimum and maximum lengths of blanks (cf. **Tab. 91**) are apparently larger than corresponding values of core tablets and plunging flakes and blades (**Tab. 94**). However, a comparison of the mean values reveals that stage 4-artifacts are bigger on average. Thus, one can also assume an entry of partly reduced cores that required soon a re-preparation and produced smaller blanks (cf. **4.4.5.3. CZ/MU: Stage 3 – Blank production**).

4.4.5.5. CZ/MU: Stage 5 – Modification and use

15.2% of the assemblage was intentionally modified into tools (60 pieces). Eleven thereof have more than one tool-modification. In addition, 73 non-modified pieces have fine retouches of usage demonstrating that 33.7% of the assemblage was used. On the one hand, exchange of arrow heads vs. new points took place on-site. On the other hand, the broad tool assemblage, use traces and tools with several modifications mirror various, intensely conducted handcrafts.

4.4.5.5.1. 5a – Intentional modification

DIRECTION DORSAL FLAKE SCARS	tools	
	n	*%*
parallel, unidirectional	47	83.9%
bipolar *sensu lato*	1	1.8%
unidirectional-transverse	4	7.1%
transverse	1	1.8%
other	3	5.4%
Σ	56	100.0%

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	19.4	7.199	7	39
width	11.8	5.672	2	23
thickness	4.4	2.407	2	10
weight	1.3	1.571	0.1	8.0

B

Tab. 95 CZ/MU. Tools: **A** – direction of dorsal flake scars and **B** – dimensions.

In addition to the 43 regular blanks, nine pieces with cortex, four irregular flakes and blades (cf. **Tab. 95A**) and four artificial chunks were modified into 60 tools. Blades were often modified into tools: More than 90% of these tools were made of flakes and blades to approximately similar proportions. 26.5% or 27 of the blades have intentional retouches and 12.3% or 29 of the flakes. Regular blanks were apparently preferred for tools.

TOOL TYPES	*n*	%
projectiles	19	31.7%
borers	2	3.3%
burins	1	1.7%
truncations	9	15.0%
end scrapers	9	15.0%
lateral retouches	5	8.3%
splintered pieces	11	18.3%
notched pieces	1	1.7%
denticulates	3	5.0%
Σ n	60	100%
% tools/assemblage		*15.2%*

D = 0.176

Tab. 96 CZ/MU. Tools with Simpson diversity index (D; tool ratio referring to the total assemblage).

The assemblage consists of 15.2% tools (**Tab. 96**). Projectiles are the most frequent tool type. Splintered pieces, truncations and end scrapers are also frequent. Nine different tool categories are present. Seven thereof were considered for the diversity index (without the single burin and notched piece): The tool spectrum is wide and does not indicate specialization on one distinct task.

Tools are generally slightly larger than the underlying flakes and blades (**Tab. 95B** cf.**Tab. 91**). Elongated and relatively regular pieces were probably preferred for tool modification: Modified blades are on average at about 0.5cm longer than non-modified flakes, but mean and maximum weights are lower.

4.4.5.5.2. 5b – Use

In addition to the 60 tools, 73 otherwise not intentionally modified pieces were also used (**Tab. 97**). A quarter of the non-modified flakes and blades have predominantly indeterminable fine, macroscopically visible use trace along the edges. 29.3% of the non-modified blades and 24.8% of the non-modified flakes were used in addition to the tools. Furthermore, traces of red ocher on an artifact show the contact with pigments.

USE TRACES	red ocher traces	use traces	other mod.	Σ (n pieces) *n*	*%*	*reference amount*
flakes	1	46	4	51	24.8%	206
blades		22		22	29.3%	75
art. debris						46
cores						8
1x ut.	1	68	4	**73**	21.8%	335
2x ut.		24		24		
3x ut.		6		6		
Σ (n ut.)	1	98	4	103		

Tab. 97 CZ/MU. Macroscopically visible use traces (ut.) on pieces without intentional tool modification. The artifacts are listed according to the blank type and refer to unmodified blanks/pieces in the assemblage. On several pieces, more than one specific use trace remain (2x ut. etc.; mod. = modification). The reference amount is all unmodified pieces.

4.4.5.5.3. 5c – Resharpening

Almost 20% of the tools were modified once or twice (**Tab. 98**). E. g. four burin blows were removed from a projectile. Most additional modifications are lateral retouches, whereas typologically classified lateral retouches were not additionally modified.

4.4.5.6. CZ/MU: Stage 6 – Discarding

For 195 reduced cores, burned tools and blanks the discarding reasons are obvious.

The amount of burned artifacts (48.6%) is large. Mostly non-modified artifacts were exposed to fire: The heating took place after their removal from the core. Some artifacts broke due to the heat (**Tab.**

99). Thus, one can conclude that these pieces were discarded carelessly and accidentally near the fireplaces. Effects of heat treatment are a combination of color change, fissures and heat pits on the artifacts (**Tab. 53**). One blade was possibly tempered.

TOOL TYPES	n ADDITIONAL MODIFICCATIONS 1	2	3	4	Σ n	%*	%**	Σ**	burins	end scrapers	lateral retouches	splintered pieces	notched pieces
projectiles				1	1	9.1%	5.3%	19	4				
borers	1				1	9.1%	50.0%	2			1		
burins	1				1	9.1%	100%	1			1		
truncations	2	1			3	27.3%	33.3%	9			1	2	1
end scrapers		1			1	9.1%	11.1%	9		1	1		
lateral retouches								5					
splintered pieces	1	1			2	18.2%	18.2%	11				3	
notched pieces	1				1	9.1%	100%	1			1		
denticulates	1				1	9.1%	33.3%	3			1		
Σ n	7	3		1	**11**	100%	18.3%	60	4	1	6	5	1
%	63.6%	27.3%		9.1%	100%								

Tab. 98 CZ/MU. Tools and additional modifications (*refers to total amount of tools with additional modifications Σ=11; **refers to total number of each tool type Σ**).

4.4.5.7. CZ/MU – Summary: Reconstruction of the reduction sequence

No nodules are present; only natural debris are signs of stage 0. Despite the medium size of the inventory, only a few pieces remain from stage 1 and indicate an initial cortex removal off-site. The cores were prepared in a less regular manner than in other assemblages: The dorsal flake scars of flakes and blades are dispersed in various directions. Hard stone percussion is probable.

Small flakes and blades might stem from later reduction cycles with already in size reduces products. The blank removal was mostly regular using a soft hammer. In addition to that the import of already reduced cores is likely, that required soon re-preparation of the cores with immediately previous regular blank production.

TIME HEAT TREATMENT	flakes n	flakes %	blades n	blades %	cores n	cores %	art. debris n	art. debris %	Σ n	Σ %
raw material heated			1	2.3%					1	0.5%
heated after blank removal	55	47.4%	24	55.8%	1	100.0%	8	25.0%	88	45.8%
thermal fracture	52	44.8%	12	27.9%			23	71.9%	87	45.3%
heated after modification	9	7.8%	6	14.0%			1	3.1%	16	8.3%
total with heat treatment	116	100.0%	43	100.0%	1	100.0%	32	100.0%	192	100.0%

Tab. 99 CZ/MU. Time of heat treatment of various blank types.

The amount of tools is medium, but additionally many non-modified pieces were used and have macroscopically visible use traces.

4.4.6. Barranco de la Hoz/Murcia (Hoz/MU)

No non-prepared raw material pieces remained.

4.4.6.1. Hoz/MU: Stage 1 – Cortex removal and preparation of core platform and reduction face

Artifacts were mostly introduced as prepared cores. Only three pieces (IDs 3191, 3676, 3816) remain from stage 1. One thereof is covered with pebble and two with chalky cortex. These pieces were not modified or used.

The large amount of 32.9% artifacts with any amount of cortex is similar to the amount of CH/MU (**Tab. 100**). Half of the corex covered pieces are flakes. Chalky cortex predominates (**Tab. 31**).

4.4.6.2. Hoz/MU: Stage 2 – Core preparation

4.4.6.2.1. Crested pieces and lateral core flakes

25 artifacts stem from the core preparation.

Cores were carefully decortified before final preparation: The 17 crested flakes and blades are hardly covered with cortex (5 pieces with cortex : 12 without cortex). The majority of crested artifacts has primary preparation of the dorsal surface (**Tab. 101B**). Amongst others, one small plunging blade (ID 3185, 0.9g) has also a two-sided primary and secondary preparation of the dorsal surface.

Additionally, eight lateral core flakes are preserved. Five thereof are still partly covered with cortex. The dorsal flake scars show varying directions (**Tab. 101A**). One lateral core flake has also a primary preparation of the dorsal surface, but the whole edge of the core was removed.

CORTEX/HEAT TREATMENT		flakes			blades			cores			art. debris			Σ*	
		unm.	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*		
with cortex	*n*	26	11	37	17	6	23	3	3	6	3	3	6	72	
	%	70.3%	29.7%	51.4%	73.9%	26.1%	31.9%	50.0%	50.0%	8.3%	50.0%	50.0%	8.3%	100%	32.9%
w/o cortex	*n*	27	14	41	77	23	100	2		2	3	1	4	147	
	%	65.9%	34.1%	27.9%	77.0%	23.0%	68.0%	100.0%		1.4%	75.0%	25.0%	2.7%	100%	67.1%
with heat treatment	*n*	8	8	16	23	3	26	2	2	4	2		2	48	
	%	50.0%	50.0%	33.3%	88.5%	11.5%	54.2%	50.0%	50.0%	8.3%	100.0%	0.0%	4.2%	100%	21.9%
w/o heat treatment	*n*	45	17	62	71	26	97	3	1	4	4	4	8	171	
	%	72.6%	27.4%	36.3%	73.2%	26.8%	56.7%	75.0%	50.0%	2.3%	50.0%	50.0%	4.7%	100%	78.1%

Tab. 100 Hoz/MU. Cortex coverage and heat treatment of unmodified (unm.) and modified (mod.) blanks. The Σ*of artifacts with or without cortex or heat treatment refers to the total assemblage n=219.

DIRECTION DORSAL FLAKE SCARS	lat. core flakes *n*	*%*
parallel, unidirectional	3	37.5%
parallel, opposing	1	12.5%
bipolar *sensu lato*	1	12.5%
bipolar-transverse	1	12.5%
transverse	1	12.5%
other	1	12.5%
Σ	8	100.0%

A

PREP. DORSAL SURFACE	crested pieces *n*	*%*
primary	13	76.5%
secondary	4	23.5%
Σ	17	100.0%

B

Tab. 101 Hoz/MU. Artifacts from stage 2 of the reduction sequence: **A** – dorsal flake scars on lateral core flakes and **B** – crested pieces with primary and secondary preparation of the dorsal surface.

4.4.6.2.2. Cores and reduction technique

Five cores are conical and three cylindrical (**Tab. 40**). They have mostly one striking platform on top (**Tab. 55**). The core platform was (re-)prepared by the removal of one core tablet or a trimming flake (**Tab. 71**). The cores of Hoz/MU are on average the second largest pieces compared to the pieces of the other analyzed assemblages (cf. **Fig. 33** where the larger cores of Car/GR are *not* depicted). The maximum length of almost 7cm is larger than the maximum values of flakes and blades of 6.8cm (blade length). This demonstrates a comparably early discarding of the cores. Obviously in this case enough supply on raw material was available and allowed discarding of fairly big cores. Only few cores were modified to tools. Small specimens thereof were preferentially used as tools.

The dominance of plain platform remnants (**Tab. 103A**) confirms the preparation of the striking platform by one flake. Furthermore, the core striking platform was facetted previous to the removal of a several flakes (11.8%) and blades (7.6%) with facetted platform remnants. Five flakes with natural surfaces on the platform remnants could originate from core preparation and not from blank production.

Moreover the core edges were slightly prepared leaving a dorsal reduction on the majority of flakes and even three quarters of the blades (**Tab. 104**).

REDUCTION FACE: DIRECTION FLAKE SCARS	AL *n*	AL *%*	CH *n*	CH *%*	CZ *n*	CZ *%*	Hoz *n*	Hoz *%*
parallel, unidirectional	2	15.4%	4	66.7%	2	28.6%	4	66.7%
bipolar *sensu lato*	4	30.8%			1	14.3%		
parallel+transversal	5	38.5%	2	33.3%	2	28.6%	2	33.3%
bipolar+transversal	2	15.4%			2	28.6%		
Σ	13	100%	6	100%	7	100%	6	100%
n.s.*	2	13%	2	25%	1	13%	2	25%

Tab. 102 MU. Core reduction faces (*the reference amounts for the core reduction faces with flake scar directions not further specified (n.s.) are the total amount of cores AL=15; CH=8; CZ=8; Hoz=8). No cores remained in AM/MU.

PLATFORM REMNANT TYPE	flakes *n*	flakes *%*	blades *n*	blades *%*
type determined	63	87.5%	65	61.9%
natural**	5	7.9%		
plain**	50	79.4%	59	90.8%
secondary facetted**	2	3.2%	1	1.5%
facetted (n.s.)**	2	3.2%	3	4.6%
crushed**	1	1.6%		
natural+primary facetted**			1	1.5%
natural+secondary facetted**	3	4.8%		
cortex+plain**			1	1.5%
w/o	9	12.5%	40	38.1%
Σ	72	100%	105	100%
n.s.*	6	7.7%	18	14.6%

A

PLATFORM REMNANT SHAPE	flakes *n*	flakes *%*	blades *n*	blades *%*
shape determined	69	88.5%	82	67.2%
oval**	19	27.5%	31	37.8%
point**	5	7.2%	9	11.0%
linear**	11	15.9%	27	32.9%
triangular**	12	17.4%	10	12.2%
rectangular**	4	5.8%	1	1.2%
irregular**	12	17.4%	2	2.4%
rhombic**	1	1.4%		
winged/wavy**	5	7.2%	2	2.4%
w/o	9	11.5%	40	32.8%
Σ	78	100%	122	100%
n.s.*			1	0.8%

B

Tab. 103 Hoz/MU. Types (**A**) and shapes (**B**) of platform remnants of flakes and blades (*reference amount of the type/shape not specified (n.s.) is the total amount of flakes=78 and blades=123; the type and shape attributes refer to flakes and blades with type/shape determined).

DORSAL REDUCTION	flakes *n*	flakes *%*	blades *n*	blades *%*
with DR	39	56.5%	61	74.4%
w/o DR	30	43.5%	21	25.6%
Σ	69	100%	82	100%
n.s.*			1	1.2%

Tab. 104 Hoz/MU. Flakes and blades with and without (w/o) dorsal reduction (DR; *blades with DR not specified (n.s.) refer to total=83).

4.4.6.3. Hoz/MU: Stage 3 – Blank production

The inventory consists only of 35.6% flakes and is dominated by far by blades with an amount of 56.2% (**Tab. 34**). 128 thereof are very regular (cf. **Tab. 33**). An additional import of blades as semi-finished products is evident for this site. Complete blanks and proximal fragments dominate flakes and blades (**Tab. 105**). Missing medial fragments could have been used as inserts in hafts and taken away as composite tools.

BLANK FRAGMENTS	flakes						blades						Σ	
	unm.		*mod.*		*Σ*		*unm.*		*mod.*		*Σ*			
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
complete	40	75.5%	8	32.0%	48	61.5%	42	44.7%	6	20.7%	48	39.0%	96	47.8%
proximal	10	18.9%	11	44.0%	21	26.9%	25	26.6%	10	34.5%	35	28.5%	56	27.9%
distal	3	5.7%	1	4.0%	4	5.1%	18	19.1%	1	3.4%	19	15.4%	23	11.4%
medial			5	20.0%	5	6.4%	9	9.6%	12	41.4%	21	17.1%	26	12.9%
Σ	53	67.9%	25	32.1%	78	100.0%	94	76.4%	29	23.6%	123	100.0%	201	100.0%

Tab. 105 Hoz/MU. Preservation of the unmodified (unm.) and modified (mod.) flakes and blades. The complete blanks consist amongst others of 2 non-modified and 4 modified flakes, 1 non-modified and 4 modified blade that are complete in length (in direction of percussion) but incomplete in their width.

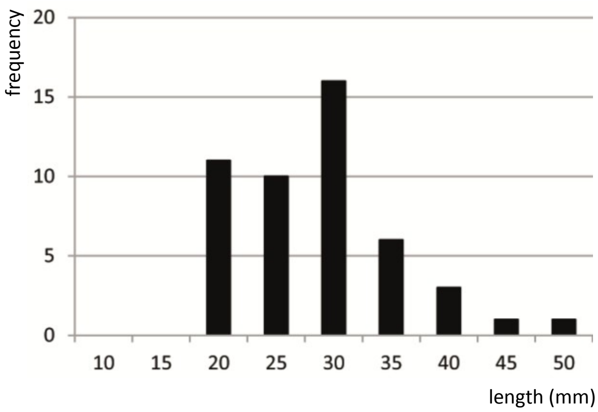


Fig. 15 Hoz/MU. Length of complete and regular flakes and blades in 5mm-ranges (from 5-10mm, to 15 etc.; Σ=48).

The artifacts are comparably large (cf. **Fig. 33** and e.g. lengths of **Tab. 106**). On the one hand, broad variances in dimensions (**Tab. 106**, **Fig. 15** and **Fig. 16**) imply large cores with estimated edge length at about 7cm – equivalent to the maximum length of flakes and blades – at the initial blank production. On the other hand complete blanks show a continuous blank production between 5-2cm lengths (**Fig. 15**).

Blades are very long, but fine and light. Modified artifacts indicate a standard width at about 1cm and 0,5cm thickness. **Fig. 16** displays that width and thickness are broadly scattered – especially among the flakes. The dispersal was possibly caused by irregular blanks with varying dimensions (**Fig. 16** and cf. **Fig. 15**).

DIMENSIONS	*n*	length (mm)				width (mm)				thickness (mm)				weight (g)			
		MIN	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*
flakes	78	11	55	28.0	9.34	10	57	25.8	9.65	2	18	7.6	3.872	0.3	31.3	6.1	6.53
unmod.	53	14	55	28.4	9.60	10	57	25.4	9.80	2	18	7.2	4.102	0.3	31.3	5.8	6.61
complete	40	14	55	28.5	10.09	10	57	25.1	10.10	2	18	7.4	4.272	0.3	31.3	6.0	6.99
mod.	25	11	52	27.0	8.87	14	52	26.5	9.47	4	15	8.6	3.203	0.9	30.8	6.8	6.44
complete	8	20	40	30.9	7.41	18	46	27.4	8.60	8	14	10.6	1.996	4.2	13.2	7.9	3.77
blades	123	4	68	28.3	9.39	4	24	10.5	3.89	1	11	4.0	1.998	0.1	9.2	1.4	1.65
unmod.	94	4	68	26.8	9.28	4	24	10.2	3.68	1	11	3.9	1.962	0.1	8.0	1.2	1.34
complete	42	16	48	27.8	8.30	4	19	9.9	3.31	1	11	3.9	1.907	0.1	3.5	1.1	0.97
mod.	29	21	53	33.2	8.11	5	20	11.5	4.45	2	10	4.4	2.080	0.2	9.2	2.2	2.25
complete	6	26	36	30.0	3.85	5	12	8.7	2.80	2	5	3.2	1.169	0.4	1.3	0.8	0.34
cores	8	21	69	37.5	15.76	16	62	31.5	15.23	10	35	19.5	8.053	4.2	110	32.5	36.32
unmod.	5	21	69	39.6	19.96	16	62	31.4	19.57	10	35	21.4	10.065	4.2	110	39.1	46.21
mod.	3	27	40	34.0	6.56	24	37	31.7	6.81	16	17	16.3	0.577	14	29.0	21.5	7.35
art. debris	10	17	46	31.9	11.90	8	41	24.9	9.24	4	24	12.6	5.542	0.4	38.8	12.3	11.99
unburned	8	17	44	31.1	12.01	8	41	24.5	10.27	4	24	12.9	5.515	0.4	38.8	12.4	12.55
burned	2	24	46	35.0	15.56	23	30	26.5	4.95	6	17	11.5	7.778	1.8	21.3	11.6	13.79

Tab. 106 Hoz/MU. Dimensions of unmodified (unmod.) and modified (mod.) blanks.

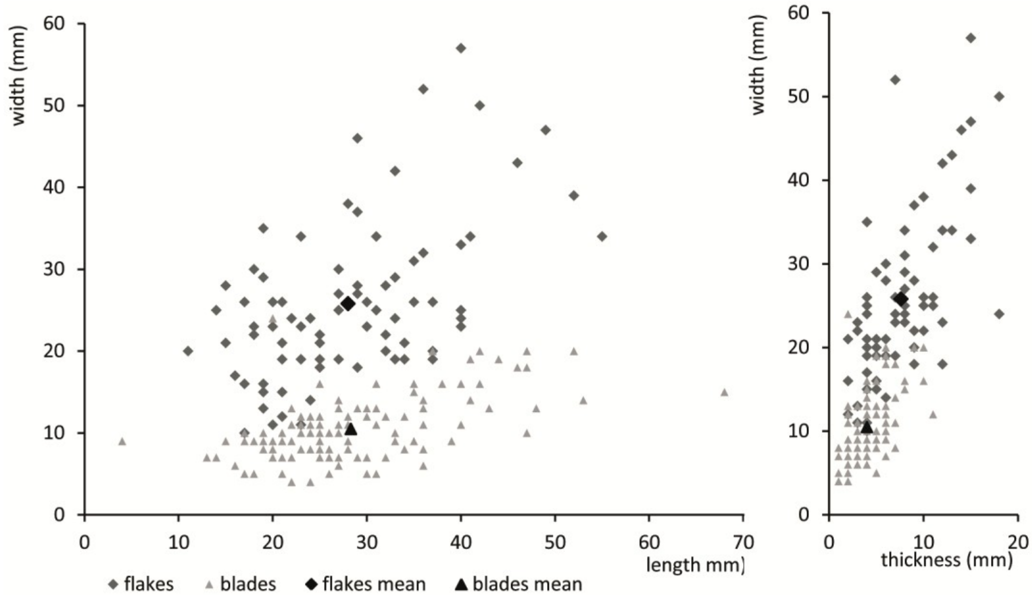


Fig. 16 Hoz/MU. Dimensions of flakes and blades.

4.4.6.3.1. Percussion technique

Almost all blades were regularly removed in a parallel or bipolar way (90.1%; **Tab. 107**). In contrast only 56.6% of the flakes remain from a regular blank production, whereas the rest is removed in various combined and other directions. Thus, half of the flakes and almost all blades are removed as regular semi-finished target products, whereas 44.4% of the flakes are likely due to preparation or to a removal during final state of the core exploitation.

The cores have reduction faces all round (**Tab. 87**) with a slight dominance of cores with only one reduction face. The removal negatives on the cores are dispersed mostly in a parallel and unidirectional way, but transversal reduction also appears (**Tab. 102**).

DIRECTION DORSAL FLAKE SCARS	flakes		blades	
	n	*%*	*n*	*%*
dorsal flake scars determined	76	97.4%	121	98.4%
parallel, unidirectional**	35	46.1%	83	68.6%
parallel,opposing**	3	3.9%	5	4.1%
bipolar sensu lato**	5	6.6%	21	17.4%
unidirectional-transverse**	14	18.4%	9	7.4%
bipolar-transverse**	3	3.9%	1	0.8%
transverse**	8	10.5%	1	0.8%
other**	8	10.5%	1	0.8%
w/o	2	2.6%	2	1.6%
Σ	78	100%	123	100%

Tab. 107 Hoz/MU. Direction of dorsal flake scars of flakes and blades (**directions refer to blanks with dorsal flake scars determined).

IMPACT MARKS	flakes		blades	
	n	*%*	*n*	*%*
with impact ring	12	17.4%		
w/o impact ring	57	82.6%	83	100%
with lip	33	47.8%	34	41.0%
w/o lip	36	52.2%	49	59.0%
with bulbar scar	22	31.9%	19	22.9%
w/o bulbar scar	47	68.1%	64	77.1%
with bulb	46	66.7%	55	66.3%
pronounced**	*15*	*32.6%*	*4*	*7.3%*
double**	*2*	*4.3%*		
diffuse**	*30*	*65.2%*	*51*	*92.7%*
splintered**	*1*	*2.2%*		
w/o bulb	23	33.3%	28	33.7%

Tab. 108 Hoz/MU. Impact marks on flakes and blades (referring to the total amount of flakes/blades with proximal ending Σ=69/83; **bulb attributes refer to all blanks with bulb).

Thus, vertical and parallel dispersal of dorsal flake scars dominates both on flakes and blades and on the cores. However, the occurrence of transversal flake scars – even though only a small amount – implies the terminal and more opportunistic exploitation of the cores.

The analysis of impact marks shows a unique amount of flakes with impact rings (**Tab. 108**). The combination of a notable amount of pronounced bulbs, dorsal reduction (cf. **Tab. 104**) and irregular, probably wide platform remnants (**Tab. 103B**) could imply hard stone percussion and preparation and cortex removal (cf. **Tab. 35**). Nevertheless, indications for organic percussion and blade production are also present: More than 90% of the blades with bulb have a diffuse bulb and accordingly 65% of the flakes. Additionally, more than 40% of the artifacts have an impact lip and 30-20% bulbar scars. Especially blades are characterized by small pointed-oval platform remnants (approximately 50%, cf. **Tab. 103B**). The amount of fine, linear platform remnants of blades points to the use of a soft hammer (cf. **Tab. 35**).

4.4.6.4. Hoz/MU: Stage 4 – Re-preparation core

Twenty pieces remain from the re-preparation of cores on-site: 11 core tablets and nine plunging flakes or blades.

Plunging flakes and blades with unidirectional dorsal flake scars show a regular blank production previous to the re-preparation of the core (**Tab. 109A**). Four artifacts indicate a slightly modified reduction process with varying directions of the dorsal flake scars and a re-orientations of the core.

Maximum length of core tablets and plunging flakes and blades (**Tab. 109B**) implies a reduction of core edge lengths during stage 3 to 4 at about 1-2.5cm (cf. **Tab. 106**), whereas the other values show the more chunky conditions of re-preparation products.

DIRECTION DORSAL FLAKE SCARS	plunging pieces *n*	*%*
parallel, unidirectional	5	55.6%
unidirectional-transverse	2	22.2%
bipolar-transverse	1	11.1%
other	1	11.1%
Σ	9	100.0%

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	30.3	7.793	18	42
width	15.7	8.041	6	34
thickness	6.8	3.242	3	12
weight	3.7	4.198	0.6	16.9

B

Tab. 109 Hoz/MU. Artifacts from stage 4 of the reduction sequence: **A** – direction of dorsal flake scars of plunging flakes and blades and **B** – dimensions of core tablets *and* plunging flakes and blades.

4.4.6.5. Hoz/MU: Stage 5 – Modification and use

148 pieces and so an extraordinary large amount of 68% artifacts were used on-site as tools or non-modified pieces with macroscopically visible use traces. About 40% of the tools have additional modifications. Thus, people intensely crafted on-site. Moreover, an exchange of tool inserts can be assumed.

4.4.6.5.1. 5a – Intentional modification

Sixty-one tools could indicate an intentional modification on-site. 23 pieces with cortex, four chunks and three cores complement the tool assemblage. The tools are dominated by similar amounts of flakes and blades of in total 90%. A relatively small amount of blades was modified. Apparently, flakes, artificial debris and cores were preferred for tools: 32.1% of the flakes, 40% of the artificial debris and 37.5% of the cores were modified, whereas only a quarter (23.6%) of the blades have a modification. The irregular blanks of tools could express a reduced blank choice and a raw material shortage.

Generally tools are wider, thicker and heavier than blanks (**Tab. 110B** cf. **Tab. 106**). Modified blades are on average only a few millimeters longer than non-modified flakes, but only half that wide and thick and though much finer.

DIRECTION DORSAL FLAKE SCARS	tools *n*	*%*
parallel, unidirectional	28	53.8%
parallel, opposing	2	3.8%
bipolar *sensu lato*	11	21.2%
unidirectional-transverse	5	9.6%
transverse	3	5.8%
other	3	5.8%
Σ	52	100.0%
*w/o**	*2*	*3.7%*

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	30.5	8.979	11	53
width	19.4	10.466	5	52
thickness	7.2	4.093	5	17
weight	5.5	6.654	0.2	20.8

B

Tab. 110 Hoz/MU. Artifacts from stage 5a of the reduction sequence: **A** – direction of dorsal flake scars of the modified flakes and blades (*reference amount: total of modified flakes and blades Σ=54) and **B** – dimensions of the tools.

TOOL TYPES	*n*	%
projectiles	3	4.9%
borers	4	6.6%
burins	4	6.6%
truncations	8	13.1%
end scrapers	14	23.0%
lateral retouches	7	11.5%
splintered pieces	14	23.0%
notched pieces	2	3.3%
denticulates	4	6.6%
other	1	1.6%
Σ n	61	100%
% tools/assemblage		*27.9%*

(ratio % 0–40; D = 0.138)

Tab. 111 Hoz/MU. Tools frequency and Simpson diversity index (D).

The amount of tools is strikingly high and diverse (**Tab. 111** cf. **Tab. 203**). End scrapers, splintered pieces and truncations are most frequent and point to the processing of animal remains beyond meat such as the scraping of hides. Despite three burins, no burin spalls are left on-site. So the modification of burins happened probably during a previous staies at other locations. Subsequently burins were brought to Hoz.

4.4.6.5.2. 5b – Use

Besides the tools, 88 pieces have use traces. 40 thereof indicate various application causing several use traces (**Tab. 112**). Polished sections and a rounded ridge remained from long term, repetitive activities. 62 (66%) of the non-modified blades have at least one use trace. Also 45.8% of the non-modified flakes and 33.3% (two of six) of the non-modified chunks were used.

USE TRACES	ridge rounding	use traces	polish	Σ (n pieces) *n*	*%*	*reference amount*
flakes		24		24	45.3%	53
blades		60	2	62	66.0%	94
art. debris		2		2	33.3%	6
cores						5
1x ut.		86	2	**88**	55.7%	158
2x ut.	1	39		40		
3x ut.		5		5		
4x ut.		1		1		
Σ (n ut.)	1	131	2	134		

Tab. 112 Hoz/MU. Macroscopically visible use traces (ut.) on pieces without intentional tool modification. The artifacts are listed according to the blank type and refer to unmodified blanks/pieces in the assemblage. On several pieces, more than one specific use trace remain (2x ut. etc.; mod. = modification). The reference amount is all unmodified pieces.

TOOL TYPES	n ADDITIONAL MODIFICATION 1	2	3	4	Σ n	%*	%**	Σ**	borers	burins	truncations	end scrapers	lateral retouches	splintered pieces	notched pieces	denticulates
projectiles	1				1	33.3%	3.8%	3						1		
borers	2	1			3	75.0%	11.5%	4	1	2			1			
burins	1			1	2	50.0%	7.7%	4		4	1	1				
truncations	3	2			5	62.5%	19.2%	8				1	6			
end scrapers	3	2			5	35.7%	19.2%	14					2	3	2	
lateral retouches	1				1	14.3%	3.8%	7					1			
splintered pieces	2	1	1		4	28.6%	15.4%	14						7		
notched pieces	1				1	50.0%	3.8%	2							1	
denticulates	3				3	75.0%	11.5%	4						2		1
other	1				1	100%	100%	1					1			
Σ n	17	6	1	1	**26**	42.6%	100%	61	1	6	1	2	11	13	3	1
%	65.4%	23.1%	3.8%	3.8%	100%											

Tab. 113 Hoz/MU. Tools and additional modifications (*refer to total amount of tools with additional modifications Σ=26; **refer to total number of each tool type Σ**).

4.4.6.5.3. 5c – Resharpening

More than 40% of the tools (26 pieces) have at least one other modification (**Tab. 113**). Tools were especially re-modified into lateral retouches or re-used as splintered pieces.

4.4.6.6. Hoz/MU: Stage 6 – Discard

Fifty-one pieces were discarded on-site: Reduced cores, core debris and burned artifacts were left.

Artifacts with heat treatment are seldom and consist mostly of blades (**Tab. 100**). All stage 6-artifacts were burned after discarding (**Tab. 114**).

TIME HEAT TREATMENT	flakes		blades		cores		art. debris		Σ	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
heated after blank removal	9	56.3%	15	57.7%	2	50.0%	1	50.0%	27	56.3%
thermal fracture			7	26.9%			1	50.0%	8	16.7%
heated after modification	7	43.8%	4	15.4%	2	50.0%			13	27.1%
total with heat treatment	16	100.0%	26	100.0%	4	100.0%	2	100.0%	48	100.0%

Tab. 114 Hoz/MU. Time of heat treatment of various blank types.

4.4.6.7. Hoz/MU – Summary: Reconstruction of the reduction sequence

No artifacts from the raw material procurement and testing remain. A few artifacts of stages 1 and 2 indicate an introduction of already pre-prepared cores. Contemporaneously an accurate cortex removal was important, thus very few artifacts in stage 2 have rests of cortex. During these stages a preparation with a hard hammer could have taken place (indicators of hard stone percussion are present).

Blanks were very regularly removed predominantly in a unidirectional way and probably by using a soft hammer. Cores decrease in stage 3 from about 5cm to 2cm in length. By trend larger blanks were selected for tools.

4.4.7. Cueva Ambrosio/Almería (CA/AL)

Despite the big assemblagen no nodules are preserved. Apparently all nodules once brought in the cave were consumed or nodules arrived in an already initiated status on-site.

4.4.7.1. CA/AL: Stage 1 – Cortex removal and preparation of core platform and reduction face

CA STAGE 1	flakes + cortex n	%	ratio on dorsal surface ≥ 2/3	complete
pebble cortex	11	23.9%	4	7
chalky cortex	35	76.1%	17	18
Σ	46	100.0%	21	25
n.s.	5	9.8%	2	3

Tab. 115 CA/MU. Artifacts from stage 1 of the reduction sequence: Flakes with more than 2/3 cortex-ratio on the dorsal surface (n.s. = cortex not specified *refers to all stage 1 artifacts Σ=51).

Fifty-one artifacts indicate cortex removal and initial core preparation on-site (**Tab. 115**). Most raw material stem from a primary source with chalky cortex, whereas rivers provide only exceptionally pebbles (cf. **Tab. 31** and **Fig. 6**). Three artifacts with large cortex rests could have been introduced as end scrapers (IDs 9853, 9840) and a burin (ID 99952). These trimming flakes were possibly subsequently modified and pass also stage 5 or they were imported as tools and could thus probably not serve as indicators of stage 1.

At 26.3%, the amount of cortex-covered artifacts is only mediocre (**Tab. 116**). The type of cortex is dominated by primary, chalky cortex, but also pebble cortex appears (cf. **Tab. 31**).

CORTEX/HEAT TREATMENT		flakes unm.	flakes mod.	flakes Σ	blades unm.	blades mod.	blades Σ	cores unm.	cores mod.	cores Σ	art. debris unm.	art. debris mod.	art. debris Σ	Σ*	
with cortex	n	248	23	271	62	8	70	33	6	39	39	6	45	425	
	%	91.5%	8.5%	63.8%	88.6%	11.4%	16.5%	84.6%	15.4%	9.2%	86.7%	13.3%	10.6%	100%	26.3%
w/o cortex	n	662	52	714	331	41	372	20	6	26	72	4	76	1188	
	%	92.7%	7.3%	60.1%	89.0%	11.0%	31.3%	76.9%	23.1%	2.2%	94.7%	5.3%	6.4%	100%	73.7%
with heat treatment	n	394	28	422	129	12	141	20	4	24	73	4	77	664	
	%	93.4%	6.6%	63.6%	91.5%	8.5%	21.2%	83.3%	16.7%	3.6%	94.8%	5.2%	11.6%	100%	41.2%
w/o heat treatment	n	516	47	563	264	37	301	33	8	41	38	6	44	949	
	%	91.7%	8.3%	59.3%	87.7%	12.3%	31.7%	80.5%	19.5%	4.3%	86.4%	13.6%	4.6%	100%	58.8%

Tab. 116 CA/AL. Cortex coverage and heat treatment of unmodified (unm.) and modified (mod.) blanks. The Σ* of artifacts with or without cortex or heat treatment refers to the total assemblage n=1613.

4.4.7.2. CA/AL: Stage 2 – Core preparation

4.4.7.2.1. Crested pieces and lateral core flakes

DIRECTION DORSAL FLAKE SCARS	lat. core flakes n	%
parallel, unidirectional	15	45.5%
parallel, opposing	4	12.1%
bipolar *sensu lato*	4	12.1%
unidirectional-transverse	2	6.1%
bipolar-transverse	2	6.1%
transverse	4	12.1%
other	2	6.1%
Σ	33	100.0%
*w/o**	*2*	*5.7%*

A

PREP. DORSAL SURFACE	crested pieces n	%
primary	27	77.1%
secondary	8	22.9%
Σ	35	100.0%

B

Tab. 117 CA/AL. Artifacts from stage 2 of the reduction sequence: **A** – direction of dorsal flake scars of lateral core flakes (*reference amount: total of lateral core flakes Σ=35) and **B** – crested pieces with primary and secondary preparation of the dorsal surface.

Seventy lateral core and crested flakes and blades remained: 35 lateral core flakes and 35 pieces with a preparation of the dorsal surface. The latter consist of 25 crested blades and 10 crested flakes with mostly primary preparation (**Tab. 117B**).

Half of the lateral core flakes have unidirectional dorsal flake scars that imply a regular previous core pre-preparation or blank production (**Tab. 117A**). Approximately one third of the lateral core flakes (15 pieces) have also a preparation of the dorsal surface: 14 primary and once secondary.

Cortex coverage is very scarce. Only nine crested flakes and nine lateral core flakes have cortex rests and verify an accurate cortex removal.

4.4.7.2.2. Cores and reduction technique

CORE SHAPE	CA		CNP	
	n	*%*	*n*	*%*
conical	36	63.2%	7	87.5%
cylindrical	16	28.1%	1	12.5%
irregular	5	8.8%		0.0%
Σ	57	100%	8	100%
n.s.*	8	12.3%	1	11.1%

Tab. 118 AL. Core shapes (reference amount for the cores with shape not further specified (n.s.) is the total amount of cores in each assemblage CA=65; CNP=9).

Most cores are regularly prepared and reduced. The cores have a conical or cylindrical shape (**Tab. 118**) mostly with one prepared, plain striking platform on top (**Tab. 119A** and **B**). About a quarter of the cores has two opposing or two platforms right-angled. Another quarter of cores has more than two platforms. 80% of the cores have a plain platform and accordingly also more than 80% of flakes and blades with a platform type determined have plain platform remnants (**Tab. 120A**). Plain platform(remnant)s indicate the (re-)preparation of the core platforms by only one trimming flake or core tablet. Additional platform preparations by facetting are rare and more common for blade removal.

PLATFORMS (n)	CA		CNP	
	n	*%*	*n*	*%*
1	31	47.7%	5	55.6%
2 opposing	9	13.8%		
2 right-angled	10	15.4%	2	22.2%
> 2	15	23.1%	2	22.2%
Σ	65	100%	9	100%

A

PLATFORM SURFACE	CA		CNP	
	n	*%*	*n*	*%*
1 negative	52	80.0%	5	55.6%
> 1 negative	7	10.8%	4	44.4%
cortex/natural	2	3.1%		
ridge	4	6.2%		
Σ	65	100%	9	100%

B

Tab. 119 AL. Core platforms (**A**) and platform surfaces (**B**).

PLATFORM REMNANT TYPE	flakes		blades	
	n	*%*	*n*	*%*
type determined	492	56.5%	179	47.4%
natural**	30	6.1%	6	3.4%
joint plane**	1	0.2%	1	0.6%
plain**	442	89.8%	154	86.0%
primary facetted**	3	0.6%		
secondary facetted**	3	0.6%	6	3.4%
facetted (n.s.)**	9	1.8%	9	5.0%
crushed**	4	0.8%	3	1.7%
w/o	379	43.5%	199	52.6%
Σ	871	100%	378	100%
n.s.*	114	11.6%	64	14.5%

A

PLATFORM REMNANT SHAPE	flakes		blades	
	n	*%*	*n*	*%*
shape determined	600	61.3%	239	54.6%
oval**	171	28.5%	64	26.8%
point**	39	6.5%	30	12.6%
linear**	164	27.3%	72	30.1%
triangular**	56	9.3%	27	11.3%
rectangular**	16	2.7%	11	4.6%
irregular**	100	16.7%	21	8.8%
scarred (ventral)**	0	0.0%	1	0.4%
rhombic**	6	1.0%	2	0.8%
winged/wavy**	42	7.0%	8	3.3%
trapezoid**	6	1.0%	3	1.3%
w/o	379	38.7%	199	45.4%
Σ	979	100%	438	100%
n.s.*	6	0.6%	4	0.9%

B

Tab. 120 CA/AL. Types (**A**) and shapes (**B**) of platform remnants of flakes and blades (*reference amount of the type/shape not specified (n.s.) is the total amount of flakes=985 and blades=442; **the type and shape attributes refer to flakes and blades with type/shape determined).

DORSAL REDUCTION	flakes		blades	
	n	*%*	*n*	*%*
with DR	239	39.6%	121	50.0%
w/o DR	365	60.4%	121	50.0%
Σ	604	100%	242	100%
n.s.*	2	0.3%	1	0.004

Tab. 121 CA/AL. Flakes and blades with and without (w/o) dorsal reduction (DR; *blanks with DR not further specified (n.s.) refer to total amount of flakes/blades with proximal ending Σ=606/243).

As displayed in **Fig. 33**, cores are by far larger (cf. weight) than flakes and blades. But the maximum lengths of flakes and blades are by far larger. Minimal core edge lengths are with only 1.6cm similar smaller as the minimum lengths of flakes and blades. Modified cores are smaller than the non-modified specimens.

Frequently an additional reduction of the core edges took place leaving dorsal reductions on 40-50% of the flakes and blades (**Tab. 121**). The dorsal reduction might have supported the removal of probably wider, longer and/or thicker pieces that were necessary during preparation and conducted probably with a hard hammer (**Tab. 35**).

4.4.7.3. CA/AL: Stage 3 – Blank production

The assemblage is dominated by 61.1% flakes vs. 27.4% blades (**Tab. 34**) with a ratio of 2:1 and a flake/blade index of 2.2. These are common amounts that do not indicate any additional inputs of semi-finished blanks. Approximately 60% of the artifacts are regular flakes and blades (cf. **Tab. 32**).

As in CZ/MU, the blank fragments consist to more or less equal amounts of complete blanks, proximal, distal endings or medial fragments (**Tab. 122**). Complete flakes and blades slightly dominate the inventory (about a third). Especially medial fragments are less frequent. Possibly medial fragments were used as inserts in haftings and were taken away.

BLANK FRAGMENTS	flakes						blades						Σ	
	unm.		*mod.*		*Σ*		*unm.*		*mod.*		*Σ*			
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
complete	324	35.6%	16	21.3%	340	34.5%	133	33.8%	7	14.3%	140	31.7%	480	33.6%
proximal	243	26.7%	23	30.7%	266	27.0%	91	23.2%	12	24.5%	103	23.3%	369	25.9%
distal	218	24.0%	9	12.0%	227	23.0%	83	21.1%	7	14.3%	90	20.4%	317	22.2%
medial	125	13.7%	27	36.0%	152	15.4%	86	21.9%	23	46.9%	109	24.7%	261	18.3%
Σ	910	92.4%	75	7.6%	985	100.0%	393	88.9%	49	11.1%	442	100.0%	1427	100.0%

Tab. 122 CA/AL. Preservation of the unmodified (unm.) and modified (mod.) flakes and blades. The complete blanks consist amongst others of 38 non-modified and 5 modified flakes, 5 non-modified and 2 modified blade that are complete in length (in direction of percussion) but incomplete in their width.

Blades have higher mean lengths than flakes, but the maximum values of flakes are larger than the equivalent values of blades (cf. e.g. mean weights in **Tab. 123** and **Fig. 33**). The larger flakes show a more flat dispersal in dimensions (**Fig. 18**), whereas the blades have a denslier scattered width.

The frequencies of present lengths (**Tab. 122** and **Fig. 17**) indicate that the blank production started with 7.5-6cm long pieces and took place on-site. However, small blanks up to 4.5cm length are numerous, whereas larger pieces are underrepresented. Most flakes are between 1-3cm in length and width, whereas most blades are also 1-3cm long but less than 2cm width. Outliers lay beyond these dimensions. Both blank types are up to 1cm width. Edge lengths of cores can be estimated of at least 9cm length.

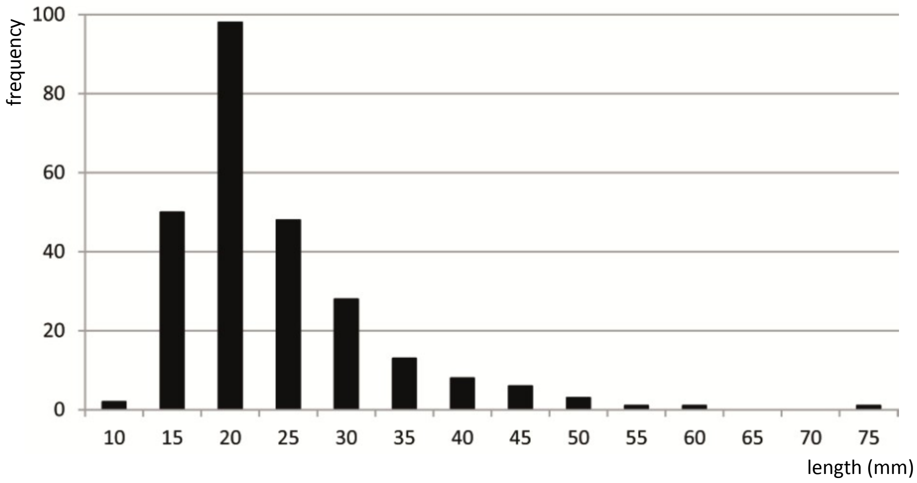


Fig. 17 CA/AL. Length of complete and regular flakes and blades in 5mm-ranges (from 5-10mm, to 15 etc.; Σ=259).

DIMENSIONS	*n*	length (mm)				width (mm)				thickness (mm)				weight (g)			
		MIN	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*
flakes	985	3	88	19.2	8.329	1	58	17.5	7.792	1	22	5.0	2.934	0.1	38.2	2.3	3.826
unmod.	910	6	88	18.8	8.126	1	58	17.2	7.747	1	22	4.8	2.814	0.1	38.2	2.1	3.775
complete	324	8	70	21.2	7.852	2	58	18.7	8.595	1	20	5.2	2.817	0.2	38.2	2.6	4.348
mod.	75	3	46	23.5	9.548	7	45	20.4	7.794	1	18	7.3	3.385	0.1	16.9	4.3	3.906
complete	16	14	33	23.4	6.966	11	45	22.4	8.655	4	15	8.1	2.849	1.1	10.8	4.4	2.905
blades	442	6	74	22.3	9.593	2	27	9.4	3.927	1	17	3.6	2.346	0.1	21.2	1.1	1.896
unmod.	393	6	74	22.1	9.605	2	27	9.5	3.827	1	17	3.7	2.372	0.1	21.2	1.1	1.897
complete	133	13	74	25.3	10.332	2	27	9.4	4.218	1	16	4.1	2.844	0.1	21.2	1.4	2.593
mod.	49	10	52	23.5	9.502	3	25	8.8	4.658	1	10	3.3	2.121	0.1	11.3	1.2	1.903
complete	7	16	45	28.1	11.796	4	16	9.0	4.865	1	10	4.3	3.251	0.1	5.0	1.6	1.832
cores	65	16	66	33.8	11.422	11	52	26.8	9.646	5	39	18.2	6.400	1.7	74.8	21.3	18.269
unmod.	53	16	66	35.5	11.413	13	52	28.0	9.957	5	39	18.3	6.477	2.2	74.8	23.2	19.235
mod.	12	16	42	26.2	8.122	11	30	21.5	5.947	8	27	17.9	6.317	1.7	31.4	13.0	9.991
art. debris	121	11	64	24.7	9.986	5	58	17.1	7.837	3	34	9.7	7.837	0.2	98.3	6.3	12.729
unburned	44	11	64	26.8	10.535	5	41	18.6	8.328	3	29	11.2	5.740	0.3	44.5	7.6	10.175
burned	77	12	64	23.6	9.540	6	58	16.2	7.458	4	34	8.8	5.186	0.2	98.3	5.5	13.984

Tab. 123 CA/AL. Dimensions of unmodified (unmod.) and modified (mod.) blanks.

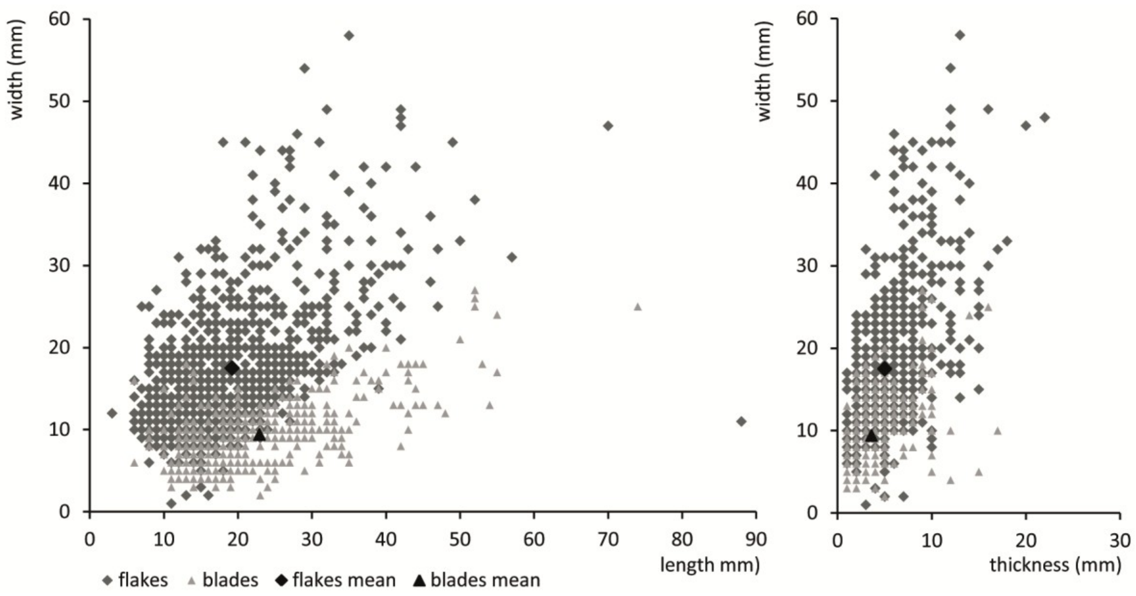


Fig. 18 *(on the previous page!)* CA/AL. Dimensions of flakes and blades in mm.

4.4.7.3.1. Percussion technique

DIRECTION DORSAL FLAKE SCARS	flakes *n*	flakes *%*	blades *n*	blades *%*
dorsal flake scars determined	907	92.2%	442	100%
parallel, unidirectional**	660	72.8%	364	82.4%
parallel,opposing**	20	2.2%	6	1.4%
bipolar sensu lato**	45	5.0%	39	8.8%
unidirectional-transverse**	63	6.9%	20	4.5%
opposing-transverse**	6	0.7%		
bipolar-transverse**	2	0.2%		
transverse**	77	8.5%	9	2.0%
concentric**	1	0.1%		
other**	33	3.6%	4	0.9%
w/o	77	7.8%		
Σ	984	100%	442	100%
n.s.*	1	0.1%		

Tab. 124 CA/AL. Direction of dorsal flake scars of flakes and blades (*blanks with dorsal flake scars not specified (n.s.) refer to the total amount of flakes=985; **directions refer to blanks with dorsal flake scars determined).

Flakes and blades were mostly removed in an unidirectional, parallel way from all around the cores (**Tab. 124** and **Tab. 134A**). 10% of the blades were regularly removed in opposing and bipolar directions. Only very few blades were irregularly reduced in various and transverse directions. In contrast, 20% of the flakes were irregularly removed.

Thus, most flakes and blades were removed during a regular removal of semi-finished target products. Furthermore, 50% of the core reduction faces (**Tab. 136B**) verify that. Irregular dispersed flake scars on 43.5% of the core's reduction faces belong in a later or terminal stadium of core exploitation.

Besides the initial preparation and re-preparation, reduction was obviously subdivided in several cycles: The percussion technique was adapted to the target products and to the conditions of the cores.

IMPACT MARKS	flakes *n*	flakes *%*	blades *n*	blades *%*
with impact ring	13	2.1%	1	0.4%
w/o impact ring	593	97.9%	242	99.6%
with lip	288	47.5%	94	38.7%
w/o lip	218	36.0%	149	61.3%
with bulbar scar	120	19.8%	56	23.0%
w/o bulbar scar	486	80.2%	187	77.0%
with bulb	472	77.9%	185	76.1%
pronounced**	*56*	*11.9%*	*8*	*4.3%*
double**	*1*	*0.2%*		
diffuse**	*407*	*86.2%*	*173*	*93.5%*
splintered**	*8*	*1.7%*	*4*	*2.2%*
w/o bulb	134	22.1%	58	23.9%

Tab. 125 CA/AL. Impact marks on flakes and blades (referring to the total amount of flakes/blades with proximal ending Σ=606/243; **bulb attributes refer to all blanks with bulb).

In addition to the presence of dorsal reduction (**Tab. 121**), the occurrence of pronounced bulbes, single flakes with an impact ring and irregular and wider platform remnants (**Tab. 120B**) are indicators of hard stone percussion and core preparation.

However, diffuse bulbs and finer platform remnants (oval, pointed or linear; **Tab. 120B**) dominate amongst most flakes and especially blades. In addition to the impact lips and bulbar scars present, these characteristics could indicate blade production with a soft hammer.

4.4.7.4. CA/AL: Stage 4 – Re-preparation of the core

Forty-seven pieces prove a re-preparation of cores in situ. 38 plunging flakes or blades and nine core tablets remain. About 75% of the plunging flakes and blades with unidirectional or bipolar dorsal flake scars imply a predominant regular blank production previous to the re-preparation (**Tab. 126A**). However, 10 pieces with transverse and other various dorsal flake scars indicate the rotation of the core during advanced blank production. The core tablets were regularly removed in parallel or transverse dispersal compared to the former platform (direction dorsal flake scars).

From flakes and blades (**Tab. 123**) to stage 4-artifacts (**Tab. 126B**) one can see a decrease in size by half.

DIRECTION DORSAL FLAKE SCARS	plunging pieces *n*	*%*
parallel, unidirectional	24	63.2%
bipolar *sensu lato*	4	10.5%
unidirectional-transverse	5	13.2%
opposing-transverse	1	2.6%
transverse	2	5.3%
other	2	5.3%
Σ	38	100.0%

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	23.1	6.985	9	41
width	15.6	6.938	5	37
thickness	6.1	2.758	2	15
weight	2.3	2.403	0.1	12.7

B

Tab. 126 CA/AL. Artifacts from stage 4 of the reduction sequence: **A** – direction of dorsal flake scars of plunging flakes and blades and **B** – dimensions of core tablets *and* plunging flakes and blades.

4.4.7.5. CA/AL: Stage 5 – Modification and use

The amount of used artifacts is small (17.2%; **Tab. 203**). 146 tools are complemented by 131 blanks without intentional modification but with macroscopically visible use traces. In addition, 29.1% of the tools have more than one modification. These artifacts were intensely use and resharpened in situ. Besides handcrafting, tool inserts (as burins) were produced on-site and used or worn tool inserts were exchanged.

4.4.7.5.1. 5a – Intentional modification

154 artifacts remain in total from stage 5a: 146 tools and eight burin spalls (**Tab. 129**) attest a fabrication of burins on-site. But, in relation to other tool types, burins only occure to a mediocre or small amount.

Generally, the amount of tools is with less than 10% (cf. **Tab. 128**) very low and – in comparison to the other inventories analyzed in this study – the lowest tool amount at all (**Tab. 203**). Nevertheless, the assemblage has a wide tool spectrum and is very divers (cf. Simpson index). Splintered pieces, end scrapers and projectiles are most frequent.

50% of the tools were made of flakes. Approximately one third was made of blades and – a relatively large amount – of cores (8%). Very few chunks were modified. 18.5% of the cores, 11.1% of the blades, 8.3% of the artificial debris and 7.6% of the flakes were intentionally modified. Flakes and blades were not selected in the same proportions, but flakes were favored. Various appearing directions of dorsal flake scars (**Tab. 127A**) on these modified flakes and blades show that not only exclusively regular blanks were required for tools. 40 tools have even remains of cortex. So, regular blanks are not particularly outstanding amongst the tools in CA.

Tools were more often made of large blanks (cf. higher mean dimensions of tools in **Tab. 127B** and mean values of regular blanks in **Tab. 123**). Modified blades are on average a few millimeters larger (cf. mean length in **Tab. 123**). Mean width, thickness and weight imply a fairly fine shape – i.e. small values – of blades that were modified.

DIRECTION DORSAL FLAKE SCARS	tools n	%
parallel, unidirectional	89	74.8%
parallel, opposing	4	3.4%
bipolar *sensu lato*	10	8.4%
unidirectional-transverse	2	1.7%
transverse	9	7.6%
concentric	1	0.8%
other	4	3.4%
Σ	119	100.0%
*w/o**	*5*	*4.0%*

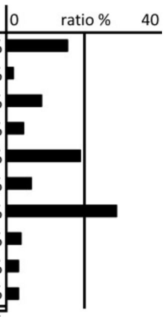
A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	24.5	10.029	3	64
width	16.8	9.381	3	58
thickness	7.3	5.738	3	29
weight	4.8	8.621	0.1	75.8

B

Tab. 127 CA/AL. Artifacts from stage 5a of the reduction sequence: **A** – direction of dorsal flake scars of the modified flakes and blades (*reference amount: total of modified flakes and blades Σ=114) and **B** – dimensions of the tools.

TOOL TYPES	*n*	%
projectiles	24	16.4%
borers	3	2.1%
burins	14	9.6%
truncations	7	4.8%
end scrapers	29	19.9%
lateral retouches	10	6.8%
splintered pieces	43	29.5%
notched pieces	6	4.1%
denticulates	5	3.4%
other	5	3.4%
Σ n	146	100%
% tools/assemblage		*9.1%*



D = 0.168

Tab. 128 CA/AL. Tool spectrum and Simpson diversity index (D).

BURIN SPALLS	*L*	*W*	*T*	*We (g)*
99105	31	7	10	1
99178	24	3	4	0.6
99244	14	6	5	0.3
99249	16	2	5	0.3
99339	12	6	5	0.3
99792	23	2	5	0.2
99952	32	8	7	1.7
99985	35	6	6	0.9

Tab. 129 CA/AL. Burin spalls with ID and dimensions (LxWxT in mm; We in g) indicate the modification of burins on-site.

USE TRACES	ridge rounding	red ocher traces	use traces	other mod.	Σ (n pieces) *n*	*%*	*reference amount*
flakes	1	1	53		55	6.1%	908
blades			72	2	74	19.1%	388
art. debris			2		2	1.8%	111
cores							53
1x ut.	1	1	127	2	**131**	9.0%	1460
2x ut.			27	3	30		
3x ut.			2		2		
Σ (n ut.)	1	1	156	5	163		

Tab. 130 CA/AL. Macroscopically visible use traces (ut.) on pieces without intentional tool modification. The artifacts are listed according to the blank type and refer to unmodified blanks/pieces in the assemblage (one burin spall/bladelet with use traces is included; w/o seven burin spalls: two on flakes and five on bladelets). On several pieces, more than one specific use trace remain (2x ut. etc.; mod. = modification). The reference amount is all unmodified pieces.

4.4.7.5.2. 5b – Use

In addition to the 146 tools, 131 pieces have fine macroscopically visible use traces (**Tab. 130**), i.e. 17.2% of the assemblage were used. 9% of the non-modified pieces have use traces (cf. **Tab. 130**) – especially blades.

The traces are predominantly very fine. The irregular retouches on the edges cannot be associated with a particular activity.

4.4.7.5.3. 5c – Resharpening

Forty-one of the 141 tools have more than one modification (**Tab. 131**). One additional modification is very common. Especially burins and borers have more than one modification. Aditional burin blows were removed from burins and additional working edges were applied to truncations and lateral retouches. Splintered pieces also often have several working edges or several areas with splintering.

TOOL TYPES	n ADDITIONAL MODIFICATION *1*	*2*	*3*	*Σ n*	*%**	*%***	*Σ***	burins	truncations	end scrapers	lateral retouches	splintered pieces	notched pieces
projectiles	1			1	2.4%	4.2%	24	1					
borers	1	1		2	4.9%	66.7%	3		1				2
burins	6	4	1	11	26.8%	78.6%	14	11	2		2	2	
truncations	1			1	2.4%	14.3%	7						1
end scrapers	6	3		9	22.0%	31.0%	29			3	4	5	
lateral retouches	1	1		2	4.9%	20.0%	10				2	1	
splintered pieces	12	1		13	31.7%	30.2%	43					14	
notched pieces		1		1	2.4%	16.7%	6				2		
denticulates		1		1	2.4%	20.0%	5		1		1		
other							5						
Σ n	28	12	1	**41**	100%	28.1%	146	12	4	3	11	22	3
%	68.3%	29.3%	2.4%	100%									

Tab. 131 CA/AL. Tools and additional modifications (*refer to total amount of tools with additional modifications Σ=41; **refer to total number of each tool type Σ**).

4.4.7.6. CA/AL: Stage 6 – Discard

704 reduced, unmodified cores, burned tools and blanks was discarded. Obviously a remarkably large part of the inventory represents only waste from knapping without any further modification. These artifacts were never used (no use traces), but discarded immediately on-site.

41.2% of the artifacts are burned (**Tab. 116**). Color changes and heat pits (**Tab. 53**) are frequent indicators of the exposure of artifacts to fire. These changes are due to destructive firings after the removal of the blank or after tool modification (**Tab. 132**). The heat caused even brakes at a third of heat treated flakes and blades.

TIME HEAT TREATMENT	flakes *n*	*%*	blades *n*	*%*	cores *n*	*%*	art. debris *n*	*%*	Σ *n*	*%*
heating after blank removal	260	61.6%	86	61.0%	19	79.2%	29	37.7%	394	59.3%
thermal fracture	141	33.4%	44	31.2%	2	8.3%	45	58.4%	232	34.9%
heating after modification	21	5.0%	11	7.8%	3	12.5%	3	3.9%	38	5.7%
total with heat treatment	422	100.0%	141	100.0%	24	100.0%	77	100.0%	664	100.0%

Tab. 132 CA/AL. Time of heat treatment on various blank types.

4.4.7.7. CA/AL – Summary: Reconstruction of the reduction sequence

Although the assemblage of CA is by far the largest with more than 1500 recorded artifacts, no indicators of stage 0 remained.

Artifacts of the cortex removal with relatively large amounts of cortex coverage imply a predominant exploitation of primary sources with chalk flint. Up to stage 2 almost all cortex was removed and the core preparation was regular.

The lengths of flakes and blades fluctuate between 6-7.5cm. One single artifact is even of 9cm length. The dimensions range broader in CA than in the Murcian sites, thus one can assume that a broader section of the reduction sequence is represented in the inventory. Indicators of percussion and reduction technique imply hard and soft hammer percussion or possibly alternating use of both techniques for preparation and regular blank production.

The largest blanks were always chosen for tool modification. The blanks were not too regular and are partly covered with cortex or have irregular dorsal flake scars. Tools were not only made of flakes and blades but amongst others also on cores. Burins occured in several assemblages, but burin spalls remained only from a few sites such as CA/AL; no burin spall is preserved from any site analyzed in Murcia. Use traces are comparably frequent. 17.2% of the inventory was used (including tools). About 30% of the tools with additional modifications point to an intense use or resharpening.

Even immediately before core re-preparation, the blank production was very regular. A re-orientation of the core during the blank reduction was only in 25% of the cases necessary. In these cases regular blank removal was impossible, thus it was irregularly continued.

4.4.8. Cabecicos Negros/Almería (CNP/AL)

No nodules are present.

4.4.8.1. CNP/AL: Stage 1 – Cortex removal and preparation of core platform and reduction face

Three artifacts with large amounts of cortex indicate cortex removal and core preparation: Two flakes have dorsal surfaces that are completely covered with pebble cortex (IDs 10570 and 10648) and a thick flake (ID 10581; 5.8g) is covered to two thirds with chalky cortex.

The amount of artifacts with cortex is remarkably low at only 14.2% (**Tab. 133**). The cortex can be mostly characterized as pebble cortex (cf. **Tab. 31**).

CORTEX/HEAT TREATMENT		flakes			Blades			cores			art. debris			Σ*	
		unm.	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*		
with cortex	*n*	24	4	28	2	2	4	1		1	1	1	2	35	
	%	85.7%	14.3%	80.0%	50.0%	50.0%	11.4%	100.0%		2.9%	50.0%	50.0%	5.7%	100%	14.2%
w/o cortex	*n*	56	19	75	86	36	122	5	3	8	5	1	6	211	
	%	74.7%	25.3%	35.5%	70.5%	29.5%	57.8%	62.5%	37.5%	3.8%	83.3%	16.7%	2.8%	100%	85.8%
with heat treatment	*n*	49	14	63	42	14	56	5	1	6	4	1	5	130	
	%	77.8%	22.2%	48.5%	75.0%	25.0%	43.1%	83.3%	16.7%	4.6%	80.0%	20.0%	3.8%	100%	52.8%
w/o heat treatment	*n*	36	4	40	47	23	70	2	1	3	2	1	3	116	
	%	90.0%	10.0%	34.5%	67.1%	32.9%	60.3%	66.7%	33.3%	2.6%	66.7%	33.3%	2.6%	100%	47.2%

Tab. 133 CNP/AL. Cortex coverage and heat treatment of unmodified (unm.) and modified (mod.) blanks. The Σ* of artifacts with or without cortex or heat treatment refers to the total assemblage n=246.

4.4.8.2. CNP/AL: Stage 2 – Core preparation

4.4.8.2.1. Crested pieces and lateral core flakes

The 14 pieces of stage 2 are hardly covered with cortex: Two of the seven lateral core flakes have very small amounts of cortex. Three thereof have a primary preparation of the dorsal surface. The other dorsal flake scars are unidirectionally and transversally dispersed.

In addition four crested blades and three crested flakes remain. One piece has a secondary dorsal preparation.

REDUCTION FACES (n)	CA *n*	CA *%*	CNP *n*	CNP *%*
1	20	30.8%	1	11.1%
2	26	40.0%	3	33.3%
3	13	20.0%	3	33.3%
4	6	9.2%	2	22.2%
Σ	65	100%	9	100%

A

REDUCTION FACES DIRECTION FLAKE SCARS	CA *n*	CA *%*	CNP *n*	CNP *%*
direction determinable	62	98.4%	9	100%
parallel, unidirectional**	26	41.9%	5	55.6%
bipolar *sensu lato***	9	14.5%		
parallel+transversal**	16	25.8%	3	33.3%
bipolar+transversal**	11	17.7%	1	11.1%
1 negative	1	1.6%		
Σ	63	100%	9	100%
n.s.*	2	3%		

B

Tab. 134 AL. Number of core reduction faces (**A**) and direction of flake scars thereon (**B**; *reference amount for the cores with not specified (n.s.) directions of the flake scars on the reduction faces is the total number of cores in CA=65).

PLATFORM REMNANT TYPE	flakes *n*	flakes *%*	blades *n*	blades *%*
type determined	52	54.7%	60	48.4%
natural**	3	5.8%		
joint plane**	1	1.9%	1	1.7%
plain**	45	86.5%	49	81.7%
primary facetted**			3	5.0%
secondary facetted**	2	3.8%	7	11.7%
facetted (n.s.)**	1	1.9%		
w/o	43	45.3%	64	51.6%
Σ	95	100%	124	100%
n.s.*	8	7.8%	2	1.6%

A

PLATFORM REMNANT SHAPE	flakes *n*	flakes *%*	blades *n*	blades *%*
shape determined	60	58.3%	62	49.2%
oval**	22	36.7%	31	50.0%
point**	10	16.7%	6	9.7%
linear**	4	6.7%	6	9.7%
triangular**	6	10.0%	3	4.8%
rectangular**	1	1.7%	1	1.6%
irregular**	8	13.3%	7	11.3%
rhombic**	1	1.7%	1	1.6%
winged/wavy**	5	8.3%	3	4.8%
trapezoid**	3	5.0%	4	6.5%
w/o	43	41.7%	64	50.8%
Σ	103	100%	126	100%

B

Tab. 135 CNP/AL. Types (**A)** and shapes (**B)** of platform remnants of flakes and blades (*reference amount of the type/shape not specified (n.s.) is the total amount of flakes=103 and blades=126; **the type and shape attributes refer to flakes and blades with type/shape determined).

4.4.8.2.2. Cores and reduction technique

Cores are mostly shaped like a cone (**Tab. 118**) with one striking platform on top. The latter was prepared and re-prepared by one trimming flake or core tablet (**Tab. 119A** and **B** cf. **Tab. 135A**).

16.7% of the blades have a facetted platform remnant and indicate facetting of core striking platforms previous to the reduction of blanks.

The maximal core edge length is congruent to the fairly small flakes and blades: Maximum length is less than 5cm and is equal to the maximum length of blades (cf. **Tab. 138**). Thus, one can assume the reduction of small nodules and cores in CNP/AL or the introduction of already initiated cores and the further debitage in situ. Cores were reduced to edge lengths of 1-1.5cm (cf. minimal length, width and thickness of cores in **Tab. 138**). The size of the rest-cores did apparently not influence their sufficiency for modification: The largest and the smallest core were modified.

DORSAL REDUCTION	flakes		blades	
	n	*%*	*n*	*%*
with DR	24	40.0%	21	33.9%
w/o DR	36	60.0%	41	66.1%
Σ	60	100%	62	100%

Tab. 136 CNP/AL. Flakes and blades with and without (w/o) dorsal reduction (DR).

Additionally, the core edges were removed and dorsal reduction remained on approximately 35-40% of blades and flakes (**Tab. 136**). The presence of dorsal reduction indicates at least a partial use of a hard hammer to remove fairly large, thick pieces.

4.4.8.3. CNP/AL: Stage 3 – Blank production

A large amount of artifacts (171) stem from stage 3 (cf. **Tab. 33**). Amongst others 41.9% flakes and 51.2% blades remain (**Tab. 34**). The assemblage of CNP/AL is – with Hoz/MU – one of the analyzed inventories with more blades than flakes. The flake/blade index is 0.8 with a ratio of flakes to blades of 1:2. In addition to on-site-blank production, an import of semi-finished products (blades) took apparently place to fulfill the demand of blades. The underrepresentation of flakes shows less blank production in situ.

Flakes are mostly preserved as proximal fragments and complete pieces (**Tab. 137**). Distal endings and medial fragments represent each approximately 20%. The dominance of medial blade fragments is striking and could imply an additional import of these fragments e.g. as modified parts of composite tools. Complete blades and distal fragments are rare.

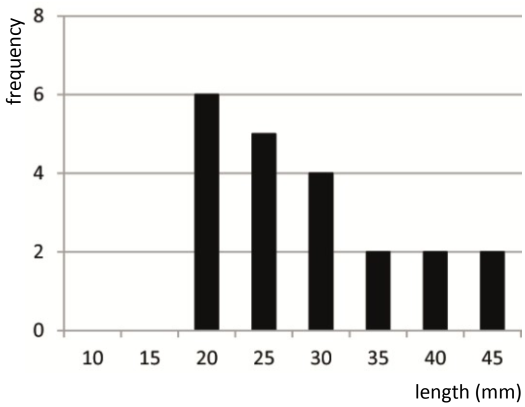


Fig. 19 CNP/AL. Frequency on the y-axis of present lengths in 5mm-ranges (from 5-10mm, to 15 etc.) on the x-axis of complete and regular flakes and blades (Σ=21).

Flakes and blades are very small (cf. **Fig. 33** and **Tab. 138**). Blades slightly longer than flakes, but other dimensions characterize blades as fine blank type. Non-modified flakes are slightly shorter than modified blades, but in all other dimensions larger (cf. especially mean weights in **Tab. 138**). The dispersal of blade thicknesses and widths is much narrower clustered than the equivalent dispersal of flakes (**Fig. 20**, graph on the right). Flakes are widely spread in length and width (left graph of **Fig. 20**). In contrast, blades vary only in length. These variable blanks (variance in blank dimensions; **Tab. 138**) imply that continuous parts of the reduction sequence took place on-site (**Fig. 19**). However, débitage stem from smaller, already reduced cores with approximate edge length of 5cm (cf. maximum values), thus complete blanks range between 4.5-2.0cm length. Large pieces and very small blanks (≤ 1.5cm) are lacking. Consequently and in combination with the scarce core preparation on-site, cores possibly arrived in CNP/AL in an already reduced stadium (cf. **4.4.8.1. CNP/AL: Stage 1 – Cortex removal and preparation of core platform and reduction face**). Alternatively, large pieces were modified into tools or inserted into hafts and were taken off-site.

BLANK FRAGMENTS	flakes						blades						Σ	
	unm.		*mod.*		*Σ*		*unm.*		*mod.*		*Σ*			
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
complete	25	31.3%	4	17.4%	29	28.2%	14	15.7%	4	10.8%	18	14.3%	47	20.5%
proximal	25	31.3%	6	26.1%	31	30.1%	38	42.7%	6	16.2%	44	34.9%	75	32.8%
distal	20	25.0%	3	13.0%	23	22.3%	10	11.2%	5	13.5%	15	11.9%	38	16.6%
medial	10	12.5%	10	43.5%	20	19.4%	27	30.3%	22	59.5%	49	38.9%	69	30.1%
Σ	80	77.7%	23	22.3%	103	100.0%	89	70.6%	37	29.4%	126	100.0%	229	100.0%

Tab. 137 CNP/AL. Preservation of the unmodified (unm.) and modified (mod.) flakes and blades. The complete blanks consist amongst others of 3 non-modified and 4 modified flakes and 3 modified blade that are complete in length (in direction of percussion) but incomplete in their width.

DIMENSIONS	*n*	length (mm)				width (mm)				thickness (mm)				weight (g)			
		MIN	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*
flakes	103	7	42	19.6	7.03	7	47	17.4	6.98	1	19	5.8	3.37	0.1	15.2	2.5	2.85
unmod.	80	7	42	19.1	7.02	7	47	17.0	6.59	2	19	5.6	3.28	0.2	15.2	2.2	2.65
complete	25	15	42	23.5	7.03	8	47	20.3	8.48	2	14	6.3	3.57	0.4	12.0	3.2	3.11
mod.	23	9	38	21.5	6.88	8	39	18.8	8.18	1	17	6.6	3.63	0.1	12.0	3.2	3.40
complete	4	19	34	24.3	7.09	13	33	20.3	9.00	4	8	5.5	1.73	1	9.5	3.4	4.08
blades	126	6	48	21.3	8.04	3	16	9.1	2.17	1	28	3.0	2.51	0.1	4.1	0.6	0.55
unmod.	89	6	48	21.0	7.81	3	16	9.2	2.27	1	28	3.0	2.88	0.1	4.1	0.6	0.52
complete	14	13	43	27.6	9.96	4	15	7.8	2.69	1	28	4.6	6.89	0.2	2.0	0.7	0.51
mod.	37	11	41	22.2	8.60	4	13	9.0	1.94	1	8	2.9	1.26	0.1	3.0	0.7	0.61
complete	4	26	41	34.8	7.50	8	12	10.0	1.63	3	8	4.5	2.38	0.4	3.0	1.5	1.13
cores	9	14	48	30.2	10.57	12	33	21.6	6.67	11	31	17.9	6.17	2.8	45.5	15.5	13.09
unmod.	6	25	42	31.7	6.28	15	33	23.7	6.56	14	31	20.0	6.42	7.5	45.4	18.7	14.40
mod.	3	14	48	27.3	18.15	12	23	17.3	5.51	11	17	13.7	3.06	2.8	18.8	9.2	8.45
art. debris	8	17	33	23.8	6.32	14	27	18.1	4.52	4	14	9.6	3.62	0.8	12.4	4.7	3.87
unburned	3	17	33	25.3	8.02	14	22	17.3	4.16	13	14	13.3	0.16	3.4	7.1	5.8	2.08
burned	5	18	33	22.8	5.89	14	27	18.6	5.13	4	11	7.4	2.51	0.8	12.4	4.0	4.75

Tab. 138 CNP/AL. Dimensions of unmodified (unmod.) and modified (mod.) blanks.

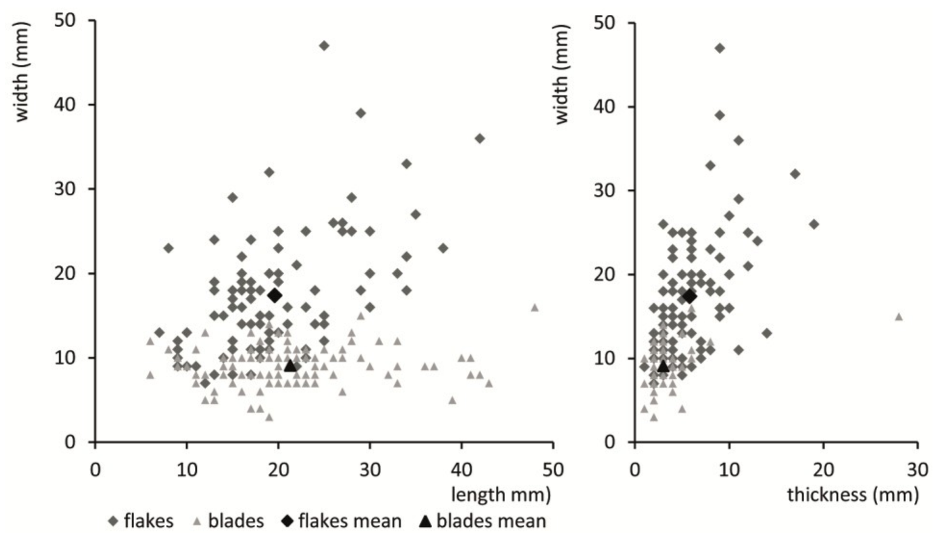


Fig. 20 CNP/AL. Dimensions of flakes and blades.

4.4.8.3.1. Percussion technique

Directions of dorsal flake scars of flakes and blades (**Tab. 139**) and of core reduction faces (**Tab. 134B**) predominantly show a regular parallel, unidirectional removal. This regular reduction is characteristic for the removal of semi-finished target products. However, 28.6% of the dorsal flake scars on flakes disperse in less regular and various directions. 44.4% of the cores have transverse flake scars on the reduction faces. These flake scars indicate a re-orientation of the cores – likely during the preparation or the terminal reduction of the core.

Dominant impact marks are diffuse bulbs (**Tab. 140**). The combination of these diffuse bulbs with the occurance of impact lips, bulbar scars, and fine platform remnants (**Tab. 135B**) indicates a soft hammer percussion, e.g. with an organic percussor. Impact lips occur frequently on blades and also on flakes. Bulbar scars were only observed on 20-25% of the blades and flakes.

In contrast, 15-20% of the blades and flakes show pronounced bulbs (**Tab. 140**). Further indicators of the use of a hard rock percussor are irregular and wide platform remnants (**Tab. 135B**) and the large amount of dorsal reduction (**Tab. 136**).

DIRECTION DORSAL FLAKE SCARS	flakes		blades	
	n	*%*	*n*	*%*
dorsal flake scars determined	91	88.3%	124	98.4%
parallel, unidirectional**	55	60.4%	118	95.2%
parallel,opposing**	5	5.5%		
bipolar sensu lato**	5	5.5%	3	2.4%
unidirectional-transverse**	4	4.4%		
bipolar-transverse**	1	1.1%		
transverse**	13	14.3%	1	0.8%
concentric**	1	1.1%		
other**	7	7.7%	2	1.6%
w/o	12	11.7%	2	1.6%
Σ	103	100%	126	100%

Tab. 139 CNP/AL. Direction of dorsal flake scars of flakes and blades (**directions refer to blanks with dorsal flake scars determined).

IMPACT MARKS	flakes		blades	
	n	*%*	*n*	*%*
with impact ring	1	1.7%		
w/o impact ring	59	98.3%	62	100%
with lip	23	38.3%	38	61.3%
w/o lip	37	61.7%	24	38.7%
with bulbar scar	15	25.0%	13	21.0%
w/o bulbar scar	45	75.0%	49	79.0%
with bulb	45	75.0%	50	80.6%
pronounced**	*10*	*22.2%*	*8*	*16.0%*
diffuse**	*34*	*75.6%*	*40*	*80.0%*
splintered**	*1*	*2.2%*	*2*	*4.0%*
w/o bulb	15	25.0%	12	19.4%

Tab. 140 CNP/AL. Impact marks on flakes and blades (referring to the total amount of flakes/blades with proximal ending Σ=60/62; **bulb attributes refer to all blanks with bulb).

4.4.8.4. CNP/AL: Stage 4 – Re-preparation of the core

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	19.7	6.914	10	35
width	11.9	4.470	7	22
thickness	4.9	1.870	2	8
weight	1.0	0.910	0.2	3.7

Tab. 141 CNP/AL. Dimensions of artifacts from stage 4 of the reduction sequence.

Five plunging flakes and blades with mostly regular unidirectional or opposing dorsal flake scars indicate a mostly regular blank reduction previous to the core re-preparation. Three core tablets were removed parallel to the former core platform.

The maximum values prove a core edge length in stage 4 of 3.5cm (**Tab. 141**) that is approximately 1cm smaller than during blank production (cf. **Tab. 138**).

4.4.8.5. CNP/AL: Stage 5 – Modification and use

Approximately 59.8% of the artifacts were used as specialized tools and furthermore, a particularly large amount of blanks was used. 20 tools have additional modifications. The tool spectrum points to the processing of various resources, e.g. lateral retouched pieces could have been meant for sickle inserts.

DIRECTION DORSAL FLAKE SCARS	tools n	tools %
parallel, unidirectional	45	78.9%
bipolar	1	1.8%
bipolar-transverse	1	1.8%
transverse	5	8.8%
concentric	1	1.8%
other	4	7.0%
Σ	57	100.0%
*w/o**	*1*	*1.7%*

A

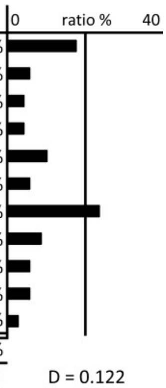
DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	22.3	8.571	9	48
width	13.2	7.114	4	29
thickness	5.1	3.878	4	17
weight	2.2	3.373	0.1	18.8

B

Tab. 142 CNP/AL. Artifacts from stage 5a of the reduction sequence: **A** – direction of dorsal flake scars of the modified flakes and blades (*reference amount: total of modified flakes and blades Σ=58) and **B** – dimensions of the tools.

4.4.8.5.1. 5a – Intentional modification

TOOL TYPES	*n*	*%*
projectiles	12	18.5%
borers	4	6.2%
sickles	3	4.6%
burins	3	4.6%
truncations	7	10.8%
end scrapers	4	6.2%
lateral retouches	16	24.6%
splintered pieces	6	9.2%
notched pieces	4	6.2%
denticulates	4	6.2%
other	2	3.1%
Σ n	65	100%
% tools/assemblage		*26.4%*



Tab. 143 CNP/AL. Tool spectrum and Simpson diversity index (D).

BURIN SPALLS	*L*	*W*	*T*	*We (g)*
10514	13	6	4	0.3
10522	18	4	5	0.4

Tab. 144 CNP/AL. Burin spalls with ID and dimensions (LxWxT in mm; We in g) indicate the modification of burins on-site.

Sixty-five tools and two burin spalls are preserved. The tool amount accounts for 26.4% (**Tab. 143**). Lateral retouches and projectiles dominate. With 11 different tool types, the assemblage of CNP/AL has the widest tool spectrum. Nevertheless, the Simpson index is low and indicates no notably specialization on-site.

In addition to the 48 modified regular blanks, 17 irregular blanks – i.e. irregular flakes and blades, three cores and two chunks – were modified. Cortex remain on six artifacts. The tool assemblage consists predominantly of blades (55%) and only to one third of flakes. 29.4% of the blades and 22.3% of the flakes were modified. Moreover, three of the nine cores and two of the eight chunks were modified into tools.

The blanks selected for tools were generally 2mm larger (**Tab. 142B**).

Two burin spalls prove the modification of burins on-site (**Tab. 144**). Nevertheless, burins are not very frequent in the tool assemblage (cf. **Tab. 143**). Possibly burins were produced on-site and subsequently taken off-site.

4.4.8.5.2. 5b – Use

In addition to 65 tools 82 otherwise non-modified pieces have macroscopically visible use traces (**Tab. 145**), but no concrete actions can be assigned.

4.4.8.5.3 5c – Resharpening

More than 30% of the tools are modified two or three times (**Tab. 146**). Five of the 16 pieces with lateral retouch do have an additional working edge with another retouch. Furthermore, edges of 10 other tools were laterally retouched.

USE TRACES	edge rounding	use traces	other mod.	Σ (n pieces) *n*	*%*	*reference amount*
flakes		21		21	26.3%	80
blades		58		58	66.7%	87
art. debris						6
cores		1		1	16.7%	6
1x ut.		80	2	**82**	45.8%	179
2x ut.		35	2	37		
3x ut.	1	4		5		
Σ (n ut.)	1	119	4	124		

Tab. 145 CNP/AL. Macroscopically visible use traces (ut.) on pieces without intentional tool modification. The artifacts are listed according to the blank type and refer to unmodified blanks/pieces in the assemblage (w/o 2 burin spalls on bladelets). On several pieces, more than one specific use trace remain (2x ut. etc.; mod. = modification). The reference amount is all unmodified pieces.

TOOL TYPES	n ADDITIONAL MODIFICATION *1*	*2*	*Σ n*	*%**	*%***	*Σ***	burins	truncations	end scrapers	lateral retouches	splintered pieces	notched pieces
projectiles						12						
borers						4						
sickles		1	1	5.0%	33.3%	3		1		1		
burins	2		2	10.0%	66.7%	3	1			1		
truncations	2	1	3	15.0%	42.9%	7			1	3		
end scrapers	1	2	3	15.0%	75.0%	4				2	1	2
lateral retouches	5		5	25.0%	31.3%	16				5		
splintered pieces	2	1	3	15.0%	50.0%	6					4	
notched pieces	1		1	5.0%	25.0%	4				2		
denticulates	2		2	10.0%	50.0%	4			1	1		
other						2						
Σ n	15	5	**20**	100%	30.8%	65	1	1	2	15	5	2
%	75.0%	25.0%	100%									

Tab. 146 CNP/AL. Tools and additional modifications (*refer to total amount of tools with additional modifications Σ=20; **refer to total number of each tool type Σ**).

4.4.8.6. CNP/AL: Stage 6 – Discard

128 artifacts were obviously discarded: 122 pieces are burned (including three thermal debris) and six finally reduced cores.

Exposure to fire frequently occured in CNP: 52.8% of the artifacts show changes in color, heat pitted surfaces or even gloss (cf. **Tab. 53**) caused by heat treatment. Probably most artifacts were exposed to fire after discarding (cf. time heat treatment in **Tab. 147**). One single piece was possibly tempered (raw material heated and flake removed).

TIME HEAT TREATMENT	flakes		blades		cores		art. debris		Σ	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
raw material heated	1	1.6%							1	0.8%
heated after blank removal	31	49.2%	26	46.4%	3	50.0%	1	20.0%	61	46.9%
thermal fracture	21	33.3%	19	33.9%	1	16.7%	4	80.0%	45	34.6%
heated after modification	10	15.9%	11	19.6%	2	33.3%			23	17.7%
total with heat treatment	63	100.0%	56	100.0%	6	100.0%	5	100.0%	130	100.0%

Tab. 147 CNP/AL. Time of heat treatment of blanks.

4.4.8.7. CNP/AL – Summary: Reconstruction of the reduction sequence

The early stages of the reduction sequence are hardly represented. Nodules are absent and there is no evidence of raw material procurement. Only three pieces indicate an at least partial cortex removal on-site. Artifacts from stage 2 have very small rests of cortex and demonstrate a careful, previous cortex removal.

The reduction process is regular, but the reduction on-site seemly started with already initiated, partly exploited, smaller cores and required various percussion techniques. Possibly initiated cores were imported. Large blanks were selected as tools and taken off-site. Many artifacts were intensely used for handcrafts.

4.4.9. Cueva de la Carigüela/Granada (Car/GR)

Nodules are absent.

4.4.9.1. Car/MU: Stage 1 – Cortex removal and preparation of core platform and reduction face

Car STAGE 1	flakes + cortex		ratio on dorsal surface	
	n	*%*	*≥ 2/3*	*complete*
pebble cortex	5	71.4%	2	3
chalky cortex	2	28.6%		2
Σ	7	100.0%	2	5

Tab. 148 Car/GR. Artifacts from stage 1 of the reduction sequence: Flakes with more than 2/3 cortex-ratio on the dorsal surface.

Seven artifacts with large amounts of cortex imply an initial core preparation on-site (**Tab. 148**).

Generally a medium to large amount of 28% of the artifacts is still covered with cortex (**Tab. 149**). Pebble cortex dominates two thirds of the cortex-covered artifacts and only one third of these have remains of chalky cortex (cf. **Tab. 31** and **Fig. 6**) indicating a primary source. Most raw material originated from a secondary source of fluvial transportation.

CORTEX/HEAT TREATMENT		flakes			blades			cores			art. debris			Σ*	
		unm.	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*		
with cortex	*n*	60	24	84	18	7	25	10	6	16	9	1	10	135	
	%	71.4%	28.6%	62.2%	72.0%	28.0%	18.5%	62.5%	37.5%	11.9%	90.0%	10.0%	7.4%	100%	28.0%
w/o cortex	*n*	180	61	241	42	23	65	5	9	14	24	4	28	348	
	%	74.7%	25.3%	69.3%	64.6%	35.4%	18.7%	35.7%	64.3%	4.0%	85.7%	14.3%	8.0%	100%	72.0%
with heat treatment	*n*	155	53	208	25	14	39	6	5	11	26	3	29	287	
	%	74.5%	25.5%	72.5%	64.1%	35.9%	13.6%	54.5%	45.5%	3.8%	89.7%	10.3%	10.1%	100%	59.4%
w/o heat treatment	*n*	85	32	117	35	16	51	9	10	19	7	2	9	196	
	%	72.6%	27.4%	59.7%	68.6%	31.4%	26.0%	47.4%	52.6%	9.7%	77.8%	22.2%	4.6%	100%	40.6%

Tab. 149 Car/GR. Cortex coverage and heat treatment of unmodified (unm.) and modified (mod.) blanks. The Σ* of artifacts with or without cortex or heat treatment refers to the total assemblage n=483.

4.4.9.2. Car/GR: Stage 2 – Core preparation

4.4.9.2.1. Crested pieces and lateral core flakes

DIRECTION DORSAL FLAKE SCARS	lat. core flakes *n*	*%*
parallel, unidirectional	8	28.6%
parallel, opposing	1	3.6%
bipolar *sensu lato*	2	7.1%
unidirectional-transverse	7	25.0%
opposing-transverse	1	3.6%
bipolar-transverse	2	7.1%
transverse	4	14.3%
other	3	10.7%
Σ	28	100.0%
*w/o**	*1*	*3.4%*

Tab. 150 Car/GR. Lateral core flakes with the direction dorsal flake scars (*reference amount: total of lateral core flakes Σ=29).

Thirty-six lateral core flakes and crested flakes and blades indicate core preparation on-site.

Twenty-nine lateral core flakes remained: Ten thereof have cortex rests and the dorsal surfaces of five pieces are prepared (three artifacts with primary and two artifacts with secondary preparation). The direction of the dorsal flake scars varies severely (**Tab. 150**) and implies a multi-directional core preparation or following blank reduction.

The seven crested pieces consist of four blades and three flakes with five times primary and twice secondary dorsal preparation. Three artifacts are covered with small amounts of cortex. Generally, hardly any cortex is left on these pieces showing an accurate previous cortex removal.

4.4.9.2.2. Cores and reduction technique

Conical cores dominate (**Tab. 151A**). Numbers and positions of striking platforms vary (**Tab. 151A**), but most common was the (re-)preparation of the platform with one trimming flake or a core tablet (cf. **Tab. 151C**).

The cores are large (cf. **Fig. 33**). Their average edge length is ca 5x3.7x2.5cm (**Tab. 155**). The largest core measures almost 10cm, whereas the smallest specimen is still 3cm long. Apparently, these cores were insufficient for the (bigger) blanks needed in Car/GR or indicate absolutely no raw material shortage. Fairly large cores were preferred for tool modification. The mean weight of modified cores is 75.3g vs. 47.6g of non-modified cores.

The platform remnants on flakes and blades (**Tab. 152A**) also indicate a previous preparation of the striking platform by the removal of a core tablet. Remaining natural surfaces or additional faceting of the platform remnants marginally appears.

The core edges were frequently prepared, so almost half of the flakes and blades are dorsally reduced (**Tab. 153**; cf. indicator of hard hammer; cf. **Tab. 35**).

A

CORE SHAPE	Car *n*	*%*
conical	18	62.1%
cylindrical	8	27.6%
irregular	2	6.9%
other	1	3.4%
Σ	29	100%
n.s.*	1	3.3%

B

PLATFORMS (n)	Car *n*	*%*
1	11	37.9%
2 opposing	9	31.0%
2 right-angled	5	17.2%
2/red. faces$^{\Delta}$	1	3.4%
> 2	3	10.3%
Σ	29	100%
n.s.*	1	3.3%

C

PLATFORM SURFACE	Car *n*	*%*
1 negative	24	80.0%
> 1 negative	3	10.0%
cortex/natural	1	3.3%
ridge	2	6.7%
Σ	30	100%

Tab. 151 Car/GR. Cores: **A**- shapes; **B** - platforms; **C** - platform surfaces (*reference amount for the cores with not further specified characteristic (n.s.) is the total amount of cores in Car/GR Σ=30; $^{\Delta}$two platforms mutually serve as reduction faces).

PLATFORM REMNANT TYPE	flakes		blades	
	n	*%*	*n*	*%*
type determined	218	70.6%	58	69.0%
natural**	15	6.9%	3	5.2%
plain**	178	81.7%	49	84.5%
primary facetted**	2	0.9%		
secondary facetted**	9	4.1%	1	1.7%
facetted (n.s.)**	8	3.7%	2	3.4%
crushed**	5	2.3%	3	5.2%
natural+secondary facetted**	1	0.5%		
w/o	91	29.4%	26	31.0%
Σ	309	100%	84	100%
n.s.*	16	4.9%	6	6.7%

A

PLATFORM REMNANT SHAPE	flakes		blades	
	n	*%*	*n*	*%*
shape determined	232	71.8%	63	70.8%
oval**	77	33.2%	20	31.7%
point**	12	5.2%	5	7.9%
linear**	34	14.7%	13	20.6%
triangular**	21	9.1%	9	14.3%
rectangular**	14	6.0%	2	3.2%
irregular**	53	22.8%	5	7.9%
rhombic**	2	0.9%		
winged/wavy**	15	6.5%	8	12.7%
trapezoid**	4	1.7%	1	1.6%
w/o	91	28.2%	26	29.2%
Σ	323	100%	89	100%
n.s.*	2	0.6%	1	1.1%

B

Tab. 152 Car/GR. Types (**A)** and shapes (**B)** of platform remnants of flakes and blades (*reference amount of the type/shape not specified (n.s.) is the total amount of flakes=325 and blades=90; **the type and shape attributes refer to flakes and blades with type/shape determined).

4.4.9.3. Car/GR: Stage 3 – Blank production

DORSAL REDUCTION	flakes		blades	
	n	*%*	*n*	*%*
with DR	112	47.9%	31	48.4%
w/o DR	122	52.1%	33	51.6%
Σ	234	100%	64	100%

Tab. 153 Car/GR. Flakes and blades with and without (w/o) dorsal reduction (DR).

219 regular flakes and blades are indicators of stage 3 (cf. **Tab. 33**). The whole assemblage consists of 67.3% flakes and 18.6% blades (**Tab. 34**). Flakes outweigh blades by a ratio of 7:2 or ca 3:1 and the flake/blade-index is 3.6. The frequency of blades in Car is even lower than the small amount of the Early Neolithic assemblage of A6/MA. Besides the blank production on-site, one can possibly assume an export of blades (mobile group and or exchange of target products).

Blank fragments consist to about 40-45% of complete flakes and blades (**Tab. 154**). Proximal endings represent another quarter, whereas distal and medial fragments are underrepresented.

BLANK FRAGMENTS	flakes						blades						Σ	
	unm.		*mod.*		*Σ*		*unm.*		*mod.*		*Σ*			
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
complete	124	51.7%	20	23.5%	144	44.3%	32	53.3%	6	20.0%	38	42.2%	182	43.9%
proximal	59	24.6%	31	36.5%	90	27.7%	14	23.3%	12	40.0%	26	28.9%	116	28.0%
distal	34	14.2%	13	15.3%	47	14.5%	6	10.0%	3	10.0%	9	10.0%	56	13.5%
medial	23	9.6%	21	24.7%	44	13.5%	8	13.3%	9	30.0%	17	18.9%	61	14.7%
Σ	240	73.8%	85	26.2%	325	100.0%	60	66.7%	30	33.3%	90	100.0%	415	100.0%

Tab. 154 Car/GR. Preservation of the unmodified (unm.) and modified (mod.) flakes and blades. The complete blanks consist amongst others of 16 non-modified and 10 modified flakes, 2 non-modified and 5 modified blades that are complete in length (in direction of percussion) but incomplete in their width.

Analogue to the big cores, the by far largest flakes and blades are preserved in the assemblage of Car/GR (cf. **Fig. 33** and **Tab. 155**). In comparison, artifacts from Car are 1-2cm larger and wider as pieces from the other sites (cf. **Tab. 155**). But artifacts vary broader in their dimensions (**Fig. 21**, **Fig. 22**). Generally flakes have a much wider span in dimensions (especially in the widths; **Fig. 21** and **Fig. 22**). The histogram of lengths (**Fig. 21**) implies that the complete reduction sequence took place on-site. Almost the whole range of sizes is present on-site (**Fig. 23**) and implies a continuous blank production with a sudden preliminary termination, when the cores became smaller than 2cm.

DIMENSIONS	n	length (mm)				width (mm)				thickness (mm)				weight (g)			
		MIN	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*
flakes	325	14	70	35	12.47	10	79	32.6	11.82	1	37	9.9	4.944	0.7	134	13.0	16.22
unmod.	240	14	79	35	12.43	10	79	31.6	31.55	2	37	9.7	5.106	0.7	134	12.2	16.67
complete	124	17	79	37	13.26	13	79	33.5	13.09	2	37	9.9	5.582	0.7	134	14.7	21.06
mod.	85	14	78	38	12.32	12	59	35.4	11.63	1	28	10.5	4.426	1.4	109	15.2	14.75
complete	20	22	60	38	10.80	15	59	35.2	12.80	4	19	10.2	3.928	1.7	32	12.6	8.96
blades	90	17	94	45	14.28	9	41	19.5	5.72	2	17	7.1	3.024	0.6	53	7.2	7.39
unmod.	60	23	94	43	14.43	9	41	17.8	5.71	3	16	6.9	2.879	0.6	53	6.3	7.90
complete	32	23	94	46	16.54	10	41	18.8	6.77	3	16	7.4	2.961	0.6	53	7.9	9.98
mod.	30	17	76	50	12.91	15	31	22.9	4.01	2	17	7.6	3.285	3	32	9.1	5.96
complete	6	47	76	58	10.27	19	31	23.8	4.83	7	9	7.8	0.983	7	17	10.7	3.69
cores	30	30	97	49	13.40	22	62	39.2	9.43	12	46	27.4	8.692	13	204	61.5	47.91
unmod.	15	33	97	48	15.87	23	62	37.3	9.78	12	46	25.1	8.972	13	173	47.6	40.53
mod.	15	30	66	49	10.94	22	55	41.1	8.98	18	45	29.7	8.042	14	204	75.3	51.97
art. debris	38	18	72	37	11.30	12	48	27.1	9.13	4	25	11.6	4.936	1.1	125	15.5	20.95
unburned	9	27	72	45	14.27	13	48	30.0	11.12	8	25	14.7	5.431	4.8	125	29.5	37.39
burned	29	18	52	35	9.05	12	47	26.2	8.44	4	22	10.6	4.436	1.1	42	11.2	9.94

Tab. 155 Car/GR. Dimensions of unmodified (unmod.) and modified (mod.) blanks.

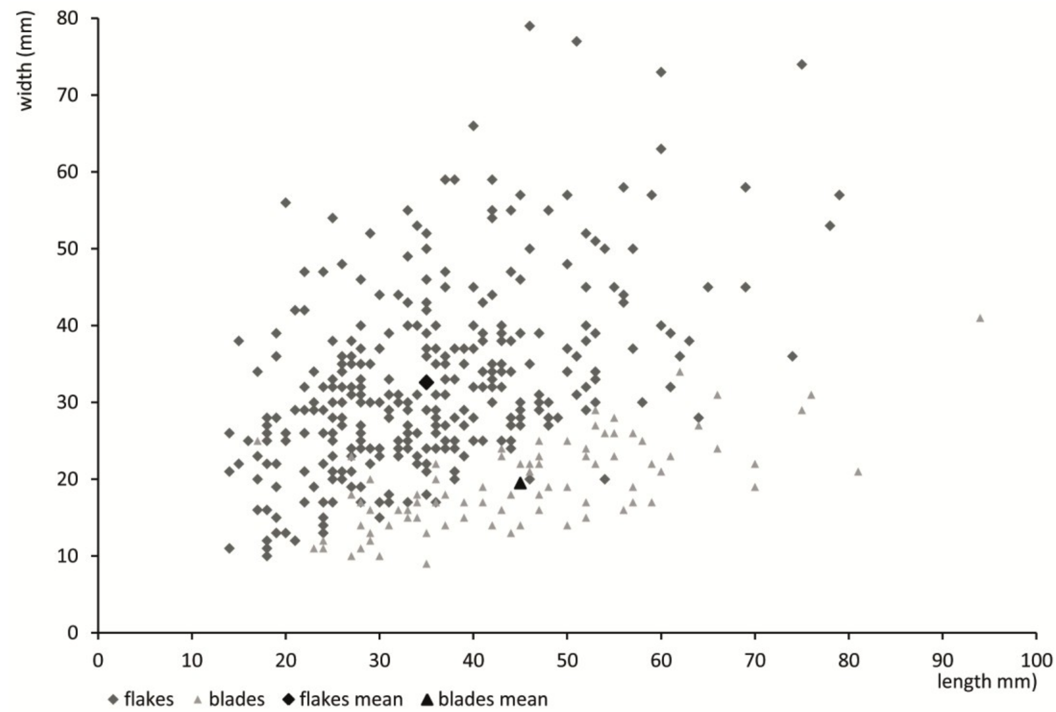


Fig. 21 Car/GR. Lengths and widths of flakes and blades in mm.

4.4.9.3.1. Percussion technique

Most flakes and blades were removed in a parallel and unidirectional way (**Tab. 156**). Blades were additionally removed in alternating parallel directions (bipolar *sensu lato*). 36.4% of dorsal flake scars of flakes disperse in an irregular way in two or more directions.

In addition, the reduction faces of the cores imply a reduction of blanks all around the core (**Tab. 157A**): 55% show parallel and bipolar directions of the dorsal flake scars (**Tab. 157A**). Besides these directions, the rest of the cores was transversally reduced during a terminal reduction stage.

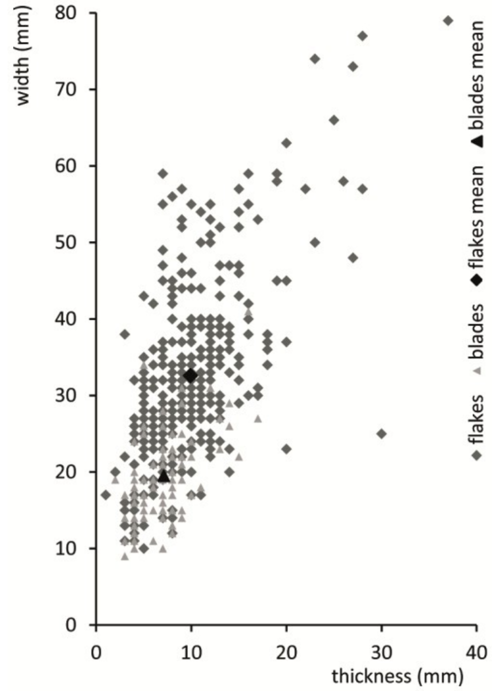


Fig. 22 Car/GR. Thicknesses and widths of flakes and blades in mm.

Thus, the blanks show a regular, systematic reduction. Blanks with irregular dorsal flake scars could originate from preparation or the terminal core exploitation. Preparation and final core exploitation were conducted differing from the common scheme to receive as many blanks as possible previous to the discarding of the completely exhausted core.

Based on the impact marks (**Tab. 158**) one can conclude separated percussion techniques for preparation and blank production: On the one hand the dominant diffuse bulbs, 65% of the artifacts with impact lip and 30% with bulbar scar point to a soft/organic hammer possibly used for the removal of blanks. On the other hand 20% of the artifacts have pronounced bulbs and a striking amount of 10% flakes have even impact rings. These attributes are fairly characteristic for artifacts removed with a hard hammer.

In addition, fine or wide platform remnants could support one or the other percussion technique (**Tab. 152B** and cf. **Tab. 35**), whereas dorsal reductions aimed at the removal of large artifacts with a hard hammer (**Tab. 35**).

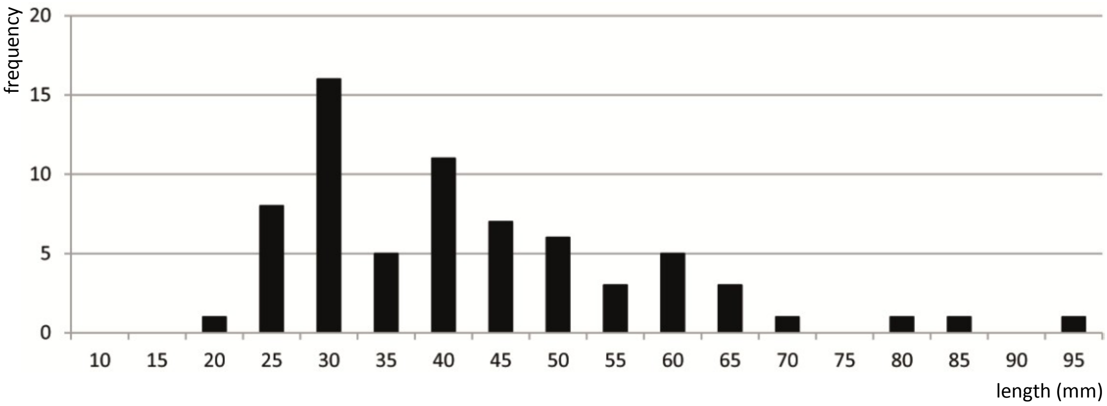


Fig. 23 Car/GR. Lengths of complete and regular flakes and blades in 5mm-ranges (from 5-10mm, to 15 etc.; Σ=69).

4.4.9.4. Car/GR: Stage 4 – Re-preparation of the core

12 pieces remain from the re-preparation of the core. The 10 plunging flakes and blades prove a fairly regular previous blank production with parallel unidirectional and bipolar flake scars on the dorsal surfaces (eight times). Dorsal flake scars of two artifacts are unidirectional-transverse or concentric. Additionally, two core tablets are removed once parallel and once transverse to the former platform.

The comparison of maximum values of stage 4-artifacts (**Tab. 159**) with these of stage 3-blanks shows a reduction in size during the blank production of approximately 2cm (cf. **Tab. 155**). **Fig. 23** allows no identification of any reduction cycle by gaps in frequencies.

DIRECTION DORSAL FLAKE SCARS	flakes		blades	
	n	*%*	*n*	*%*
dorsal flake scars determined	310	95.4%	87	96.7%
parallel, unidirectional**	170	54.8%	58	66.7%
parallel,opposing**	6	1.9%	2	2.3%
bipolar *sensu lato***	21	6.8%	15	17.2%
unidirectional-transverse**	47	15.2%	6	6.9%
opposing-transverse**	4	1.3%	1	1.1%
bipolar-transverse**	10	3.2%	3	3.4%
transverse**	32	10.3%	1	1.1%
concentric**	5	1.6%		
other**	15	4.8%	1	1.1%
w/o	15	4.6%	3	3.3%
Σ	325	100%	90	100%

Tab. 156 Car/GR. Direction of dorsal flake scars of flakes and blades (**directions refer to blanks with dorsal flake scars determined).

4.4.9.5. Car/GR: Stage 5 – Modification and use

48.7% of the artifacts were obviously once in use: 135 pieces have intentional tool modifications and on 100 blanks one can observe fine, macroscopically visible use traces remaining from their use. In addition, 65 tools have more than one modification, thus people intensively handcrafted on-site.

4.4.9.5.1. 5a – Intentional modification

135 tools represent the intentional modification, i.e. an amount of 28% in relation to the whole assemblage (**Tab. 160**). In comparison this is the highest amount of tools comparable to Hoz/MU and CNP/AL (cf. **Tab. 203**). Amongst the tools, splintered pieces and pieces with lateral retouches are predominating. Neither burins nor burin spalls indicate the existence of burins on-site. The Simpson index is slightly above 0.2 as in the Early Neolithic inventory of A6/MA. Thus, the tool diversity of these assemblages is high, but – in comparison to the other assemblages – the tool spectrum is slightly less divers and slightly points to more specialization.

Thirty-eight tools have cortex remains, two thirds are made of flakes, 20% of blades and 10% of cores. The largest transformation rate into tools have cores: Half thereof are modified (15 modified cores). 33.3% of the blades, 26.2% of the flakes and 13.2% of the artificial debris were modified.

Modified flakes and blades have various directions of dorsal flake scars (**Tab. 161A**). 65% have parallel dorsal flake scars. The rest shows a variety of directions that could imply a re-orientation of the core.

Modified pieces are large (**Tab. 161B**). Non-modified flakes are on average 1.5cm shorter than modified blades. The latter are less fine as comparable specimens in other assemblages: The mean width of flakes is over 2cm in Car compared to less than 1.5cm in all other inventories (**Fig. 34**).

REDUCTION FACES (n)	Car	
	n	*%*
1	8	26.7%
2	8	26.7%
3	9	30.0%
4	5	16.7%
Σ	30	100%

A

REDUCTION FACE DIRECTION FLAKE SCARS	Car	
	n	*%*
parallel, unidirectional	10	35.7%
bipolar *sensu lato*	6	21.4%
parallel+transversal	8	28.6%
bipolar+transversal	4	14.3%
Σ	28	100%
n.s.*	2	6.7%

B

Tab. 157 Car/GR. Reduction faces of cores: **A** – number and **B** – direction of flake scars (*reference amount for not specified (n.s.) direction is the total amount of cores in Car Σ=30).

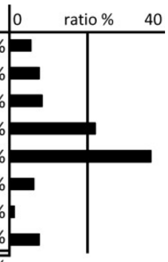
IMPACT MARKS	flakes		blades	
	n	*%*	*n*	*%*
with impact ring	24	10.3%	5	7.8%
w/o impact ring	209	89.7%	59	92.2%
Σ	233	100%	64	100%
n.s.*	1	0.4%		
with lip	153	65.7%	41	64.1%
w/o lip	80	34.3%	23	35.9%
Σ	233	100%	64	100%
n.s.*	1	0.4%		
with bulbar scar	71	30.3%	19	29.7%
w/o bulbar scar	163	69.7%	45	70.3%
Σ	234	100%	64	100%
with bulb	205	87.6%	55	85.9%
pronounced**	*47*	*22.9%*	*10*	*18.2%*
diffuse**	*148*	*72.2%*	*42*	*76.4%*
splintered**	*10*	*4.9%*	*3*	*5.5%*
w/o bulb	29	12.4%	9	14.1%
Σ	234	100%	64	100%

Tab. 158 Car/GR. Impact marks on flakes and blades (*blanks with not further specified (n.s.) characteristics refer to the total amount of flakes/blades with proximal ending Σ=234/64; **bulb attributes refer to all blanks with bulb).

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	41.4	15.459	23	76
width	24.3	7.596	11	37
thickness	9.8	3.571	5	17
weight	8.7	4.803	1.5	16.9

Tab. 159 Car/GR. Dimensions of artifacts from stage 4 of the reduction sequence.

TOOL TYPES	*n*	%
borers	8	5.9%
truncations	11	8.1%
end scrapers	12	8.9%
lateral retouches	31	23.0%
splintered pieces	51	37.8%
notched pieces	9	6.7%
denticulates	2	1.5%
other	11	8.1%
Σ n	135	100%
% tools/assemblage		*28.0%*



D = 0.219

Tab. 160 Car/GR. Tools: absolute number, amount of each tool type, tool ratio referring to the total assemblage, and Simpson diversity index (D).

DIRECTION DORSAL FLAKE SCARS	tools *n*	*%*
parallel, unidirectional	61	54.5%
parallel, opposing	2	1.8%
bipolar *sensu lato*	11	9.8%
unidirectional-transverse	13	11.6%
opposing-transverse	2	1.8%
bipolar-transverse	6	5.4%
transverse	10	8.9%
concentric	3	2.7%
other	4	3.6%
Σ	112	100.0%
*w/o**	*3*	*2.6%*

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	41.8	13.417	14	78
width	32.9	11.689	12	59
thickness	12.0	7.909	12	45
weight	20.4	28.534	1.1	204.2

B

Tab. 161 Car/GR. Artifacts from stage 5a of the reduction sequence: **A** – direction of dorsal flake scars of the modified flakes and blades (*reference amount: total of modified flakes and blades Σ=115) and **B** – dimensions of the tools.

4.4.9.5.2. 5b – Use

Approximately half of the Early Neolithic artifacts of Car were used: 135 tools and in addition 100 pieces without intentional modification but with macroscopic use traces (**Tab. 162**). 46.7% of the otherwise non-modified blades have small traces of use and nearly a third (28.8%) of the not intentionally modified flakes (**Tab. 162**). However, the use traces are fairly fine, irregular reductions on the blank edges and could not be associated with distinct activities.

USE TRACES	use traces	other mod.	Σ (n pieces) *n*	*%*	*reference amount*
flakes	69		69	28.8%	240
blades	28		28	46.7%	60
art. debris	3		3	9.1%	33
cores					15
1x ut.	100		**100**	28.7%	348
2x ut.	46	1	47		
3x ut.	4		4		
Σ (n ut.)	150	1	151		

Tab. 162 Car/GR. Macroscopically visible use traces (ut.) on pieces without intentional tool modification. The artifacts are listed according to the blank type and refer to unmodified blanks/pieces in the assemblage. On several pieces, more than one specific use trace remain (2x ut. etc.; mod. = modification). The reference amount consists of all unmodified pieces.

TOOL TYPES	n ADDITIONAL MODIFICATION *1*	*2*	*3*	*4*	*Σ n*	*%**	*%***	*Σ***	borers	truncations	end scrapers	lateral retouches	splintered pieces	notched pieces	denticulates	other
borers	2	1			3	4.6%	37.5%	8	1		1	2				
truncations	2	4	1		7	10.8%	63.6%	11				10	1	1	1	
end scrapers	1	6			7	10.8%	58.3%	12		1		9	3			
lateral retouches	15	2			17	26.2%	54.8%	31		1		15	3			
splintered pieces	17	5	1		23	35.4%	45.1%	51					29			1
notched pieces	2		1	2	5	7.7%	55.6%	9		2		6	1	4		
denticulates	1				1	1.5%	50.0%	2				1				
other	1	1			2	3.1%	18.2%	11					1			2
Σ n	40	18	3	2	**65**	100%	48.1%	135	1	4	1	43	38	5	1	3
%	61.5%	27.7%	4.6%	3.1%	100%											

Tab. 163 Car/GR. Tools and additional modifications (*refer to total amount of tools with additional modifications Σ=65; **refer to total number of each tool type Σ**).

4.4.9.5.3. 5c – Resharpening

Almost 50%, i.e. 65, of the 135 tools have multiple intentional modifications. More than 50% of the truncations, end scrapers, lateral retouches and notched pieces have at least one other modification (cf. %** in **Tab. 163**). Truncations and end scrapers are often laterally retouched. Pieces primarily assigned to lateral retouches are additionally modified on the edges or bilateral. Splintered pieces also have several working edges or areas with marks. Four additional modifications were on two of the notched pieces.

4.4.9.6. Car/GR: Stage 6 – Discarding

A large amount of 285 pieces, about 60% of the inventory, was obviously discarded because of reasons mentioned in **Tab. 32**.

The exposure of artifacts to heat is comparably to the amount in other inventories: 59.4% of the artifacts have changes in color, heat pits and fissures caused by heat treatment (**Tab. 149**; **Tab. 53**). Most blanks were immediately after their removal from the core or cores after the reduction exposed to fire (**Tab. 164**). Two flakes were possibly intentionally thermally treated: The raw material was obviously heated previous to the removal of blanks. But all other artifacts were probably accidentally exposed to fire after discarding.

TIME HEAT TREATMENT	flakes		blades		cores		art. debris		Σ	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
raw material heated	2	1.0%							2	0.7%
heated after blank removal	114	54.8%	23	59.0%	7	63.6%	13	44.8%	157	54.7%
thermal fracture	49	23.6%	6	15.4%	1	9.1%	14	48.3%	70	24.4%
heated after modification	43	20.7%	10	25.6%	3	27.3%	2	6.9%	58	20.2%
total with heat treatment	208	100.0%	39	100.0%	11	100.0%	29	100.0%	287	100.0%

Tab. 164 Car/GR. Time of heat treatment on various blank types.

4.4.9.7. Car/GR – Summary: Reconstruction of the reduction sequence

No nodules are remained on-site, but cortex removal took at least to a small amount place on-site: Seven artifacts remained from stage 1. However, following stages with very few cortex on lateral core flakes, crested pieces and blanks imply an accurate cortex removal.

The core was prepared by removing pieces in various directions likely by using hard hammer percussion, whereas during the following reduction stage blanks were knapped very regular in predominantly parallel directions possibly with a soft stone. Seemingly the biggest part of the blank production took place on-site and blanks ranging from 9.4-2cm length remained.

A few pieces prove a core re-preparation and continuance of the blank production on-site.

With 28% the tool modification and use is well represented in Car. The tools are not all comparably regular. They are big, have partly irregular dorsal flake scars showing that the underlying blank stem from a more irregular section in the blank production, 28.2% of the tools have still remains of cortex and only 20% of the tools are made of blades. Half of the tools have one or more additional modifications intending possibly an intense use, resharpening and a change in the function of the former tool.

4.4.10. Abrigo 6/Málaga (A6/MA)

4.4.10.1. Epipaleolithic assemblage of A6/MA (A6 EPI/MA)

Within the Epipaleolithic assemblage stage 0 is present with several pebbles (**Tab. 165**): two unmodified pebbles (ID 8165, 8166), two pebbles with removal negatives due to raw material testing (ID 8163, 8937) and another one with traces of ocher (ID 8179). This one indicates a secondary use of nodules within the treatment of pigments.

PEBBLES	*L*	*W*	*T*	*We (g)*
8163	69	50	36	152.7
8165	42	37	25	57.8
8166	53	35	15	38.3
8179	91	73	45	445.0
8937	43	32	20	39.1
Ø	59.6	45.4	28.2	146.58
SD	20.635	16.891	12.194	173.386

Tab. 165 A6 EPI/MA. Dimensions of pebbles.

After testing, the pebbles were brought from their fluvial source to the rock shelter as nodules for reduction and as ground stone tools for other purposes such as treatment of pigments.

Due to the size of the nodules (**Tab. 165** and equivalent values in **Tab. 172**), these specimens would have been sufficient to initiate cores and a reduction sequence. The pebbles have the by far highest minimum, maximum and mean values of all dimensions and thus all other blanks could have been processed from them. Thus, these pebbles imply good raw material availability in the river and their size was obviously sufficient for blank production.

In the Early Neolithic level more, but on average smaller nodules remained (cf. **Tab. 183**).

4.4.10.1.1. A6 EPI/MA: Stage 1 – Cortex removal and preparation of core platform and reduction face

The four flakes from the initial core preparation process (cf. **Tab. 33**) are also covered with pebble cortex and prove the availability of pebble raw material in site-vicinity.

In contrast artifacts from the primary source with chalky cortex (**Tab. 31** and **Fig. 6** cf. **Tab. 184A**) apparently do not pass stages 0-1 on-site. The single blade (ID 85864; 2.9g) with less than one third chalky cortex on the dorsal surface was introduced already as a target product. People used (fine use traces) and subsequently discarded this blade (changes in color and scarring trough exposure to fire). Thus, this raw material was imported possibly as prepared cores and semi-finished product (blanks) or – as the before mentioned single blade implies – even as target products.

At 34.6% the amount of artifacts with cortex is generally high (**Tab. 166**).

CORTEX/HEAT TREATMENT		flakes			blades			cores			art. debris			pebbles	Σ*	
		unm.	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm./Σ*		
with cortex	*n*	100	7	107	19	1	20	6	2	8	29	1	30	5	170	
	%	93.5%	6.5%	62.9%	95.0%	5.0%	11.8%	75.0%	25.0%	4.7%	96.7%	3.3%	17.6%	2.9%	100%	34.6%
w/o cortex	*n*	151	21	172	99	25	124	1	1	2	22	1	23		321	
	%	87.8%	12.2%	53.6%	79.8%	20.2%	38.6%	50.0%	50.0%	0.6%	95.7%	4.3%	7.2%		100%	65.4%
with heat treatment	*n*	191	22	213	74	18	92	6	2	8	41	2	43	3	359	
	%	89.7%	10.3%	59.3%	80.4%	19.6%	25.6%	75.0%	25.0%	2.2%	95.3%	4.7%	12.0%	0.8%	100%	73.1%
w/o heat treatment	*n*	60	6	66	44	8	52	1	1	2	10	0	10	2	132	
	%	90.9%	9.1%	50.0%	84.6%	15.4%	39.4%	50.0%	50.0%	1.5%	100.0%	0.0%	7.6%	1.5%	100%	26.9%

Tab. 166 A6 EPI/MA. Cortex coverage and heat treatment of blanks. Unmodified (unm.) and modified (mod.) blanks refer to the sum of each blank type and the sum of blanks refers to the total amount with or without (w/o) cortex or heat treatment. The sum of artifacts with or without cortex or heat treatment* refer to the total assemblage n=491.

4.4.10.1.2. A6 EPI/MA: Stage 2 – Core preparation

4.4.10.1.2.1. Crested pieces and lateral core flakes

The 38 artifacts of stage 2 have a relatively high standard deviation that is due to a big lateral core flake (ID 8173, 82 x 57 x 13mm, 122g). Without this flake the total weight of stage 2-artifacts accounts for 159.8g with a mean value of 4.3±2.907g. The flake is covered with a maximum of one third pebble cortex and parallel unidirectional flake scars. Thus, accordingly the initial size of decortified pre-cores can be estimated at about 8cm.

In total with this large flake, 23 lateral core flakes are present: Three are covered with small amounts of cortex and one piece has a primary dorsal preparation. In addition, the dorsal flake scars are mostly parallel unidirectional and approximately 15% disperse in other divers and combined directions (**Tab. 167A**). The latter imply a preparation adapted to the core or to the reduction.

Fifteen crested pieces - five flakes and 10 blades - are mostly primary dorsally prepared (**Tab. 167B**).

EPIPALEOLITHIC

DIRECTION DORSAL FLAKE SCARS	lat. core flakes n	%
parallel, unidirectional	15	68.2%
parallel, opposing	1	4.5%
bipolar *sensu lato*	3	13.6%
opposing-transverse	1	4.5%
transverse	1	4.5%
other	1	4.5%
Σ	22	100.0%
*w/o**	*1*	*4.3%*

A

PREP. DORSAL SURFACE	crested pieces n	%
primary	11	73.3%
secondary	4	26.7%
Σ	15	100.0%

B

EARLY NEOLITHIC

DIRECTION DORSAL FALKE SCARS	lat. core flakes n	%
parallel, unidirectional	4	33.3%
parallel, opposing	2	16.7%
unidirectional-transverse	3	25.0%
transverse	3	25.0%
Σ	12	100.0%
*w/o**	*4*	*25.0%*

C

PREP. DORSAL SURFACE	crested pieces n	%
primary	5	71.4%
secondary	2	28.6%
Σ	7	100.0%
n.s.	1	11.1%

D

Tab. 167 A6/MA. Artifacts from stage 2 of the reduction sequence: **A** – direction of dorsal flake scars of Epipaleolithic lateral core flakes (*reference amount: total of lateral core flakes Σ=22); **B** – Epipaleolithic crested pieces with primary and secondary preparation of the dorsal surface; **C** – direction of dorsal flake scars of Early Neolithic lateral core flakes (*reference amount: total of lateral core flakes Σ=16) and **D** – Early Neolithic crested pieces with primary and secondary preparation of the dorsal surface.

4.4.10.1.2.2. Cores and reduction technique

CORE SHAPE	A6 EPI n	%	A6 NEO n	%	A6 Σ n	%
conical	2	33.3%	8	88.9%	10	66.7%
cylindrical	2	33.3%	1	11.1%	3	20.0%
irregular	1	16.7%			1	6.7%
other	1	16.7%			1	6.7%
Σ	6	100%	9	100%	15	100%
n.s.*	4	40.0%	9	50.0%	13	46.4%

Tab. 168 A6/MA. Core shapes (reference amount for the cores with shape not further specified (n.s.) is the total amount of cores in each assemblage EPI=10; NEO=18; Σ=8).

The shapes of the present six cores are tripartite (**Tab. 168**): Pairs of cores, either conical, cylindrical or with other directions. The cores' striking platforms are more uniform (**Tab. 186A** and **B**): Seven have only one plain platform that was prepared by the removal of one negative or core tablet.

The cores of the Epipaleolithic assemblage are bigger than the present Early Neolithic cores. Core edge lengths fit to the present flakes and blades (**Tab. 172**). Modified cores weight slightly more than non-modified ones. Thus, fairly massive cores were modified to tools.

Congruently the platform remnants of flakes and blades are also dominated by plain types (**Tab. 169A**). Almost 10% of the artifacts with platform remnant are still covered by natural surfaces.

Thus, besides these probable trimming flakes, which were removed while the core platform still consisted of cortex, platform remnants indicate an initial preparation of the striking platform by removing one flake. The platforms of the reduced cores show that these were regularly re-prepared by removal of core tablets.

PLATFORM REMNANT TYPE	flakes		blades	
	n	%	n	%
type determined	181	70.2%	59	44.4%
natural**	17	9.4%	3	5.1%
joint plane**	1	0.6%	1	1.7%
plain**	157	86.7%	51	86.4%
primary facetted**	1	0.6%	1	1.7%
secondary facetted**	1	0.6%	2	3.4%
facetted (n.s.)**	1	0.6%		
crushed**	3	1.7%	1	1.7%
w/o	77	29.8%	74	55.6%
Σ	258	100%	133	100%
n.s.*	21	7.5%	11	7.6%

A

PLATFORM REMNANT SHAPE	flakes		blades	
	n	%	n	%
shape determined	199	72.1%	70	48.6%
oval**	58	29.1%	17	24.3%
point**	27	13.6%	10	14.3%
linear**	27	13.6%	18	25.7%
triangular**	6	3.0%	5	7.1%
rectangular**	3	1.5%		
irregular**	58	29.1%	11	15.7%
rhombic**			1	1.4%
winged/wavy**	18	9.0%	7	10.0%
trapezoid**	2	1.0%	1	1.4%
w/o	77	27.9%	74	51.4%
Σ	276	100%	144	100%
n.s.*	3	1.1%	0	0.0%

B

Tab. 169 A6 EPI/MA. Types (**A**) and shapes (**B**) of platform remnants present on flakes and blades (*reference amount of the type/shape not specified (n.s.) is the total amount of flakes=279 and blades=144; the type and shape attributes refer to flakes and blades with type/shape determined).

DORSAL REDUCTION	flakes		blades	
	n	%	n	%
with DR	79	39.1%	46	65.7%
w/o DR	123	60.9%	24	34.3%
Σ	202	100%	70	100%

Tab. 170 A6 EPI/MA. Flakes and blades with and without (w/o) dorsal reduction (DR).

Additionally the core edges were reduced: On 40% of the flakes and even 65% of the blades a dorsal reduction remains (**Tab. 170**). Apparently Epipaleolithic settlers conducted dorsal reduction not only previous to the removal of trimming flakes but also previous to the reduction of large blades.

4.4.10.1.3. A6 EPI/MA: Stage 3 – Blank production

248 and thus more than 50% of the artifacts imply a regular blank production in Epipaleolithic times (cf. **Tab. 33**). This is relatively more than during the Early Neolithic, where about one third of the inventory can be assigned to stage 3 (cf. **4.4.10.2.3. A6 NEO/MA: Stage 3 – Blank production**).

56.8% flakes and 29.3% blades are present in the Epipaleolithic assemblage of A6 (**Tab. 34**). Flakes outweigh blades with a ratio of 2:1 and a flake/blade-index of 1.9. Apparently, the ratios are fairly normal and balanced. This indicates blank production on-site without major import and export activities *or* compensating events.

BLANK FRAGMENTS	flakes						blades						Σ	
	unm.		*mod.*		*Σ*		*unm.*		*mod.*		*Σ*			
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
complete	113	45.0%	8	28.6%	121	43.4%	24	20.3%	5	19.2%	29	20.1%	150	35.5%
proximal	71	28.3%	10	35.7%	81	29.0%	35	29.7%	6	23.1%	41	28.5%	122	28.8%
distal	36	14.3%	1	3.6%	37	13.3%	20	16.9%	2	7.7%	22	15.3%	59	13.9%
medial	31	12.4%	9	32.1%	40	14.3%	39	33.1%	13	50.0%	52	36.1%	92	21.7%
Σ	251	90.0%	28	10.0%	279	100.0%	118	81.9%	26	18.1%	144	100.0%	423	100.0%

Tab. 171 A6 EPI/MA. Preservation of the unmodified and modified flakes and blades. The complete blanks consist also of 21 non-modified and 5 modified flakes, 2 non-modified and 3 modified blades that are complete in length (in direction of percussion) but incomplete in their width.

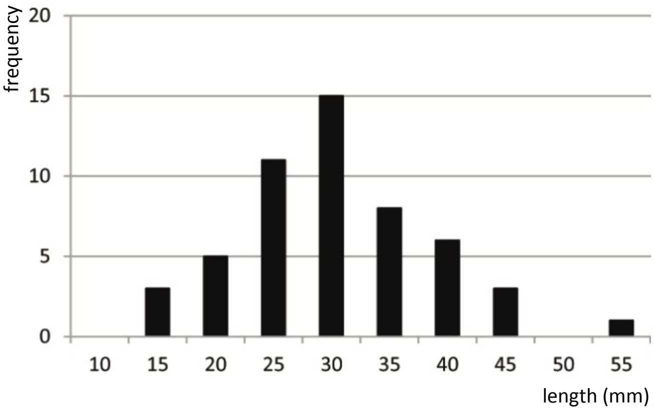


Fig. 24 A6 EPI/MA. Lengths of complete and regular flakes and blades in 5mm-ranges (from 5-10mm, to 15 etc.; Σ=115).

Complete flakes dominate with regard to the other flake fragments (**Tab. 171**). In contrast, blades are predominated by medial fragments and proximal endings. A fifth of the blades consists of complete blanks and distal fragments are less present. Thus, one can assume an additional import of medial blade fragments.

Apart from the artifacts of Car/GR, the present blanks are fairly large (**Fig. 33**, **Fig. 34** and **Tab. 172**). Flakes and blades are more or less of the same size as the Early Neolithic artifacts. Pieces of artificial debris are slightly more massive than flakes. The lengths and widths of flakes and blades are patchy and widely scattered (**Fig. 25** cf. **Fig. 24**). Thickness varies mostly below 1cm (**Fig. 26**). The variance in the dimensions illustrates the range of flakes and blades on-site with lengths between 5.5 and 1.5cm. In combination with the dimensions of the nodules and the pre-core of stage 1, one can assume that people started knapping with cores of approximately 5.5cm core edge length. These initial phases of knapping are similar to that of the Early Neolithic (cf. Early Neolithic stage 3).

DIMENSIONS	*n*	length (mm)				width (mm)				thickness (mm)				weight (g)			
		MIN	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*
flakes	279	8	82	25	8.73	7	57	21	7.102	1	39	7	3.71	0.1	122	5	9.40
unmod.	251	8	82	24	8.34	7	57	21	6.962	1	39	7	3.61	0.1	122	4	9.21
complete	113	13	82	27	8.68	7	57	23	7.320	2	39	7	4.13	0.4	122	6	13.28
mod.	28	18	56	30	10.43	13	44	25	7.739	2	20	8	4.24	0.9	43.8	9	10.33
complete	8	18	36	26	5.50	13	31	22	6.413	4	10	7	2.13	1.2	6.3	4	1.79
blades	144	11	55	28	9.36	4	29	13	5.097	2	12	5	2.02	0.2	8.4	2	1.68
unmod.	118	11	54	27	8.51	4	26	12	3.495	2	11	4	1.97	0.2	8.3	2	1.29
complete	24	20	54	32	8.02	7	18	12	2.946	4	10	6	1.61	0.6	5.6	2	1.32
mod.	26	14	55	34	11.40	6	29	16	5.175	3	12	5	2.12	0.7	8.4	3	2.47
complete	5	27	44	38	6.53	13	18	16	2.168	4	12	7	2.97	1.8	5.0	3	1.56
cores	10	18	59	36	12.12	15	45	27	8.913	8	26	17	5.31	2.7	68.8	24	20.23
unmod.	7	18	59	35	12.62	15	45	28	10.766	8	26	16	6.07	2.7	68.8	22	22.37
mod.	3	26	50	40	12.49	23	27	26	2.309	19	21	20	1.00	10	45.6	27	17.72
art. debris	53	14	49	29	7.80	8	46	19	7.380	4	22	11	4.30	0.7	42.6	8	8.98
unburned	10	19	49	31	9.13	10	37	20	7.633	6	20	12	4.94	1.3	38.4	10	10.70
burned	43	14	47	29	7.56	8	46	19	7.391	4	22	11	4.18	0.7	42.6	7	8.61
pebbles	5	42	91	60	20.63	32	73	45	16.891	15	45	28	12.19	38	445	147	173.39

Tab. 172 A6 EPI/MA. Dimensions of unmodified (unmod.) and modified (mod.) blanks.

4.4.10.1.3.1. Percussion technique

Most flakes and blades have parallel or bipolar dispersed dorsal flake scars (**Tab. 173**). These are presumably semi-finished target products removed during systematic blank production. Furthermore, dorsal flake scars of 28.3% of the flakes have various, combined or irregular other directions that could be due to preparation or final core reduction.

The reduction faces of cores show removal negatives in similar directions and amounts (**Tab. 174B**): 60% parallel and 40% combined parallel- or bipolar-transversal reduction.

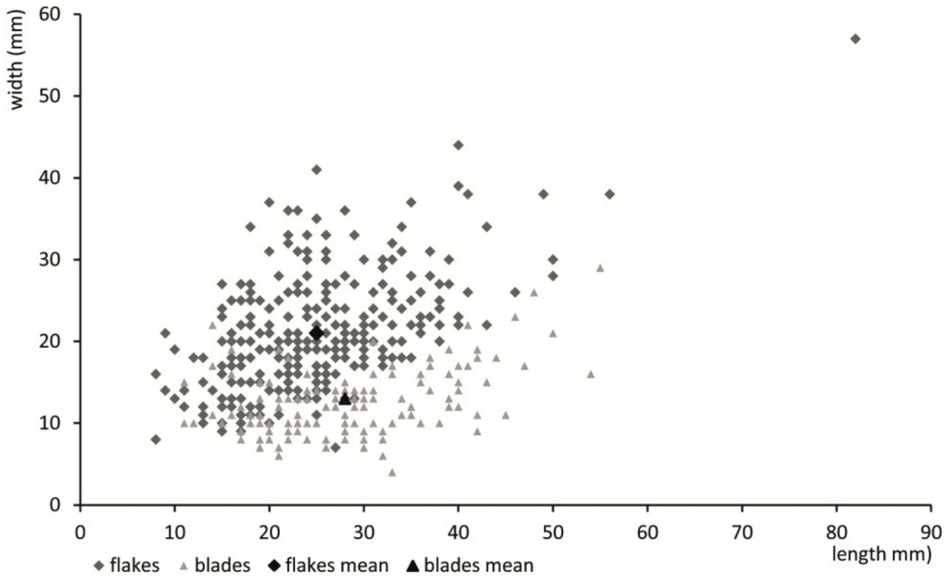


Fig. 25 A6 EPI/MA. Lengths and widths of flakes and blades in mm.

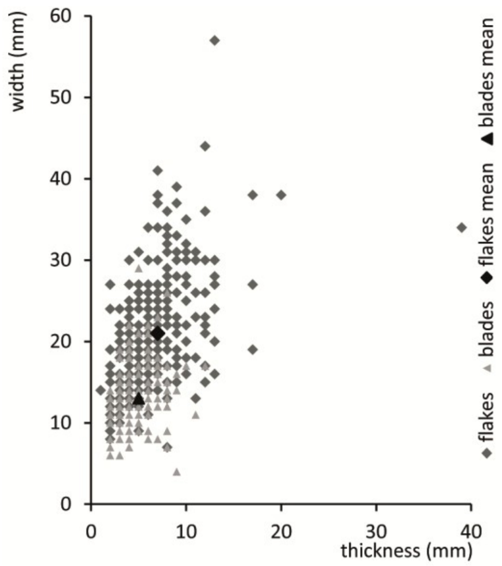


Fig. 26 A6 EPI/MA. Thicknesses and widths of flakes and blades in mm.

DIRECTION DORSAL FLAKE SCARS	flakes *n*	flakes *%*	blades *n*	blades *%*
dorsal flake scars determined	233	83.5%	142	98.6%
parallel, unidirectional**	154	66.1%	110	77.5%
parallel,opposing**	7	3.0%	6	4.2%
bipolar sensu lato**	6	2.6%	11	7.7%
unidirectional-transverse**	24	10.3%	9	6.3%
opposing-transverse**	2	0.9%		
bipolar-transverse**	1	0.4%		
transverse**	28	12.0%	5	3.5%
concentric**	1	0.4%		
other**	10	4.3%	1	0.7%
w/o	46	16.5%	2	1.4%
Σ	279	100%	144	100%

Tab. 173 A6 EPI/MA. Direction of dorsal flake scars of flakes and blades (**directions refer to blanks with dorsal flake scars determined).

REDUCTION FACES (n)	A6 EPI *n*	A6 EPI *%*	A6 NEO *n*	A6 NEO *%*	A6 Σ *n*	A6 Σ *%*
1	5	50.0%	7	38.9%	12	42.9%
2	3	30.0%	6	33.3%	9	32.1%
3	2	20.0%	4	22.2%	6	21.4%
4			1	5.6%	1	3.6%
Σ	10	100%	18	100%	28	100%

A

REDUCTION FACE DIRECTION FLAKE SCARS	A6 EPI *n*	A6 EPI *%*	A6 NEO *n*	A6 NEO *%*	A6 Σ *n*	A6 Σ *%*
parallel, unidirectional	6	60.0%	8	44.4%	14	50.0%
bipolar *sensu lato*			6	33.3%	6	21.4%
parallel+transversal	3	30.0%	3	16.7%	6	21.4%
bipolar+transversal	1	10.0%	1	5.6%	2	7.1%
Σ	10	100%	18	100%	28	100%

B

Tab. 174 A6/MA. Number of core reduction faces (**A**) and direction of flake scars (**B**) on the reduction faces.

IMPACT MARKS	flakes		blades	
	n	*%*	*n*	*%*
with impact ring	10	5.0%		
w/o impact ring	192	95.0%	70	100%
with lip	108	53.5%	43	61.4%
w/o lip	94	46.5%	27	38.6%
with bulbar scar	54	26.7%	20	28.6%
w/o bulbar scar	148	73.3%	50	71.4%
with bulb	169	83.7%	57	81.4%
pronounced**	*36*	*21.3%*	*6*	*10.5%*
double**	*1*	*0.6%*		
diffuse**	*129*	*76.3%*	*50*	*87.7%*
splintered**	*3*	*1.8%*	*1*	*1.8%*
w/o bulb	33	16.3%	13	18.6%

Tab. 175 A6 EPI/MA. Impact marks on flakes and blades (referring to the total amount of flakes/blades with proximal ending Σ=202/70; **bulb attributes refer to all blanks with bulb).

Thus, the reduction likely varied in direction according to preparation (irregular), systematic blank production (regular) and final exploitation of the core (irregular, opportunistic).

These varying percussion techniques are also supported by the present impact marks (**Tab. 175**). Diffuse bulbs in combination with lips, bulbar scars and furthermore fine platform remnants (64.3% of the blades with oval, pointed or linear platform remnants cf. **Tab. 169B**) could originate from regular blank production using a soft hammer (cf. **Tab. 35**). In contrast, evidence of hard stone percussion is less prevalent: Pronounced bulbs, impact rings (**Tab. 175**), dorsal reduction (**Tab. 170**) and wide platform remnants (almost 30% of the flakes with irregular platform remnants cf. **Tab. 169B**).

4.4.10.1.4. A6 EPI/MA: Stage 4 – Re-preparation of the cores

Eleven plunging flakes and blades and five core tablets remain from a core re-preparation on-site.

Unidirectional and transverse dorsal flake scars on plunging flakes and blades (**Tab. 176A**) show a re-orientation of the core before stage 4. The blank production was elongated. More blanks were gained, even though these were less regular. Most plunging flakes and blades with unidirectional of opposing dorsal flake scars imply a foregoing regular reduction.

Core tablets and plunging flakes and blades show core edge lengths at about 4cm (cf. maximum length in **Tab. 176B**), whereas core dimensions of at least up to 5.5cm are evident in the maximum length of regular flakes and blades (**Tab. 172**). Thus, meanwhile in stage 3 the cores decrease about 1cm.

DIRECTION DORSAL FLAKE SCARS	plunging pieces	
	n	*%*
parallel, unidirectional	3	27.3%
parallel, opposing	1	9.1%
bipolar *sensu lato*	1	9.1%
unidirectional-transverse	5	45.5%
concentric	1	9.1%
Σ	11	100.0%

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	30.9	6.742	19	43
width	20.3	7.389	12	38
thickness	7.3	3.256	3	17
weight	5.3	7.261	1.7	31.9

B

Tab. 176 A6 EPI/MA. Artifacts from stage 4 of the reduction sequence: **A** – dorsal flake scars of plunging flakes and blades and **B** – dimensions of core tablets *and* plunging flakes and blades.

4.4.10.1.5. A6 EPI/MA: Stage 5 – Modification and use

38.1% of the assemblage consists of tools (59) and pieces with macroscopically visible use traces (128). 22 of the tools have additional modification beyond the type designating retouch. Additionally, three burin spalls are present. Besides numerous various processing activities on-site, small-scale production of tool insets (e.g. burins) and the repairing and exchange of these (e.g. projectile points) also took place on-site. The pieces were intensively used.

4.4.10.1.5.1. 5a – Intentional modification

TOOL TYPES	n	%
projectiles	3	5.1%
borers	1	1.7%
burins	7	11.9%
truncations	6	10.2%
end scrapers	11	18.6%
lateral retouches	4	6.8%
splintered pieces	19	32.2%
notched pieces	5	8.5%
denticulates	1	1.7%
other	2	3.4%
Σ	59	100%
% tools/assemblage		*12.0%*

D = 0.165

Tab. 177 A6 EPI/MA. Tools: absolute number, amount of each tool type, tool ratio referring to the total assemblage, and Simpson diversity index (D).

Fifty-nine tools and three burin spalls are preserved. For the whole assemblage, the amount of tools is 12%. It is a comparably low amount (cf. **Tab. 203**) and obviously lower than the tool amount in the Early Neolithic inventory, although the tool types are similar and similarly frequent. Splintered pieces and end scrapers dominate the otherwise diverse Epipaleolithic tool assemblage (**Tab. 177**).

This low tool amount also influences the modification amounts of the blank types: Three of the 10 cores, 18.1% of the blades, 10% of the flakes and two of the 52 artificial chunks are intentionally modified. Most tools are made of flakes and blades in similar proportions. If not, single tools are made of artificial debris and cores (cf. **Tab. 34**).

Besides almost 70% regular flakes and blades as blanks for tools, blanks with multidirectional dorsal flake scars were also modified (**Tab. 178A**). Eleven pieces are partly covered with cortex. These artifacts imply a partial opportunistic use of less regular blanks for tools.

DIRECTION DORSAL FLAKE SCARS	tools *n*	*%*
parallel, unidirectional	35	67.3%
parallel, opposing	3	5.8%
bipolar *sensu lato*	2	3.8%
unidirectional-transverse	2	3.8%
opposing-transverse	1	1.9%
transverse	5	9.6%
concentric	1	1.9%
other	3	5.8%
Σ	52	100.0%
*w/o**	*2*	*3.7%*

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	32.3	10.861	14	56
width	20.4	7.729	6	44
thickness	7.7	4.763	6	21
weight	7.2	9.637	0.7	45.6

B

Tab. 178 A6 EPI/MA. Artifacts from stage 5a of the reduction sequence: **A** – direction of dorsal flake scars of the modified flakes and blades (*reference amount: total of modified flakes and blades Σ=54) and **B** – dimensions of the tools.

BURIN SPALLS	*L*	*W*	*T*	*We (g)*
8097	33	4	9	1.1
8147	30	9	6	1.2
8902	30	7	8	1.2

Tab. 179 A6 EPI/MA. Burin spalls with ID and dimensions (LxWxT in mm; We in g) indicate the modification of burins on-site.

Dimensions display the selection of fairly big blanks for modification (**Tab. 178B**). Non-modified flakes are on average about 1cm shorter, 0.5cm narrower and a few millimeters thinner than modified blades.

The three burin spalls show the modification of burins on-site (**Tab. 179**).

4.4.10.1.5.2. 5b – Use

In addition to the 59 tools, 128 artifacts were also used. The latter were not intentionally modified, but fine, irregular use traces are macroscopically visible (**Tab. 180**). 55.6% of the non-modified blades (cf. **Tab. 180**) and 25.9% of the non-modified flakes have such use wares.

Most use traces are fine, irregular marginal retouches or three times thinned bulbs that cannot be assigned to a definite use. But red ocher traces imply the treatment of pigments. Red ocher, end scrapers and truncations point to hide scraping. Two polished sections imply a time consuming, repetitive action.

USE TRACES	tr. red ocher	use traces	other mod.	mod. bulb	polish	Σ (n pieces) *n*	*%*	*reference amount*
flakes		61	1	2	1	65	25.9%	*251*
blades		61	3			64	55.6%	*115*
art. debris	1					1	2.0%	*51*
cores								*7*
pebbles	1					1	20%	*5*
1x ut.	2	122	1	2	1	**128**	29.8%	*429*
2x ut.		65	4	1	1	71		
3x ut.		9				9		
Σ (n ut.)	2	196	5	3	2	208		

Tab. 180 A6 EPI/MA. Macroscopically visible use traces (ut.) on pieces without intentional tool modification (tr. red ocher= traces of red ocher). The artifacts are listed according to the blank type and refer to unmodified blanks/pieces in the assemblage (w/o 3 burin spalls on bladelets). On several pieces, more than one specific use trace remain (2x ut. etc.; mod. = modification). The reference amount is all unmodified pieces.

4.4.10.1.5.3. 5c – Resharpening

Twenty-two of the 59 tools have one to three other intentional modifications. The splintered pieces have often several working edges. All other tools are modified laterally.

TOOL TYPES	n ADDITIONAL MODIFICATIONS *1*	*2*	*3*	*Σ n*	*%**	*%***	*Σ***	burins	truncations	end scrapers	lateral retouches	splintered pieces	other
projectiles							3						
borers	1			1	4.5%	100%	1				1		
burins	2	1	1	4	18.2%	57.1%	7	4	1		2		
truncations	1	1		2	9.1%	33.3%	6				3		
end scrapers	2	2	1	5	22.7%	45.5%	11			4	5		
lateral retouches	2			2	9.1%	50.0%	4				1	1	
splintered pieces	7			7	31.8%	36.8%	19					5	2
notched pieces		1		1	4.5%	20.0%	5				2		
denticulates							1						
other							2						
Σ n	15	5	2	**22**	100%	37.3%	59	4	1	4	14	6	2
%	68.2%	22.7%	9.1%	100%									

Tab. 181 A6 EPI/MA. Tools and additional modifications (*refer to total amount of tools with additional modifications Σ=22; **refer to total number of each tool type Σ**).

4.4.10.1.6. A6 EPI/MA: Stage 6 – Discard

336 pieces are useless due to – amongst other reasons – final reduction and destruction caused by unintended fire contact.

Generally heat treatment appears very frequently on 73.1% of the artifacts (**Tab. 166**). It occurs predominantly on flakes. One can identify contact with fire often by color changes partly in combination with fissures and heat pits (cf. **Tab. 53**). One pebble was exposed to fire as a raw material. Whether this was intentional or not remains ambiguous. Obviously all the other artifacts were exposed to heat and fire by accident after discarding (**Tab. 182**). Several pieces even broke due to sudden, great heat. The same applies to some tools after their modification, use or exhaustion.

TIME HEAT TREATMENT	flakes		blades		cores		art. debris		pebbles		Σ	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
raw material heated									1	33.3%	1	0.3%
heated after blank removal	137	64.3%	54	58.7%	7	87.5%	21	48.8%	2	66.7%	221	61.6%
thermal fracture	57	26.8%	22	23.9%	1	12.5%	22	51.2%			102	28.4%
heated after modification	19	8.9%	16	17.4%							35	9.7%
total with heat treatment	213	100.0%	92	100.0%	8	100.0%	43	100.0%	3	66.7%	359	100.0%

Tab. 182 A6 EPI/MA. Time of heat treatment on various blank types.

4.4.10.1.7. A6 EPI/MA – Summary: Reconstruction of the reduction sequence

Besides the Early Neolithic level, the Epipaleolithic assemblage of A6 is the only site where nodules, i.e. pebbles, occur. Five pieces were not only destined as raw material for knapping, but one can also expect other functions such as the treatment of red ocher. The edge lengths of the pebbles range between 9-4cm. Thus, this could be the common starting basis for knapping, if one considers those pieces as representative.

Also from the subsequent stage 1, only pieces with pebble cortex are present. Pre-cores after cortex removal measured approximately 8cm at the edge.

Currently one has to assume that people imported raw material with chalky cortex as prepared cores, blanks or even tools – at least after cortex removal. For this raw material, indicators of stages 0 and 1 are missing in situ.

The cores were prepared surprisingly regularly to obtain cores at about 5.5cm length to start the first blank production. Lots of flakes and blades remained on-site and reflect the complete process. At the end of stage 3, when cores were nearly preliminarily exhausted, people re-oriented a certain part of the cores and continued with a – compared to the previous reduction – transversal reduction. Re-preparation became necessary, when cores were reduced to about 4cm length. Signs of both soft and hard hammer percussion are present.

38.1% of the pieces on-site were used as intentional tools or just as blanks that show now use traces. In addition, 37.3% of the tools have several modifications. Those and burin spalls could indicate a resharpening on-site.

Finally a considerable amount of artifacts was accidentally exposed to fire.

4.4.10.2. Early Neolithic assemblage of A6/MA (A6 NEO/MA)

Fourteen unmodified pebbles (IDs 8201, 8202, 8223, 8422-8424, 8438, 8439, 8455, 8489, 8490-8493) and one chunk (ID 8244) are indicators of raw material procurement in the Early Neolithic assemblage of A6/MA. One nodule with single removal negatives (ID 8455) indicates an initial raw material testing possibly at the source in the river bed. However, the remaining nodules were apparently mostly not or not primarily intended for reduction but to other purposes as implied by polished sections on 10 of them (cf. **Tab. 183** IDs marked with *; IDs 8201, 8223, 8422, 8423, 8439, 8455, 8489, 8490, 8492, 8493).

PEBBLES	*L*	*W*	*T*	*We (g)*
8201*	47	38	35	92.4
8202	37	26	22	33.5
8223*	43	27	23	39.2
8422*	37	30	20	33.8
8423*	46	40	6	73.3
8424	46	40	32	84.8
8438	40	33	27	47.7
8439*	47	40	38	78.5
8455*	*NA*	29	14	18.0
8489*	34	27	19	26.4
8490*	34	30	17	25.3
8491	36	28	18	27.3
8492*	40	35	22	48.5
8493*	35	27	18	36.0
Ø	40.2	32.1	22.2	47.5
SD	5.080	5.419	8.505	24.552

Tab. 183 A6 NEO/MA. Dimensions of pebbles (*pebbles with polish – ØL=40.3mm and ØWe=47.1g; pebbles w/o polish: ØL=39.8mm and ØWe 48.3g; NA=length not available).

A comparison of minimum, maximum and mean values shows the inappropriate dimensions of those pebbles for core initialization: Even the maximum values of the pebble dimensions are too small to receive the present flakes or blades. Thus, one can assume that all larger pebbles are used for blank reduction and the present ones were considered as too small. The five pebbles left from the Epipaleolithic context are much larger (cf. **Tab. 165**).

Generally the dimensions of either Epipaleolithic or Early Neolithic pebbles seem to overlap each other. The overall mean values for Epipaleolithic and Early Neolithic pebbles are (LxWxTxWe including standard deviations in parentheses): 45.1mm (14.568) x36.9mm (10.849) x24.4mm (9.598) x76.6g (97.320).

EPIPALEOLITHIC

EPI STAGE 1	flakes + cortex *n*	*%*	ratio on dorsal surface *≥ 2/3*	*complete*
pebble cortex	37	100.0%	4	33
n.s.	1	2.6%	1	

A

EARLY NEOLITHIC

NEO STAGE 1	flakes + cortex *n*	*%*	ratio on dorsal surface *≥ 2/3*	*complete*
pebble cortex	41	95.3%	9	32
chalky cortex	2	4.7%		2
Σ	43	100.0%	9	34
n.s.	1	2.3%		1

B

Tab. 184 A6/MA. Epipaleolithic (**A**) and Early Neolithic (**B**) artifacts from stage 1 of the reduction sequence: Flakes with more than 2/3 cortex-ratio on the dorsal surface (n.s. = cortex not specified *refers to all stage 1 artifacts in the Epipaleolithic Σ=38 and in the Early Neolithic Σ=44).

4.4.10.2.1. A6 NEO/MA: Stage 1 – Cortex removal and preparation of core platform and reduction face

41 flakes with large amounts of pebble cortex imply the use of pebbles for reduction (**Tab. 184**). One (ID 85839; 8.4g) also has a polished pebble cortex. Thus, several pebbles were used first for polishing and subsequently for blank production.

Additionally first farmers of A6 used a small amount raw material originating from a primary source. It was processed on-site at least from stage 1 onwards. Two pieces with dorsal surfaces completely covered with chalky cortex demonstrate the cortex removal and initial core preparation step. Thus, farmers used this raw material more frequently than Epipaleolithic settlers and conducted the complete reduction sequence on-site. This differs from the Epipaleolithic occupation of A6 (cf. **4.4.10.1.1. A6 EPI/MA: Stage 1 – Cortex removal and preparation of core platform and reduction face**).

The Early Neolithic assemblage of A6 presents the highest cortex (39.8%) and heat treatment amount (78.5%) in this study (**Tab. 185** and cf. **Fig. 29** and **Fig. 37**).

CORTEX/HEAT TREATMENT		flakes			blades			cores			art. debris			pebbles	Σ*
		unm.	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm.*	*mod.*	*Σ*	*unm./Σ*	
with cortex	*n*	142	19	161	11	3	14	12	2	14	30	6	36	14	239
	%	88.2%	11.8%	67.4%	78.6%	21.4%	5.9%	85.7%	14.3%	5.9%	83.3%	16.7%	15.1%	5.9%	100% 39.8%
w/o cortex	*n*	202	46	248	44	20	64	3	1	4	34	12	46		362
	%	81.5%	18.5%	68.5%	68.8%	31.3%	17.7%	75.0%	25.0%	1.1%	73.9%	26.1%	12.7%		100% 60.2%
with heat treatment	*n*	274	48	322	40	19	59	14	2	16	58	14	72	3	472
	%	85.1%	14.9%	68.2%	67.8%	32.2%	12.5%	87.5%	12.5%	3.4%	80.6%	19.4%	15.3%	0.6%	100% 78.5%
w/o heat treatment	*n*	70	17	87	15	4	19	1	1	2	6	4	10	11	129
	%	80.5%	19.5%	67.4%	78.9%	21.1%	14.7%	50.0%	50.0%	1.6%	60.0%	40.0%	7.8%	8.5%	100% 21.5%

Tab. 185 A6 NEO/MA. Cortex coverage and heat treatment of blanks. Unmodified (unm.) and modified (mod.) blanks refer to the sum of each blank type and the sum of blanks refers to the total amount with or without (w/o) cortex or heat treatment. The sum of artifacts with or without cortex or heat treatment* refer to the total assemblage n=601.

4.4.10.2.2. A6 NEO/MA: Stage 2 – Core preparation

4.4.10.2.2.1. Crested pieces and lateral core flakes

24 artifacts are indicators of core preparation on-site. Sixteen are lateral core flakes that hardly contain any cortex (one piece with maximum one third). The flake scars of the lateral core flakes are multidirectional. Various directions and combinations of directions appear to similar amounts (**Tab. 167C**). Three pieces have additionally a primary preparation on the dorsal surface.

The eight crested flakes and blades (four of each) are covered with only very small amounts of cortex. Primary preparation of the dorsal surface predominates (**Tab. 167D**).

4.4.10.2.2.1. Cores and reduction technique

Cores are predominantly shaped like a cone (**Tab. 168**) with one plain striking platform on top (**Tab. 186A** and **B**). They are small (cf. Epipaleolithic assemblage in **Tab. 172** and **Fig. 33**).

PLATFORMS (n)	A6 EPI		A6 NEO		A6 Σ	
	n	*%*	*n*	*%*	*n*	*%*
1	7	70.0%	8	44.4%	15	53.6%
2 opposing			6	33.3%	6	21.4%
2 right-angled	1	10.0%	3	16.7%	4	14.3%
> 2	2	20.0%	1	5.6%	3	10.7%
Σ	10	100%	18	100%	28	100%

A

PLATFORM SURFACE	A6 EPI		A6 NEO		A6 Σ	
	n	*%*	*n*	*%*	*n*	*%*
1 negative	7	70.0%	11	64.7%	18	66.7%
cortex/natural	2	20.0%	3	17.6%	5	18.5%
ridge	1	10.0%	3	17.6%	4	14.8%
Σ	10	100%	17	100%	27	100%
n.s.*			1	5.6%	1	3.6%

B

Tab. 186 A6/MA. Platforms (**A**) and platform surfaces (**B**) of the present cores (*reference amount for the cores with platform surface not further specified (n.s.) is the total amount of cores NEO =18 and Σ=28).

PLATFORM REMNANT TYPE	flakes n	flakes %	blades n	blades %
type determined	205	53.5%	39	54.9%
natural**	30	14.6%	1	2.6%
plain**	171	83.4%	37	94.9%
secondary facetted**	1	0.5%		
crushed**	3	1.5%	1	2.6%
w/o	178	46.5%	32	45.1%
Σ	383	100%	71	100%
n.s.*	26	6.4%	7	9.0%

A

PLATFORM REMNANT SHAPE	flakes n	flakes %	blades n	blades %
shape determined	229	56.3%	46	59.0%
oval**	68	29.7%	19	41.3%
point**	28	12.2%	7	15.2%
linear**	27	11.8%	6	13.0%
triangular**	13	5.7%	1	2.2%
rectangular**	3	1.3%		
irregular**	61	26.6%	8	17.4%
rhombic**	4	1.7%		
winged/wavy**	13	5.7%	2	4.3%
trapezoid**	12	5.2%	3	6.5%
w/o	178	43.7%	32	41.0%
Σ	407	100%	78	100%
n.s.*	2	0.5%		

B

Tab. 187 A6 NEO/MA. Types (**A**) and shapes (**B**) of platform remnants present on flakes and blades (*reference amount of the type/shape not specified (n.s.) is the total amount of flakes=409 and blades=78; the type and shape attributes refer to flakes and blades with type/shape determined).

DORSAL REDUCTION	flakes n	flakes %	blades n	blades %
with DR	74	32.6%	18	39.1%
w/o DR	153	67.4%	28	60.9%
Σ	227	100%	46	100%
n.s.*	4	1.7%		

Tab. 188 A6 NEO/MA. Flakes and blades with and without (w/o) dorsal reduction (DR; *flakes with DR not specified refer to 231).

Congruently platform remnant of flakes and blades are also dominantly plain (**Tab. 187A**) and almost 15% of the flakes were removed from a core with a striking platform still covered by natural surface. Thus, apparently in this context, trimming flakes are characterized by a natural surface on the platform remnant, whereas regularly striking platforms were first prepared with the removal of one flake and constantly re-prepared by core tablets.

Moreover people prepared core edges to remove large pieces possibly with a hard hammer (cf. **Tab. 35**): 30-40% of the blanks have a dorsal reduction (**Tab. 188**).

4.4.10.2.3. A6 NEO/MA: Stage 3 – Blank production

Approximately one third of the assemblage (220 artifacts) could be from the regular blank production (cf. **Tab. 33**). In general, the Early Neolithic assemblage is characterized by a particularly large amount of flakes: 68.1% flakes vs. 13% blades (**Tab. 34**). Flakes outweigh blades five times (ratio 5:1 and flake/blade-index 5.2). Due to the small amount of blades and in comparison to the inventory of Car/GR (**4.4.9. Cueva de la Carigüela/Granada (Car/GR)**), one can assume a giving away of blades or an export of blades by the leaving group.

BLANK FRAGMENTS	flakes unm. n	flakes unm. %	flakes mod. n	flakes mod. %	flakes Σ n	flakes Σ %	blades unm. n	blades unm. %	blades mod. n	blades mod. %	blades Σ n	blades Σ %	Σ n	Σ %
complete	125	36.3%	7	10.8%	132	32.3%	16	29.1%	3	13.0%	19	24.4%	151	31.0%
proximal	75	21.8%	24	36.9%	99	24.2%	16	29.1%	11	47.8%	27	34.6%	126	25.9%
distal	78	22.7%	9	13.8%	87	21.3%	9	16.4%	2	8.7%	11	14.1%	98	20.1%
medial	66	19.2%	25	38.5%	91	22.2%	14	25.5%	7	30.4%	21	26.9%	112	23.0%
Σ	344	84.1%	65	15.9%	409	100.0%	55	70.5%	23	29.5%	78	100.0%	487	100.0%

Tab. 189 A6 NEO/MA. Preservation of the unmodified and modified flakes and blades. The complete blanks also consist of 30 non-modified and 3 modified flakes, 4 non-modified and 3 modified blades that are complete in length (in direction of percussion) but incomplete in their width.

Flake fragments consist almost equally of complete pieces (above 30%), proximal fragments (about 25%), and approximately 20% of both medial and distal fragments (**Tab. 189**) as in CZ/MU and CA/AL. Blades are predominantly preserved as proximal fragments. 25% consist of both medial fragments and complete pieces. Thus, amongst blades an additional import of medial fragments as target products for tools is possible.

Apart from pebbles, blanks are comparably large in the Early Neolithic inventory of A6 (**Tab. 190** cf. **Fig. 33**). Flakes and blades are broadly scattered by length and width (**Fig. 28** cf. **Fig. 27**). Variances in dimensions are possibly caused by the reduction process with decreasing core sizes on-site. Initial cores could have had an edge length at about 5-5.5cm.

4.4.10.2.3.1. Percussion technique

The dominant amount of blanks was removed parallel, unidirectional from the core (**Tab. 191**). But both blades (12.8% with unidirectional-transverse dorsal flake scars) and especially flakes (34.8% with combined, transverse or other directions of dorsal flake scars) also show irregular dispersed dorsal flake scars.

DIMENSIONS	n	length (mm)				width (mm)				thickness (mm)				weight (g)			
		MIN	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*	*MIN*	*MAX*	*Ø*	*SD*
flakes	409	2	56	24	8.63	3	62	22	7.52	2	19	7	3.35	0.4	49.8	5	5.52
unmod.	344	2	56	23	8.43	3	62	22	7.63	2	19	7	3.30	0.4	49.8	5	5.71
complete	125	11	56	24	8.47	3	62	22	8.18	2	18	7	3.33	0.4	49.8	5	6.80
mod.	65	8	52	28	8.73	11	50	24	6.72	2	17	8	3.57	0.7	22.0	6	4.34
complete	7	20	46	31	8.79	19	50	26	11.08	6	13	9	2.98	2.3	11.3	6	3.80
blades	78	11	58	33	10.21	8	27	14	4.52	2	15	6	2.67	0.4	16.9	3	2.63
unmod.	55	12	58	33	10.29	0.8	27	14	4.85	2	15	7	2.70	0.4	16.9	3	2.93
complete	16	16	58	33	11.88	8	22	12	4.28	2	9	6	2.22	0.4	8.3	3	2.34
mod.	23	11	55	33	10.23	8	20	14	3.68	2	14	6	2.65	0.6	7.2	3	1.80
complete	3	30	34	33	2.31	12	17	14	2.65	4	8	7	2.31	1.6	3.5	3	1.04
cores	18	23	46	34	6.05	15	38	25	5.90	3	26	16	5.39	5.5	37.2	17	8.45
unmod.	15	23	46	34	6.27	17	38	26	5.21	10	26	17	4.56	5.5	37.2	18	8.44
mod.	3	28	40	34	6.03	15	25	19	5.51	3	19	12	8.19	7.5	11.3	9	1.92
art. debris	82	13	47	25	8.01	8	45	19	7.29	4	33	11	5.49	0.5	39.9	7	8.72
unburned	10	15	41	24	8.67	9	32	19	7.89	5	20	10	4.67	1.1	33.0	8	10.88
burned	72	13	47	25	7.97	8	45	19	7.27	4	33	11	5.62	0.5	39.9	7	8.46
pebbles	14	35	47	40	5.08	26	40	32	5.42	6	38	22	8.51	18	92.4	48	24.55

Tab. 190 A6 NEO/MA. Dimensions of unmodified (unmod.) and modified (mod.) blanks.

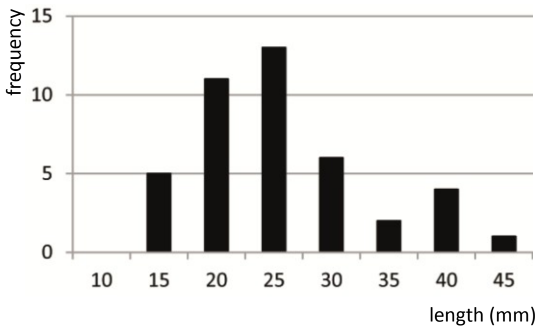


Fig. 27 A6 NEO/MA. Length of complete and regular flakes and blades in 5mm-ranges (from 5-10mm, to 15 etc.; Σ=42).

Flake scars of the core reduction faces present similar amounts (**Tab. 191**): Approximately 80% of the blanks were removed regularly, whereas the rest was removed irregularly and alternatingly.

Impact marks (**Tab. 192**) that could originate both from a hard hammer (32.8% pronounced bulbs of flakes) and from a soft hammer percussion (75% and 63.8% diffuse bulbs on blades and flakes, about half of the artifacts with lip and more than 15% with bulbar scar) are present. Indicators of soft stone or organic percussion dominate and are further supported by the presence of fine platform remnants on 69.5% of the blades (oval, pointed or linear cf. **Tab. 187B**). Thus, the majority of artifacts obviously stem from regular blank production.

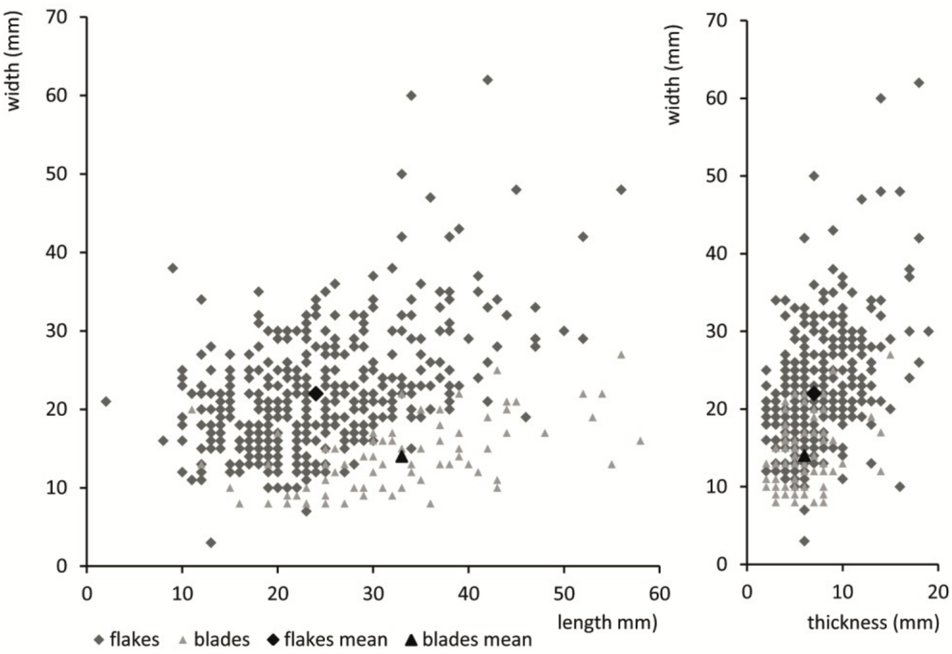


Fig. 28 A6 NEO/MA. Dimensions of flakes and blades in mm.

DIRECTION DORSAL FLAKE SCARS	flakes		blades	
	n	*%*	*n*	*%*
dorsal flake scars determined	356	87.0%	78	100%
parallel, unidirectional**	211	59.3%	60	76.9%
parallel,opposing**	14	3.9%	5	6.4%
bipolar sensu lato**	7	2.0%	2	2.6%
unidirectional-transverse**	43	12.1%	10	12.8%
opposing-transverse**	1	0.3%		
bipolar-transverse**	1	0.3%		
transverse**	55	15.4%	1	1.3%
concentric**	3	0.8%		
other**	21	5.9%		
w/o	53	13.0%		
Σ	409	100%	78	100%

Tab. 191 A6 NEO/MA. Direction of dorsal flake scars of flakes and blades (**directions refer to blanks with dorsal flake scars determined).

IMPACT MARKS	flakes		blades	
	n	*%*	*n*	*%*
with impact ring	2	0.9%		
w/o impact ring	227	99.1%	46	100%
Σ	229	100%	46	100%
n.s.*	2	0.9%		
with lip	109	47.4%	25	54.3%
w/o lip	121	52.6%	21	45.7%
Σ	230	100%	46	100%
n.s.*	1	0.4%		
with bulbar scar	36	15.7%	8	17.4%
w/o bulbar scar	193	84.3%	38	82.6%
Σ	229	100%	46	100%
n.s.*	2	0.4%		
with bulb	174	75.7%	36	78.3%
pronounced**	*57*	*32.8%*	*6*	*16.7%*
diffuse**	*111*	*63.8%*	*27*	*75.0%*
splintered**	*6*	*3.4%*	*3*	*8.3%*
w/o bulb	56	24.3%	10	21.7%
Σ	230	100%	46	100%
n.s.*	1	0.4%		

Tab. 192 A6 NEO/MA. Impact marks on flakes and blades (*blanks with not further specified (n.s.) characteristics refer to the total amount of flakes/blades with proximal ending Σ=231/46; **bulb attributes refer to all blanks with bulb).

4.4.10.2.4. A6 NEO/MA: Stage 4 – Re-preparation of cores

Seventeen core tablets and 14 plunging flakes and blades remain from re-preparation of cores in the Early Neolithic level of A6.

Around 50% of the plunging flakes and blades have regular dorsal flake scars exclusively and combined unidirectional and opposing dorsal flake scars (**Tab. 193A**). Furthermore, unidirectional-transverse and concentric directions prove the turning of the core in terminal stage 3.

The core tablets were removed parallel and transverse to the platform.

The dimensions of stage 4-artifacts are striking and call for an explanation (**Tab. 193B**): Apparently core tablets, plunging flakes and blades have still more or less the same dimensions as the blanks of stage 3 (cf. **Tab. 190**).

DORSAL FLAKE SCARS	plunging pieces n	%
parallel, unidirectional	5	35.7%
parallel, opposing	1	7.1%
bipolar *sensu lato*	1	7.1%
unidirectional-transverse	3	21.4%
transverse	1	7.1%
concentric	2	14.3%
other	1	7.1%
Σ	14	100.0%

A

SIZE	*Ø*	*SD*	*MIN*	*MAX*
length	27.1	9.135	14	53
width	18.9	5.290	5.3	10
thickness	8.6	3.989	3	18
weight	5.2	4.655	0.7	18.0

B

Tab. 193 A6 NEO/MA. Artifacts from stage 4 of the reduction sequence: **A** – direction of dorsal flake scars of plunging flakes and blades and **B** – dimensions of core tablets *and* plunging flakes and blades.

This similarity could indicate that the re-preparation of cores already took place in an early state of the reduction sequence and much earlier than in the other sites and earlier than in the Epipaleolithic assemblage of this site (cf. **all paragraphs concerning stage 4**).

4.4.10.2.5. A6 NEO/MA: Stage 5 – Modification and use

DIRECTION DORSAL FLAKE SCARS	tools n	%
parallel, unidirectional	52	60.5%
parallel, opposing	7	8.1%
bipolar *sensu lato*	1	1.2%
unidirectional-transverse	6	7.0%
opposing-transverse	1	1.2%
transverse	14	16.3%
concentric	3	3.5%
other	2	2.3%
Σ	86	100.0%
*w/o**	*2*	*2.3%*

A

DIMENSIONS	*Ø*	*SD*	*MIN*	*MAX*
length	28.8	9.930	8	55
width	20.9	7.160	8	50
thickness	7.9	3.936	8	20
weight	5.6	5.191	0.6	33.0

B

Tab. 194 A6 NEO/MA. Artifacts from stage 5a of the reduction sequence: **A** – direction of dorsal flake scars of the modified flakes and blades (*reference amount: total of modified flakes and blades Σ=88) and **B** – dimensions of the tools.

35.6% of the preserved inventory consists of tools and pieces with macroscopically visible use traces. Tools, use traces and additional modifications imply an intense use of artifacts for handcraft activities on-site. Single burin spalls and discarded projectile points additionally indicate production and repairing of tools on-site.

4.4.10.2.5.1. 5a – Intentional modification

TOOL TYPES	n	%	0 ratio % 40
projectiles	2	1.8%	
borers	2	1.8%	
burins	10	9.2%	
truncations	7	6.4%	
end scrapers	21	19.3%	
lateral retouches	12	11.0%	
splintered pieces	45	41.3%	
notched pieces	6	5.5%	
denticulates	4	3.7%	
Σ n	109	100%	
% tools/assemblage		*18.1%*	D = 0.230

Tab. 195 A6 NEO/MA. Tools: absolute number, amount of each tool type, tool ratio referring to the total assemblage, and Simpson diversity index (D).

BURIN SPALLS	*L*	*W*	*T*	*We (g)*
85739	20	10	16	3
85790	21	8	8	1.3

Tab. 196 A6 NEO/MA. Burin spalls with ID and dimensions (LxWxT in mm; We in g) indicate the modification of burins on-site.

Two burin spalls prove the modification of burins on-site (**Tab. 196**). Additionally, 109 pieces are designated to tools and 28 thereof are partly covered with cortex.

Within the whole assemblage, the tool amount accounts for 18.1% (**Tab. 195**). Amongst the tools, splintered pieces dominate the inventory by far with more than 40%. Besides these pieces, end scrapers and pieces with lateral retouches and burins are also present. The Simpson index has the highest value in contrast to other inventories of this study. Nevertheless, the inventory is still diverse and no specialization is visible.

Amongst the underlying blanks, flakes predominate with 60%. Blades (20%) and (17%) artificial debris occur less. Looking at the blank assemblage, blades especially were used for tools and 29.5% of the present blades are modified; but also a large amount of 22% of the artificial debris was obviously sufficient or available at the right moment and therefore opportunistically used as tools. A few flakes were modified, too (15.9% of the present flakes). The large amount of artificial debris within the tools is remarkable and denies a complete standardization of tools, but implies a partly opportunistic, situational blank picking for tools. This is also visible in the varying directions of the dorsal flake scars and dimensions (**Tab. 194A/B**).

The modified blades are again finer and longer than the non-modified artifacts (**Tab. 190**).

4.4.10.2.5.2. 5b – Use

In addition to the 109 tools, 103 non-modified pieces have small traces due to use (**Tab. 197**). All kinds of blanks were used ad hoc. People especially favored blades and pebbles and their conditions for an unprepared use amongst unmodified blanks (60% of each with use traces).

Besides fine irregular use traces that could not be assigned to a distinct activity, people preferably used pebbles for polishing or the nodules were polished.

4.4.10.2.5.3. 5c – Resharpening

41 tools have two or multiple intentional modifications (**Tab. 198**). Splintered pieces show again that they have regularly multiple working edges with splinterings. Five of the six present pieces with notches have varying additional modifications. People modified the edges of many tools with additional lateral retouches.

USE TRACES	edge rounding	ridge rounding	use traces	other mod.	polish	Σ (n pieces) *n*	*%*	*reference amount*
flakes	1	1	41	4	10	57	16.6%	343
blades		1	29	2		32	59.3%	54
art. debris			1		2	3	4.7%	64
cores					2	2		14
pebbles					9	9	60.0%	15
1x ut.	1	2	71	6	23	**103**	21.0%	490
2x ut.		1	24	1	1	27		
3x ut.			4			4		
Σ (n ut.)	1	3	99	7	24	134		

Tab. 197 A6 NEO/MA. Macroscopically visible use traces (ut.) on pieces without intentional tool modification. The artifacts are listed according to the blank type and refer to unmodified blanks/pieces in the assemblage (w/o 2 burin spalls on bladelets). On several pieces, more than one specific use trace remain (2x ut. etc.; mod. = modification). The reference amount is all unmodified pieces.

TOOL TYPES	n ADDITIONAL MODIFICATIONS *1*	*2*	*3*	*Σ n*	*%**	*%***	*Σ***	burins	truncations	lateral retouches	splintered pieces	notched pieces	denticulates
projectiles							2						
borers							2						
burins		2	1	3	7.3%	30.0%	10	3	1	3			
truncations	1			1	2.4%	14.3%	7			1			
end scrapers	4	2	1	7	17.1%	33.3%	21			8	2	1	
lateral retouches	4			4	9.8%	33.3%	12			3			2
splintered pieces	12	6	2	20	48.8%	44.4%	45				28		
notched pieces	1	3	1	5	12.2%	83.3%	6		1	2	2	1	1
denticulates	1			1	2.4%	25.0%	4		1				
Σ n	23	13	5	**41**	100%	37.6%	109	3	3	17	32	2	3
%	56.1%	31.7%	12.2%	100%									

Tab. 198 A6 NEO/MA. Tools and additional modifications (*refer to total amount of tools with additional modifications Σ=41; **refer to total number of each tool type Σ**).

4.4.10.2.6. A6 NEO/MA: Stage 6 – Discard

Approximately three quarters (440 pieces) of the Early Neolithic artifacts were discarded due to currently evident reasons (cf. **Tab. 32**). On the heated artifacts, color changes, fissures and heat pitting appear frequently and mixed (cf. **Tab. 53**). Thus, 11 artifacts show signs of intentional heat treatment (**Tab. 199**) whereas all other artifacts were apparently burned after their discarding.

TIME HEAT TREATMENT	flakes *n*	*%*	blades *n*	*%*	cores *n*	*%*	art. debris *n*	*%*	pebbles *n*	*%*	Σ *n*	*%*
raw material heated	5	1.6%	1	1.7%			3	4.2%	2	66.7%	11	2.3%
heated after blank removal	191	59.3%	32	54.2%	13	81.3%	26	36.6%	1	33.3%	263	55.8%
thermal fracture	91	28.3%	12	20.3%	1	6.3%	37	52.1%			141	29.9%
heated after modification	35	10.9%	14	23.7%	2	12.5%	5	7.0%			56	11.9%
total with heat treatment	322	100.0%	59	100.0%	16	100.0%	71	100.0%	3	100.0%	471	100.0%
n.s.							1	*1.4%*			1	*0.2%*

Tab. 199 A6 NEO/MA. Time of heat treatment on various blank types.

4.4.10.2.7. A6 NEO/MA – Summary: Reconstruction of the reduction sequence

Early Neolithic settlers used pebbles at about 4cm length for knapping and as ground stone tools. Alternatively they were used first as ground stone tools for polishing, subsequently decortified and then included in the knapping sequence. One artifact with dorsal polished pebble cortex is an indicator of this procedure.

Raw material was processed from a primary source with chalky cortex, but those nodules were obviously all exploited. No stage 0-pieces are left, but products from cortex removal remained in situ.

Lateral core flakes and crested pieces with very few cortex of stage 2 demonstrate an accurate previous cortex removal and subsequently a core preparation by multi-directional removal of trimming flakes.

The blank production is regular. Despite obviously smaller starting pebbles in the Early Neolithic of A6, the dimensions of starting cores and blanks are as similar as in the Epipaleolithic context. Latest flakes and blades immediately previous to stage 4 indicate a re-orientation of the cores to receive more blanks. Their occurrence is similar or even more often than in the Epipaleolithic. Lithic artifacts provide indications of both hard and soft hammer percussion used on-site.

But in comparison with the equivalent Epipaleolithic artifacts, the Early Neolithic core tablets and plunging pieces from stage 4 are larger with a remaining edge length of 3cm after blank production.

The tools are generally made of large blanks, but those were not specifically standardized. Additionally, artificial debris and pieces with cortex were modified. 214 tools and not intentionally modified pieces were used. Burin spalls and the 37.6% of the tools with additional modifications could indicate a resharpening on-site.

Finally many pieces were discarded and no attention was paid to fire exposure.

4.4.10.3. A6: Epipaleolithic and Early Neolithic reduction sequences in comparison

Only in A6 are nodules due to stage 0 present in the assemblages. This issue does possibly not correspond to reality (i.e. nodules can be expected in other assemblages, too), but could be caused by former common archaeological work practice. During early excavations, it was probably not common to keep all, even non-modified pieces.

On average the pebbles are 4.5cm long and weight 76.6g. They range up to 9cm and 445g. During both time periods, these pieces served not only as raw material for the chipped stone industry but also or first as ground stone tools attached to polishing or the processing of pigments. Subsequently people used some of these nodules as raw material for knapping.

In both phases, settlers exploited also flint varieties with chalky cortex from primary sources. However, the utilization of this raw material was rare in the Epipaleolithic. But apparently both the Epipaleolithic and Early Neolithic groups did not bring complete nodules of these raw material(s) with them on-site. Alternatively, they could have completely transformed them non-traceably thereafter. There are signs of processing this flint on-site with stage 1 (in the Early Neolithic) and later in stage 2 (in the Epipaleolithic). Probably this flint came to A6 as partly decortified cores (Early Neolithic) or products of all further reduction-stages (prepared cores, blanks, tools; Epipaleolithic and Early Neolithic).

Pieces of subsequent stages with rare cortex demonstrate a careful cortex removal during the preparation of the core platform and the reduction face obtaining pre-cores of 8cm length (Epipaleolithic, stage 2). While Epipaleolithic stage 2-artifacts with mostly parallel dorsal flake scars indicate a regular core preparation, equivalent Early Neolithic pieces are covered by multi-directional flake scars. The initial cores had estimated edge lengths at about 5.5cm and the lengths of the following reduction products range between 4.5-1.5cm. Keeping in mind that only few cores exist, their shapes are more variable in the Epipaleolithic inventory. Early Neolithic cores have single striking platforms and additionally also opposing striking platforms. Furthermore, an extraordinary large amount of natural surfaces remained on the platform remnants of flakes.

In the blank-spectrum, differences between Epipaleolithic and Early Neolithic occupation of A6 are obvious. In the Early Neolithic assemblage, the amount of flakes is much higher and they outweigh blades much more than in the Epipaleolithic inventory. Thus, an export of blades is probable. Dimensions imply that many pieces from the complete reduction process remained on-site.

For the percussion technique, both indicators of hard and soft hammer percussion and thus preparation, blank production and final exploitation of the cores are present in both chronological stages. Signs of a removal by a hard stone dominate slightly in the Epipaleolithic with a large amount of dorsal reduction even on blades and a relatively large amount of impact rings. Apart from that, e.g. a large amount of diffuse bulbs in combination with other present characteristics could indicate the percussion with a soft stone.

People removed especially blades almost exclusively in a regular way and likewise the predominant part of the flakes. Pieces of stage 4 indicate a re-orientation of the core to extend the blank reduction.

People modified, used, resharpened or repaired tools on-site. 12.0% (Epipaleolithic) and 18.1% (Early Neolithic) of the assemblage are tools. Besides a dominance of splintered pieces, end scrapers and burins appear in both assemblages similarly frequently. Specialization indices are low for the Epipaleolithic (D=0.165) as well as for the Early Neolithic tool inventory (D=0.230). In both assemblages, blades were mostly used as tools. Additionally, in the Epipaleolithic inventory a comparably large amount of cores was modified, whereas Early Neolithic settlers utilized 22% of the artificial debris. The pebbles are never intentionally modified, but have use traces (cf. **Tab. 180**; **Tab. 197**; **4.4.10.1. Epipaleolithic assemblage of A6/MA** and **4.4.10.2. Early Neolithic assemblage of A6/MA**).

Generally many artifacts without intentional modification have macroscopically visible use traces (26.1%/17.1%). Burin spalls and about 37% of the tools with several modifications indicate an intense use of the tools or resharpening on-site.

Finally all artifacts were discarded and a considerable amount was carelessly exposed to fire.

Thus, both assemblages unfold similar knapping concepts and draw a similar picture about possible actions in and functions of the site throughout Epipaleolithic and Early Neolithic.

4.5. Comparative characterization of the reduction sequences

Generally there are very few indicators of raw material procurement and testing in the studied assemblages (cf. **Tab. 33**). This indicates an initial rough preparation of the raw material off-site as AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO (2011) and MARTÍNEZ FERNÁNDEZ ET AL. (2010, 165-166 cf. SÁNCHEZ ROMERO 2000, 160) assume equivalently for Ner/MA and Cast/GR. CZ/MU (natural debris), the Epipaleolithic and the Early Neolithic assemblage of A6/MA (pebbles) and equivalent assemblages of Ner/MA (AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO 2011) are all exceptions, with non-modified raw material pieces on-site. The A6/MA pebbles are obviously signs of an overlap of ground stone and chipped stone industries. People used the pebbles as tools for polishing, processing of pigments, knapping raw material and even for several of these purposes in succession. These nodules measure between 4-9cm length, on average 4.5cm and 76.6g. Even in other big assemblages such as AL/MU or CA/MA, no nodules indicate a direct acquisition of raw materials. But cortex-covered pieces of the following stages show that apparently various primary and secondary raw material sources were frequented (cf. **4.3. Raw material**).

Indicators of stage 1 are also only present in small amounts and even completely missing in AM/MU. All other sites provide artifacts proving cortex removal and preparation of the core platform and reduction face. Cortex-covered artifacts imply a predominant exploitation of primary sources with chalk flint in CA/AL. Whereas in A6/MA this stage is predominantly indicated by pieces with pebble cortex: During the Epipaleolithic, people brought the raw material with chalky cortex as prepared cores, blanks or even tools to the site, and there was only an observable cortex removal of pebbles on-site. At other sites (including Cast/GR), small amounts of cortex removal-artifacts indicate an introduction of already pre-prepared cores, besides the partial cortex removal on-site (Hoz/MU, CNP/AL and Car/GR). On the one hand some inventories show that an accurate cortex removal was not necessary and artifacts with cortex still appear up to stage 3 (CH/MU). However, on the other hand, assemblages with very few cortex in stage 2 prove that cortex removal took place very accurately (Hoz/MU, CA and CNP/AL, Car/GR, A6/MA).

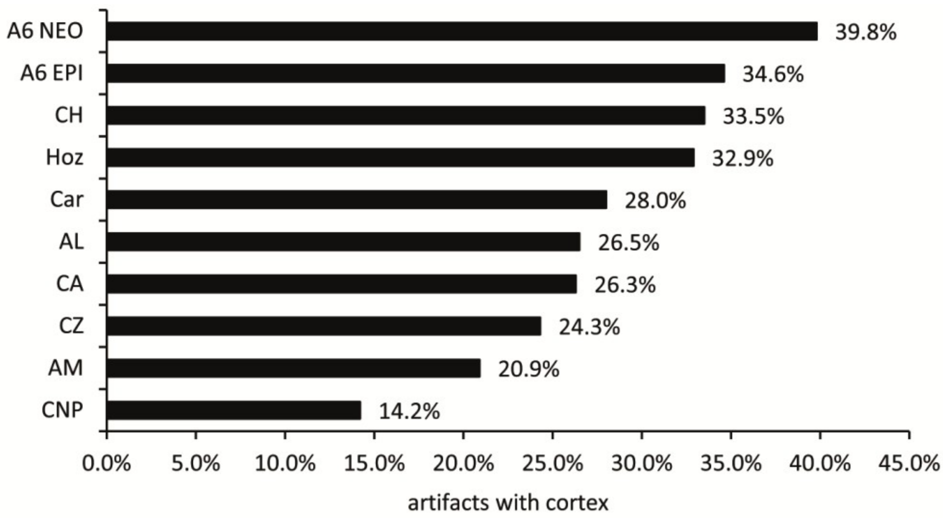


Fig. 29 Decreasing amounts (%) of cortex covered artifacts per assemblage in comparison (mean=28.1%).

The presence of at least partly cortex-covered artifacts in all assemblages indicates cortex removal and the initial steps of the reduction sequence at every site (**Fig. 29**). Especially the Early Neolithic inventory of A6/MA has a large amount of almost 40% artifacts with remains of cortex. Between 33-

35% are the amounts in Epipaleolithic assemblages in CH and Hoz/both in MU. In contrast, inventories of Car/GR, CA/AL, AL and CZ/both in MU present amounts ranging from 24-28%. In AM/MU only 20.9% of the artifacts have cortex left over and in CNP/AL only 14.2%. These percentages seem to represent a somehow stepwise decrease and thus a decreasing cortex removal on-site or rather a less represented initial reduction sequence since decortified products, i.e. blades, are already present on the sites. These amounts confirm a decreasing production of blanks in situ and the augmented input of already decortified products.

Thus, the Epipaleolithic cortex amounts range between 20-35% showing two very narrow clusters: The sites with cortex amounts in the 20ies (AM, CZ, AL/all in MU; CA/AL) and in the 30ies (Hoz, CH/both in MU and A6 EPI/MA). This low cortex amount could be evidence of either a partial cortex removal off-site and additional import of decortified target products from former sites or a higher amount of stage-1-artifacts/-actions on-site and an export of decortified target products.

Again the Early Neolithic inventories are on the extreme ends of the ranges with almost 40% (A6 NEO/MA) vs. 15% (CNP/AL) and in the center (Car/GR with 28%). This could be due to the dataset with only three inventories that cover the whole range.

CRESTED PIECES		*n*	%
MU	AL	16	3.1%
	AM	2	2.2%
	CH	13	5.1%
	CZ	14	3.5%
	Hoz	17	7.8%
AL	CA	35	2.2%
	CNP	7	2.8%
GR	Car	7	1.5%
MA	A6 EPI	15	3.1%
	A6 NEO	8	1.3%

Tab. 200 Crested pieces referring to the total numbers of artifacts in each assemblage.

Although there are few stage 2-artifacts, crested flakes and blades indicate a certain core preparation initiating the reduction sequence everywhere. MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS (1984, 17 footnote 13) considered the preparation of ridges to initiate a blank production as Upper Paleolithic traditions that continued in the Epipaleolithic. Additionally, the present study confirms a similar preparation in the Early Neolithic with crested pieces present in all assemblages (1.3-7.8%; cf. **Tab. 200**).

The typical core was a pointed based cone (≥60% of the cores) with one plain platform on top (cf. **SITE GAZETTEER: El Duende/Málaga** with predominantly pyramidal one platform blade-cores). The Epipaleolithic cores of A6/MA are an exception as the few cores are distributed over several core shapes: One third consists of cones and another third of cylinders. Cores in CZ/MU have predominantly more than two striking platforms – keeping in mind that here as well few cores are present and dispersed over four characteristics.

Furthermore, striking platforms were also facetted. Generally the amount is under 10% of facetted platform remnants, but in some inventories it is higher (16.5% of the flakes and 15.4% of the blades in AL/MU with facetted platform remnants; 19.5% of the flakes and 22.2% of the blades in AM/MU; 10% of the blades in CZ/MU; 11.2% of the flakes in Hoz/MU; 16.7% of the blades in CNP/AL). There are few natural surfaces on the platform remnants. Only in the Early Neolithic assemblage of A6/MA 14.6% of the platform remnants of flakes are covered by natural surfaces.

Dorsal reduction was very common and accounts generally for far more than a third of flakes and blades and provides a slight hint of hard stone percussion (cf. **Tab. 35**). In some assemblages, a re-orientation of the core in this early stage was obviously necessary (AM, CZ/both in MU, Car/GR, Early Neolithic of A6/MA).

In contrast, artifacts of all following stages occur in every inventory, and in nearly all assemblages most pieces were left over from the regular, mostly unidirectional blank production in stage 3. Their amount is generally 50% or higher. But artifacts are relatively lightweight and small (cf. mean weights in **Tab. 33**), and thus their amount of the total weight is about 30% or less. Especially Murcian Epipaleolithic blanks have a mean just less than 2.0g.

Generally, the compositions of the blank-spectra suggest mainly a blank production in situ without remarkable import-/export-/exchange activities or at least compensating events. This seems to be the case in AL, AM, CH, CZ/all in MU, CA/AL and the Epipaleolithic assemblage of A6 and Du/MA each with a large amount of flakes between 50-60%, followed by 25-40% blades (**Fig. 30** cf. **Tab. 258** with references) and cores, artificial and natural debris and pebbles in minor amounts.

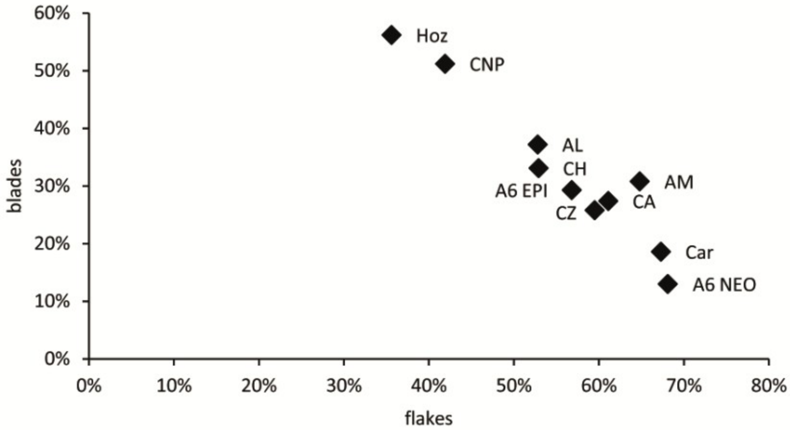


Fig. 30 Flake and blade amounts (% cf. **Tab. 34**) of the analyzed assemblages.

Thus, one can assume that during Epipaleolithic times, settlers knapped regularly on-site, and created more or less similar amounts of 60% flakes and decreasing amounts of other blanks. Alternatively, these amounts could have been accomplished by a regular im- and export to all sites: I.e. people could have taken a distinct amount of semi-finished blanks (/blades) produced on-site A with them to site B, where they modified these blanks, discarded them, started a new reduction sequence and took the blades again to the following occupation spot etc. Thus, neither import nor export nor exchange is actually noticeable in these assemblages.

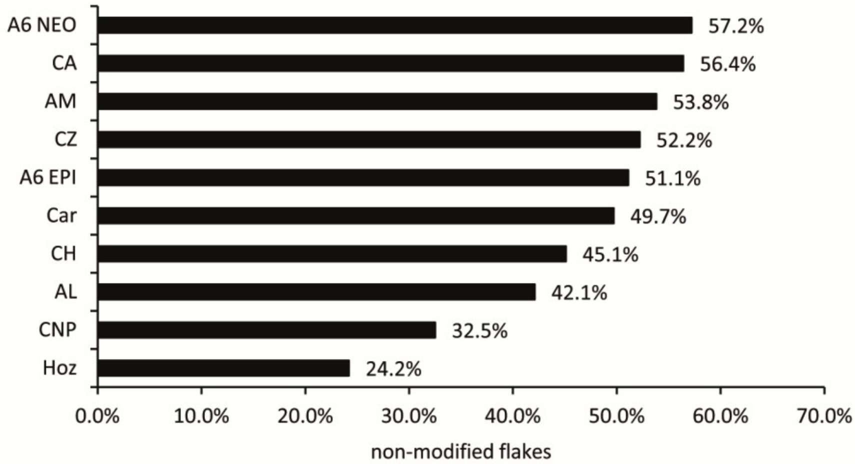


Fig. 31 Amount of non-modified flakes (%) refering to the total number of artifacts per assemblage (not refering to the amount of flakes per assemblage as in **Tab. 34**; mean=46.4%).

The three evaluated Early Neolithic assemblages are again on both extremes: A6/MA and Car/GR have large amounts of flakes, whereas CNP/AL even has more blades than flakes. However, the assemblages of Car/GR and the Early Neolithic inventory of A6/MA are striking due to an outstandingly large amount of almost 70% flakes (**Fig. 30**) followed by small amounts of other blanks, i.e. 18.6% blades in Car/GR and 13% blades and 13.6% artificial debris in A6 NEO/MA etc. (cf. **Tab. 34**). The sites could be production-sites, where people produced many blades and exported them, and a disproportional large amount of flakes were left behind (A6 NEO/MA and Car/GR). One can assume here a give-away of blades to other sites, where people did less blank production, or settlers took blades with them to their next stopover after leaving either Car/GR or A6 NEO/MA (**Fig. 31**). By comparison, the assemblages of Hoz/MU, CNP/AL and Early Neolithic Cast/GR (**Tab. 260** with references) have a surplus of blades pointing to an additional introduction of products. In Murcia and Almería blank production (i.e. non-modified flakes) was more frequent at sites situated slightly in the hinterland of the submediterranean zone (CZ, AM/MU and CA/AL). Coastal sites (CNP/AL; AL, CH/both in MU) and sites in the thermo-mediterranean zone (Hoz/MU) had less non-modified flakes. This could indicate a down-the-line exchange of raw material from the interior SE Spanish areas to the coastal areas.

Whether these export and import mechanisms were due to the "one" occupying and moving mobile group or due to an exchange is ambiguous. Due to the apparently short-term occupations of the settlements and the omnipresent high mobility in the groups, I tend to support the first hypothesis (mobility of the group). Amounts in Hoz/MU could be influenced by the excavation and preservation context (cf. **SITE GAZETTEER**: **Barranco de la Hoz/Murcia**). The Early Neolithic blank assemblage of Ner/MA is nearly tripartite with 30-35% of each flakes, debris and blades (**Tab. 249** with references).

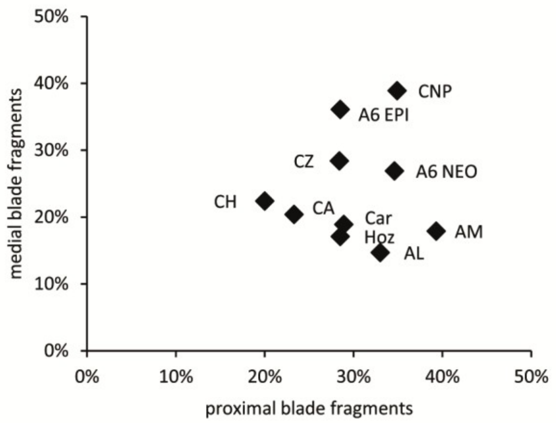


Fig. 32 Ratio of proximal and medial blade fragments (%) of the analyzed assemblages.

As far as complete blanks and blank fragments are concerned, various concepts become apparent (cf. also **Fig. 32**). First, complete blanks and proximal endings clearly dominate in AL, AM, CH, Hoz/all in MU and Car/GR. One can assume a blank segmentation on-site and an export of medial fragments as semi-finished target products or even as target products inserted into hafts of composite tools. In contrast, CZ/MU and CA/AL have relatively equal amounts of complete, proximal, distal and medial fragments representing another concept regarding the blank segmentation and application of fragments. The amounts of CNP/AL tend to the latter composition, but especially for blades, medial and proximal fragments dominate by far indicating a probable import of modified medial fragments. The assemblages of A6/MA have unique amounts, too: The Epipaleolithic flakes correspond better to the amount of most Murcian sites and Car/GR, with a dominance of complete flakes and proximal endings. However, a dominant amount of medial blade fragments indicates that they were additionally imported. The Early Neolithic blank assemblage has amounts of complete and blank parts more or less similar to those in CZ/MU and CA/AL with a slight tendency to an additional import of medial fragments as in CNP/AL and possibly the Epipaleolithic assemblage.

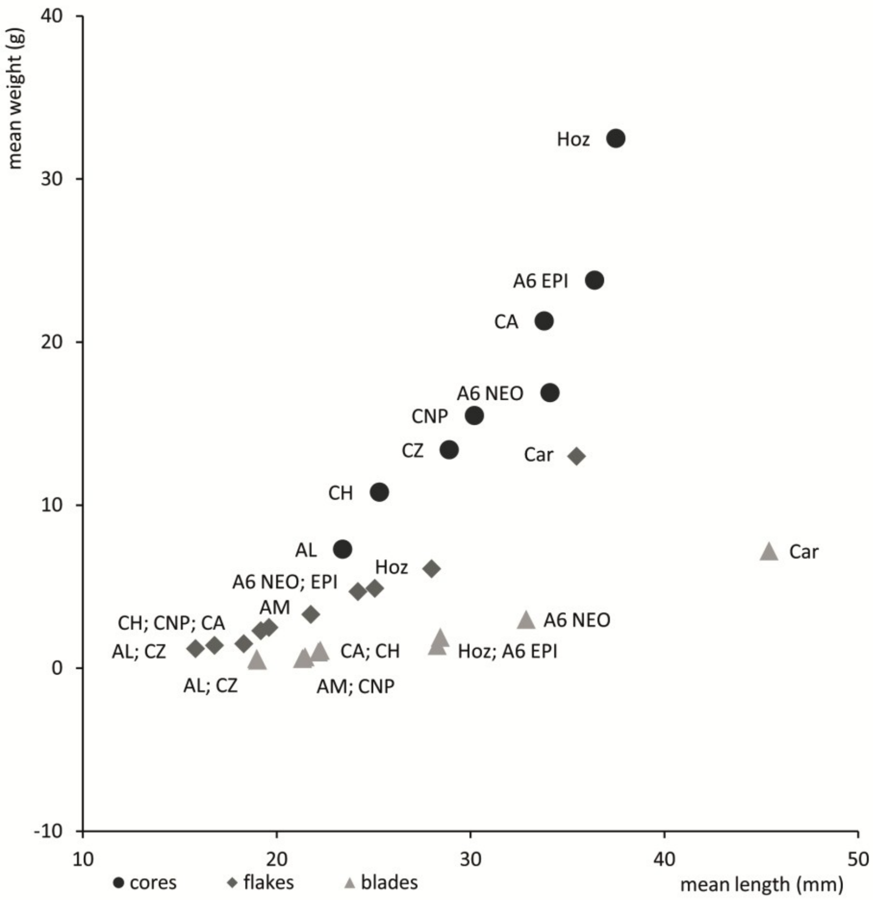


Fig. 33 Comparison of core, flake and blade dimensions. Mean values of the length (in mm) and weight (in g) are displayed without the outlier of Car/GR (39.2mm/61.5g).

Cores regularly represent the largest blanks in all assemblages (**Fig. 33**). Dimensions decrease amongst the blanks down to blades, which are usually the most light-weight blanks. Generally big artifacts are preserved in Car/GR and Hoz/MU. The blanks in the Epipaleolithic assemblage of A6 are bigger than the Early Neolithic ones (apart from non-modified blades, cf. mean weights **Tab. 172** and **Tab. 190**). The dimensions of flakes and blades are fairly widely spread and standardization is not apparent (cf. length-width and thickness-width graphs). The dimensions indicate foremost the reduction of small initial cores or of already reduced cores (of less than 4.5cm edge length in AL/MU and in CNP/AL) or a selection and further use and finally export of larger, excellent – meanwhile – modified and used blanks with dimensions of between 6-4cm (single large artifacts apparent in stage 1-2 in CH/MU). In Hoz/MU, cores at about 5-2cm length and in A6/MA of 5.5cm were reduced and larger blanks modified to tools. In AM and CZ/both in MU, the reduction on-site seems to start only with the re-preparation of cores leaving the largest products. Thereafter during a secondary reduction sequence, blanks were removed from cores with edge lengths of 4-1.5cm. Small cores with maximum lengths of less than 4cm are present in AL and CH/both in MU. In Hoz/MU and CA/AL present cores are still large with almost 7cm. In Car/GR the "huge" cores fit to the present large artifacts. The existing pebbles in the Epipaleolithic assemblage of A6/MA represent – according to their large dimensions – sufficient starting products for core-initialization and blank production and give an impression of suitable, local raw material nodules. Obviously the raw material supply was sufficient, as people did not have to reduce these pebbles further. Present pebbles of the Early Neolithic inventory were not used for reduction, possibly because of their limited dimensions (undersized), but were still useful for other purposes as indicated by the macroscopically visible use traces. Bigger pieces were probably utilized and are no longer present in the inventory.

Generally an import of already initiated, reduced cores and a further reduction of those on-site was apparently common practice amongst hunter-gatherers (AL, AM, CZ/all in MU) and even amongst the mobile farming people (CNP/AL; Cast/GR cf. **SITE GAZETTEER**: **Los Castillejos/Granada**). In addition, tools for various handicraft activities were introduced as functioning tools to the sites (e.g. in CNP/AL), and settlers probably modified larger semi-finished products and took them to the next camp (AL, AM, CH, CZ/all in MU). Thus, these blanks are no longer present in the assemblage, whereas small blanks might have been useless for further modification and were discarded immediately and remained on-site. In CA/AL and A6/MA, a broader dimension range is present, and thus a broader section of the reduction sequence is represented in the inventory.

Pieces from Car/GR and A6/MA have bigger mean values. In Car/GR the difference could probably be explained by the re-use of Middle Paleolithic artifacts (cf. **SITE GAZETTEER**: **Cueva de la Carigüela/Granada** with references). In addition, the blank production apparently took place more or less completely on-site and blanks ranging from 9.4-2cm length remained in Car/GR.

Generally flakes and blades were removed from the cores predominantly regularly unipolarly. It was exceptional, if artifacts were removed in a parallel opposing or bipolar (*sensu lato*) way (**Tab. 201**). 85-100% of the blades have dorsal flake scars dispersed unipolarly. In contrast, 20-45% of dorsal flake scars of the flakes disperse in other and combined irregular directions, implying turnings of the core during blank production. Thus, one can assume three processes are reflected: 1. to a small degree, core preparation with irregular removed flakes, 2. for most: a systematic reduction of semi-finished target products, and 3. the final, opportunistic, situational exploitation of the rest core by disorderly removed flakes. The presence of this last, more disordered, terminal exploitation of the core on all sites indicates a strong exploitation of the raw material. MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS (1984, 20-21) also identified three (but divergent) production cycles and characterized the Epipaleolithic blank production as indifferent and mixed (cf. **SITE GAZETTEER**: **El Duende/Málaga**).

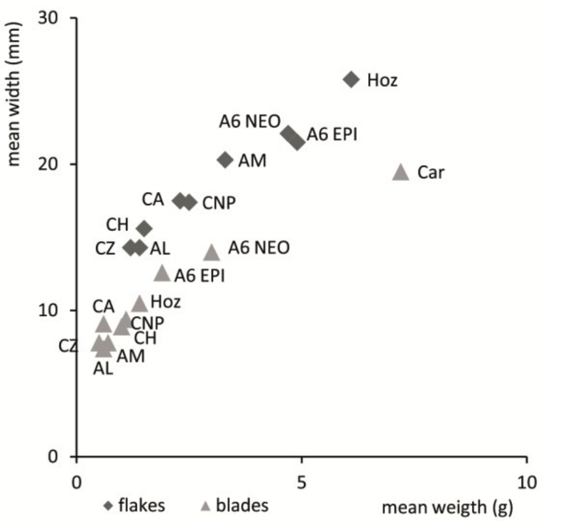


Fig. 34 Comparison of flake and blade dimensions. Mean values of the weight (in g) and width (in mm) are displayed without the outlier flake-values of Car/GR (13g/32.6mm).

Accordingly, indicators are present in all inventories for both hard stone percussion, traditionally connected with preparation and cortex removal processes, and for soft stone or organic percussion, which is usually connected with blade production (cf. **Tab. 35**). There is more evidence of soft hammer percussion technique, congruent with the mass of flakes and blades. Characteristic are a very large amount of diffuse bulbs on blades. Additionally, pronounced bulbs exist to a considerable amount, too. Apparently people used variable percussion techniques in parallel – in accordance with the function and purpose or with taste or skills (**Tab. 202**). MARTÍNEZ FERNÁNDEZ ET AL. (2010, 165) assume pressure technique in Cast/GR.

Additional core preparations, i.e. re-preparations/stage 4 after reduction cycles, were conducted on all sites: Amounts vary between 2-10%. Thus, one can observe elongating of the reduction process by renewed reduction of re-prepared cores. Cores were not automatically discarded, and we can assume maintained exploitation and economic handling rather than an abundance of raw material. Cores at about 4-3cm (A6/MA; AL/MU) edge length were re-prepared.

DORSAL	AL		AM		CH		CZ		Hoz		CA		CNP		Car		A6 EPI		A6 NEO	
FLAKE SCARS	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*
regular	75	95	62	100	68	95	78	94	57	90	80	93	71	98	64	86	72	89	65	86
irregular	25	5	28		32	5	22	6	43	10	20	7	29	2	36	14	28	11	35	14

Tab. 201 Percentages of regular (parallel and bipolar) and irregular direction of dorsal flake scars of flakes (F) and blades (B) of the assemblages (refer to blanks with dorsal flake scars determined; in *%*).

RATIO	AL		AM		CH		CZ		Hoz		CA		CNP		Car		A6 EPI		A6 NEO	
BULBS	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*	*F*	*B*
diffuse	74	84	77	86	84	97	90	94	65	92	86	94	76	80	72	76	76	88	64	75
pronounced	24	13	19	7	10		7	6	32	7	12	4	22	16	23	18	21	11	33	17

Tab. 202 Percentages of diffuse and pronounced bulbs of flakes (F) and blades (B) of the assemblages (refer to blanks with bulb determined; in *%*).

Smaller pieces following stage 4 during the renewed blank production were also desirable, and there was no exclusive emphasis on big blanks. The Early Neolithic assemblage of Car/GR provides in comparison fewest core tablets and plunging flakes or blades. One core tablet is also preserved from Cast/GR (**Tab. 260** with references). People focused on big blanks of a primary blank production with less necessity for a core re-preparation to gain additional but smaller blanks. A reduced reduction sequence with less effort in core re-preparations possibly took place in Car/GR indicating a better raw material supply. Certain tool demands were even satisfied by reusing available Middle Paleolithic artifacts (see above and cf. **SITE GAZETTEER**: **Cueva de la Carigüela/Granada**).

People modified rather fine, elongated blanks, i.e. blades have the longest mean length, but all other dimensions are smaller than comparable values of non-modified flakes. But, as especially in CZ/MU, no special selection of blanks for tools is visible: Apparently blades or flakes with varying dimensions were modified opportunistically. The same applies to cores: People modified big and small pieces, in some sites predominantly big pieces were modified (Car/GR), whereas in CA/AL modified cores are the smaller pieces.

The mean weights of the tools (cf. **Tab. 33**) indicate a preference for fairly big blanks for tools. The average values exceed the mean weights of stage 3-blanks and are sometimes twice as big. But the tools are not very regular and partly cortex-covered.

Tool production or rather use and re-sharpening also took place on all sites (stage 5, **Tab. 203**; including Du/MA cf. **SITE GAZETTEER**: **El Duende/Málaga**). On several sites, preferred blanks for intentional tool modification were not blades, but various blank types (cf. **Tab. 34**). Apparently no special regularity was necessary for the tools – as in AL, AM/both in MU, CA/AL and A6 EPI/MA. In most of these sites – with exception of CA/AL – people used many otherwise non-modified blades for various actions, as indicated by macroscopically visible use traces (cf. e.g. **Tab. 50**; **Tab. 65**; **Tab. 130**; **Tab. 180**) and thus a specialized tool modification was not needed. In CA/AL with a low amount of tool and artifacts with use wares, one can assume in addition an export of tools and of used, not intentionally modified blanks: Settlers took those with them to their next camp.

In contrast in CH, CZ, Hoz/all in MU, CNP/AL, Car/GR and A6 NEO and Du/both in MA people modified comparatively more blades to tools (cf. **Tab. 34** and **SITE GAZETTEER**: **El Duende/Málaga** with references). In addition, people also used regular not intentionally modified blades for processing goods and handcrafting: Macroscopically visible use traces appear often on otherwise non-modified blades (cf. **Tab. 81**; **Tab. 97**; **Tab. 145**; **Tab. 162**; **Tab. 197**; **SITE GAZETTEER**: **El Duende/Málaga**). In CH/MU and Car/GR, many cores were also transformed into tools after reduction, whereas artificial debris was opportunistically used in A6 NEO/MA.

Generally people modified few cores to tools (**Tab. 34**): Approximately 15% of the cores in the Early Neolithic assemblage of A6/MA are modified, 20% in AL/MU and CA/AL, about a third in CNP/AL and the Epipaleolithic inventory of A6/MA and up to 40% in Hoz/MU. However, half of the cores in Car/GR and two thirds of the cores in CH/MU were used as tools. Settlers in CZ/MU immediately discarded the present eight cores after reduction.

Thus, regular blanks possibly were slightly less important in Epipaleolithic contexts, where blanks were more opportunistically modified and used; whereas Early Neolithic settlers obviously more often used regular blades for tools and various other activities (use traces). Probably blanks had to have a designated shape to be suitable for tools or tool inserts, which were more specialized for particular purposes.

The amount of tools with intentional tool modification ranges between 9-28% (**Fig. 35** and **Tab. 203**). In the large assemblage of CA/AL only 9.1% of the artifacts are modified, whereas Car/GR has the highest tool amount in a medium-sized inventory. A similarly large amount is present not only in the Early Neolithic assemblage of CNP/AL but also in Hoz/MU. The tool amount increases from Epipaleolithic to Early Neolithic in A6/MA. Equivalent information for the Early Neolithic assemblage of Cast/GR varies between 6.2-19.1% tools (**Tab. 260** with references). With 3.4% the tool amount of the largest lithic assemblage in the working area of Du/MA is strikingly low (**Tab. 258**).

Almost all tool inventories are easily dominated by splintered pieces. Exceptions are: CH/MU with a higher amount of lateral retouches followed by splintered pieces and end scrapers and CZ/MU with many projectiles followed by splintered pieces, truncations and end scrapers. In Hoz/MU, splintered pieces and end scrapers are equally present. CNP/AL provides many lateral retouches and projectiles. Lateral retouches dominate the tool inventory of Cast/GR (**Tab. 260** with references). The second most frequent tool type is fairly diverse throughout the assemblages: End scrapers are second most frequent in CA/AL, A6/MA (both inventories) and AL/MU, but the latter also has a large amount of projectiles, whereas in AM/MU projectiles and truncations and in CNP/AL lateral retouches are present. It is striking that there are no projectiles in Car/GR (cf. MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 35 footnote 32). However, projectiles are present in the other Early Neolithic inventories. Additionally, three sickles are preserved in CNP/AL. Thus, the remains on the sites not only stem from chipping floors and tool repairing or resharpening but also indicate a variety of activities (handcrafts) on-site.

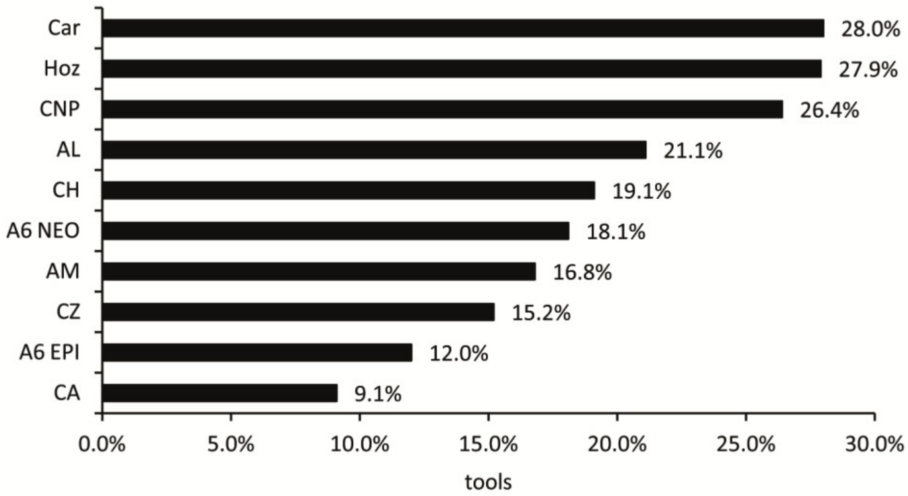
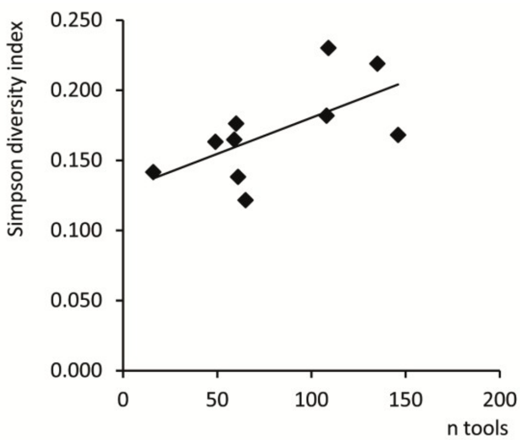


Fig. 35 Frequeny of tools (%) per assemblage (mean=19.4%).

MU: STAGE 5	AL		AM		CH		CZ		Hoz	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
tools	108	21.1%	16	16.8%	49	19.1%	60	15.2%	61	27.9%
thereof tools with several mod.*	26	24.1%	6	37.5%	9	19.6%	11	18.3%	26	42.6%
non-mod. pieces with ut.**	64	15.8%	34	45.3%	40	19.2%	73	21.8%	88	55.7%
Σ used pieces	172	33.5%	50	54.9%	89	34.6%	133	33.7%	149	68.0%

STAGE 5	CA/AL		CNP/AL		Car/GR		A6 EPI/MA		A6 NEO/MA	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
tools	146	9.1%	65	26.4%	135	28.0%	59	12.0%	109	18.1%
thereof tools with several mod.*	41	29.1%	20	30.8%	65	48.1%	22	37.3%	41	37.6%
non-mod. pieces with ut.**	131	9.0%	82	45.8%	100	28.7%	128	29.8%	103	21.0%
Σ used pieces	277	17.2%	147	59.8%	235	48.7%	187	38.1%	212	35.6%
burin spalls	8	0.5%	2	0.8%			3	0.5%	2	0.4%

Tab. 203 Tools with single and several modifications and non-modified (non-mod.) pieces with use traces (ut.) indicating stage 5 of the reduction sequence (generally referring to total assemblage; *referring to total amount of tools; **referring to total amount of non-modified pieces).



DIVERSITY	index	tools
A6 NEO/MA	0.230	109
Car/GR	0.219	135
AL/MU	0.182	108
CZ/MU	0.176	60
CA/AL	0.168	146
A6 EPI/MA	0.165	59
CH/MU	0.163	49
AM/MU	0.142	16
Hoz/MU	0.138	61
CNP/AL	0.122	65

Fig. 36 Correlation of tool numbers and Simpson indices of the analyzed inventories (r=0.628). Concerning the complete artifact assemblages and indices, r equals even 0.769.

Of the tools, very few have additional modifications in Du/MA (15 of 128 tools/10.5%; cf. **SITE GAZETTEER**: **El Duende/Málaga** with references). In this study, at least 18.3% (in CZ/MU) have several modifications up to 42.6% in Hoz/MU and 48.1% in Car/GR. The amount of non-modified pieces with macroscopically visible use traces also fluctuates immensely and apparently without a pattern between 9-55%. Thus, the amount of actually used pieces increases and varies between 17-68% of the whole assemblages.

The diversity index is on all sites between 0.1-0.3 (**Fig. 36**; Ner/MA: 0.147/ENEO, 0.125 and 0.135/both from EPI based on listing in **Tab. 249** with references; Du/MA: 0.287 cf. **Tab. 258** with references; Cast/GR about 0.273 cf. **Tab. 260** with references: calculated without types 1A and 2A/use traces). Thus, no specialization is visible in the tool inventories. With seven to eleven tool types, all sites have a diverse tool spectrum, regardless of whether they have been identified as Epipaleolithic or as Early Neolithic. However, the positive correlation of tool number and specialization of the tool assemblage possibly points to several occupations and repetitive, intensive on-site tool use (cf. **4.4.1.4. Tools**).

Artifacts from discarding in stage 6 were treated relatively carelessly after they became useless, and they ended up in the fire. The amount of artifacts exposed to fire ranges between 13-80% and is thus much broader than the cortex-amounts (**Fig. 37**). The assemblages of A6/MA have superior amounts of 78.5% heat treatment in the Early Neolithic and 73.1% in the Epipaleolithic. Both other Early Neolithic assemblages also have large amounts in the 50ies (Car/GR with 59.4% and CNP/AL with 52.8%). The big inventories of CA/AL and the Murcian CZ have 48.6% and 41.2% heat-treated artifacts, respectively. There is then a sudden decline, with an amount of 23.4% in AL and in CH/both in MU of only 13.2% burned artifacts. Thus, the declining heat treatment amounts mean one can assume increasing care of discarded artifacts while the raw material supply obviously decreases. Intentional heat treatment is – with few exceptions (**4.4.1.2.1.3. Heat treatment**) – negligible in the studied assemblages or is possibly hidden by the non-intentional fire exposure. MARTÍNEZ FERNÁNDEZ ET AL. (2010, 165) recognized intentional (?) heat treatment on 48.2% of the Early Neolithic artifacts from Cast/GR and identified heat treatment as typical Early Neolithic characteristic (cf. **SITE GAZETTEER**: **Los Castillejos/Granada**).

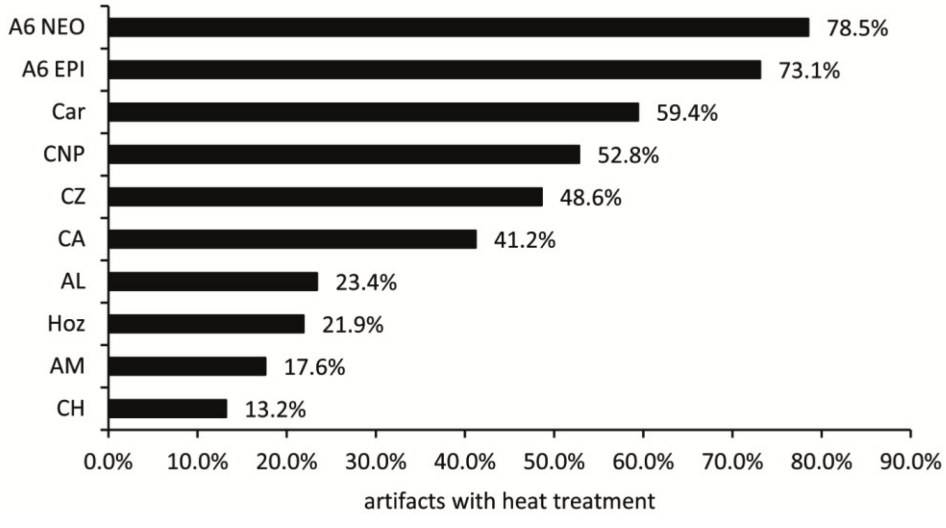


Fig. 37 Decreasing amount (%) of heat treated artifacts per assemblage in comparison (mean=43.0%).

4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra

The statistics applied to evaluate the blank and tool assemblages demand comparably less data processing and preparation than the pottery inventories and correspondence analyses (cf. **5.5. Similarities in pottery decoration: Sequence as defined by correspondence analyses (CA)**). Moreover, published blank and tool amounts of additional sites could be included in the analysis. But that is also precisely where the difficulties lie: The categories of blanks and tools (cf. **Tab. 204** and **Tab. 205**) have to be absolutely congruent or other classifications have to be split up or subsumed to fit in the present categories (blank and tool types). But such re-groupings could result in scientific constructs. Currently, Cueva Nerja, El Duende/both in MA and Los Castillejos/GR promise suitable additional data and one can expect appropriate data submission for Cueva Bajondillo/MA and Abrigos del Pozo/MU in the future.

BLANKS	flakes	blades	art. debris	cores	pebbles
A6EPI	279	144	53	10	5
A6NEO	409	78	82	18	14
AL	271	191	36	15	0
AM	59	28	4	0	0
CA	985	442	121	65	0
Car	325	90	38	30	0
CH	136	85	28	8	0
CNP	103	126	8	9	0
CZ	235	102	50	8	0
Hoz	78	123	10	8	0

Tab. 204 Blank spectra: Underlying table for conducted tests (art. debris = artificial debris).

I analyzed intra-assemblage similarities and groupings of the blank and tool inventories (see **Tab. 204** and **Tab. 205**) with distance matrices as an intermediate step when applying the Adonis algorithm (ROTH 2011b cf. ANDERSON 2001) and the Mantel test (MANTEL/VALAND 1970). These analyses were conducted in R Statistical Computing (R DEVELOPMENT CORE TEAM 2011) with the package "vegan" (OKSANEN ET AL. 2011). The associated R-script and underlying data are provided in **Appendix to the statistic evaluation of the lithic artifacts**. ROTH (2011b) provides an elaborate guideline.

In the present study, I only provide tendencies, which require further corroboration with additional datasets and in new studies.

4.6.1. Approach

TOOLS	projectiles	borers	sickles	burins	truncations	end scrapers	lateral retouches	splintered pieces	notched pieces	denticulates	other
A6EPI	3	1	0	7	6	11	4	19	5	1	2
A6NEO	2	2	0	10	7	21	12	45	6	4	0
AL	20	2	0	7	9	27	10	29	1	1	2
AM	3	0	0	2	3	1	1	5	0	1	0
CA	24	3	0	14	7	29	10	43	6	5	5
Car	0	8	0	0	11	12	31	51	9	2	11
CH	5	4	0	0	3	8	15	9	0	2	3
CNP	12	4	3	3	7	4	16	6	4	4	2
CZ	19	2	0	1	9	9	5	11	1	3	0
Hoz	3	4	0	4	8	14	7	14	2	4	1

Tab. 205 Tool spectra: Underlying table for conducted tests.

Distance matrices calculate the differences between cases – i.e. assemblages – according to occurring attributes and their frequency. I considered the frequency of distinct blank types and subsequently of tool types (cf. ROTH 2011b; concerning distance matrices in general cf. BORCARD/GILLET/LEGENDRE 2011, 31; 33; LEGENDRE/LEGENDRE 1998, 279; 286; LEGENDRE/GALLAGHER 2001). Within this step, the dis-/similarities of cross tabulated cases and attributes were measured and displayed in a triangular distance matrix with distance values between 0 expressing complete similarity to 1.41 for most distant. The Chord distance (ORLOCI 1967) evaluates the distance between occurring types and does not consider non-present types, whereas the Hellinger distance (NIKULIN 2002) attaches greater weight to poorly represented types such as artificial debris and pebbles or sickles.

GROUPINGS	stage	bioclimate	zone	location
A6EPI/MA	EPI	XTH	West	coast
A6NEO/MA	NEO	XTH	West	coast
AL/MU	EPI	XTH	East	coast
AM/MU	EPI	MS	East	interior
CA/AL	EPI	XTH	East	interior
Car/GR	NEO	MS	West	interior
CH/MU	EPI	XTH	East	coast
CNP/AL	NEO	XTH	East	coast
CZ/MU	EPI	MS	East	interior
Hoz/MU	EPI	XTH	East	interior

Tab. 206 Possible groupings of the assemblages by chronological stages (EPI = Epipaleolithic, NEO = Early Neolithic), bioclimatic zones (XTH = xerothermo/thermomediterranean, MS = meso/submediterranean) or their location in the research area in the West, East or at the cost or in the interior.

Subsequently I checked whether the assemblages belonged to one of the groups determined by a third nominal attribute. Assemblages can be divided in groups by chronological stage, location in a bioclimatic zone, in the W or E of the research area and at the coast or in the hinterland (cf. **Fig. 5**; **Tab. 206**). The Adonis algorithm tests whether the variance of distances within a group is smaller than between the groups (ROTH 2011b cf. ANDERSON 2001: pseudo F-test, MANOVA; concerning the application in another prehistoric context see MAIER 2012). The grouping is evaluated by its coefficient of determination r^2 between 0 and 1. The coefficient indicates bad and good correlation of expected and actual values. The correlation is significant and is not a result of coincidence, if the probability is <0.05.

Finally, I applied the Mantel test (MANTEL/VALAND 1970) on two distance matrices of blank and tool types to evaluate whether both attributes cluster in a similar pattern. The test checks the dissimilarity of both matrices. The correlation coefficient r lies between -1 and 1. A negative correlation is expressed by (a value close to) -1, no correlation by (values around) 0, and a positive correlation is expressed by (a value close to) 1.

4.6.2. Results

A chronological grouping (cf. stages in **Tab. 206**) of the blank spectra produces no significant result (Adonis function applied on chord $r^2 = 0.047$, $p = 0.604$ and Hellinger distances $r^2 = 0.087$, $p = 0.486$). But a tendency is visible where tool types are concerned: $r^2 = 0.128$, $p = 0.313$ (Chord) and $r^2 = 0.160$, $p = 0.177$ (Hellinger distance) present a weak correlation between differences in tool assemblages and time periods. This tendency remains stabile even without sickles (Hellinger distance without sickles: $r^2= 0.155$, $p = 0.179$).

Another trend is indicated by variances in blank assemblages and the location of sites in various bioclimatic zones (cf. **Tab. 206**). The composition of the blank assemblages is slightly different in the thermo-mediterranean and the submediterranean bioclimate ($r^2 = 0.165$, $p = 0.217$ (Chord) and $r^2 = 0.125$, $p = 0.283$ (Hellinger distance)). In contrast, specific values for the tool assemblages imply that the tool composition does not differ between the bioclimatic zones ($r^2 = 0.094$, $p = 0.589$ (Chord) and 0.071, $p = 0.707$ (Hellinger)).

Significant values result from the correlation of blank and tool assemblages within broader regions of E and W of the working area (cf. **Tab. 206**). A weak association of variances in blank and tool spectra is congruent with the location in the E or W of the study area and is expressed by r^2 of around 0.3 (for blanks: $r^2 = 0.327$, $p = 0.082$ (Chord) and $r^2 = 0.337$, $p = 0.040$ (Hellinger) and for tools: $r^2 = 0.255$, p =

0.031 (Chord) and $r^2 = 0.247$, $p = 0.023$ (Hellinger)). With 1 expressing a good correlation, it is questionable whether one can refer to a "trend", but I expect verification with additional data. These differences in blank and tool spectra of sites in the E and W could possibly point to the dispersal direction of the Neolithization from E to W. Dissimilarities in assemblages of both blanks and tools do so far *not* unfold any congruent patterns when compared with the Mantel test (for Chord distance matrices: $r = 0.061$, $p = 0.329$; Hellinger: $r = 0.079$, $p = 0.355$). Possibly the tool spectrum is similar on every site, despite the variations in the blank assemblages. Thus, I hypothesize the following: Groups used similar tools for similar on-site activities. The different blank spectrum was due to different raw material availability and varying response strategies dealing with this.

So far similarities in the blank or tool spectra do not correlate with the location of the site in a coastal area or further in the hinterland (**Tab. 206**; blanks: $r^2 = 0.009$, $p = 0.832$ (Chord) and $r^2 = 0.036$, $p = 0.838$ (Hellinger); tools: $r^2 = 0.054$, $p = 0.764$ (Chord) and $r^2 = 0.033$, $p = 0.993$ (Hellinger)).

4.7. Conclusion: The lithic assemblages as indicators of the Neolithization process

A comparison of Epipaleolithic and Early Neolithic lithic assemblages allows hypotheses on the predominantly active agents within the dispersal of Neolithic elements in the research area.

Various raw materials were exploited (**4.3. Raw material**). Currently only cortex conditions (pebble vs. chalky cortex) allow conclusions concerning the use of fluvial or primary raw materials. By trend, pebbles dominate within the Early Neolithic raw material procurement (60-almost 100%) and possibly indicate slightly more sedentaryness with the exploitation of local sources.

The descriptive analyses and analyses of the *chaîne operatoire* (**4.3. Raw material** and **4.4. Descriptive analyses: Reconstruction of the reduction sequence (*chaîne operatoire*)**) did *not* unfold either striking differences between Epipaleoltihic and Early Neolithic assemblages or accurately limited regional variances. Both Epipaleolithic and Early Neolithic assemblages fluctuate within the same chronological stage and diachron. Analyzed attributes range broadly (cf. **Tab. 225**) and do not unfold solid patterns. Currently a grouping is pointless.

The following generalizations provide an impression of the similarities and variations in the assemblages. These statements do not apply to all assemblages. There are always individual outliers.

Artifacts due to stage 0 of the reduction sequence are generally absent on-site, apart from the Epipaleolithic and Early Neolithic assemblage of A6/MA with pebbles.

In almost all sites – with only AM/MU as an exception – pieces from cortex removal and initial core preparation (stage 1) are present. Several different raw material sources are represented in all assemblages. But the amount of cortex-covered artifacts fluctuates severely between the inventories. Early Neolithic inventories present high, low and intermediate amounts, whereas the Epipaleolithic data are found clustered in two groups in between the Early Neolithic ones.

The dominant cores in all assemblages are pointed-based cones with one platform on top. In addition, people prepared these cores on the edges, frequently leaving dorsal reductions on flakes and blades. The initial core preparation was probably irregular, followed by a removal of flakes and blades in predominantly regular directions, but in the terminal stadium of core exploitation also in various directions. Accordingly indicators of various percussion techniques are present.

The remaining blanks represent semi-finished target products from the whole reduction sequence. Especially the lithic industry of Car/GR consists of very large blanks, which is probably not an indicator for the Early Neolithic but due to the specific circumstances in Car with the re-use of Middle Paleolithic artifacts (cf. **SITE GAZETTEER**: **Cueva de la Carigüela/Granada** with references).

After reduction sequence(s) cores were re-prepared on all sites.

Thus, the prevailing absence of raw material nodules and the exploitation of the cores could imply a consistent an economic raw material handling.

Generally people preferred larger blanks and mostly also regular blanks for the intentional modification to the defined tool types. Furthermore, blanks with irregular shapes, abnormal dimensions or cortex-coverage were opportunistically, situationally picked for tools. Additionally, blanks without intentional tool modification were used on every site. In this context, the assemblage of CA/AL is striking with a low amount of stage-5-aritfacts.

The tool assemblage is variable and consists dominantly and to varying amounts of splintered pieces, end scrapers, projectiles, truncations and/or lateral retouches. So, besides on-site-knapping, tool production, resharpening, repairing and use are also likely.

Finally a varying amount of all kinds of artifacts was discarded and partly damaged due to fire exposure.

Altogether the assemblages vary in the presented ranges and *no* chronological rupture between Epipaleolithic and Early Neolithic is visible.

The statistical tests (**4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra**) provide only weak and contradictory trends that have to be further validated by additional data and studies (correlation of blank spectra and bioclimatic zones; correlation of tool spectra with chronological stages).

Variations in the compositions of blank and tool spectra tend to correlate very lowly with the E or W location of the site in the working area, where there is an r^2 of around 0.25-0.3, with 1 showing a good correlation. Epipaleolithic and Early Neolithic assemblages appear more or less similar with respect to their blank and tool spectra, but dissimilarities occur due to the site location. This could point to the Neolithic dispersal direction from E to W congruently with many Neolithization models.

Despite the doubts mentioned at the very beginning of this chapter, I conclude currently that an Epipaleolithic base persists apparently in the Early Neolithic lithic assemblages. Thus, only from the lithic point of view, hunter-gatherers seemingly adopted Neolithic elements or integrated Neolithic people and with them the elements into their group.

5. Pottery

Initially the recorded attributes (**5.1. Recorded attributes**) and the dataset is presented (**5.2. Correction and data set**) and **5.4. Descriptive analyses** includes the analyses. Mineralogical raw material studies of pottery sherds from CNP/AL conducted by H. Müller-Sigmund and M. Harmath (Institute for Geosciences of the University of Freiburg i.Br./Germany) are summarized in **5.3. Raw materials: Mineralogical and chemical analyses of pottery and clay deposits**. Additionally, I used correspondence analyses to look for dispersals in the ceramic decoration (**5.5. Similarities in pottery decoration: Sequence as defined by correspondence analyses (CA)**). Finally, the results are evaluated with regard to the research questions (cf. **1. Approach and research questions**) in **5.6. Conclusion: The pottery assemblages as indicators of the Neolithization process**.

5.1. Recorded attributes

First, I sorted the pottery into vessel units (VUs), i.e. former vessels (STEHLI 1973, 60). For the sorting all ceramic fragments of a site including all levels have to be spread out on a large table and then sorted first of all into rough groups and then into more and more, finer and finer sub-groups that would each finally turn out to represent one VU. The fragments do not have to refit, but refittings verify the grouping. VUs of this study consist of single sherds up to 23 sherds. About 2-2.5 sherds were on average in a VU in CNP/AL (Σ sherds=1605), Car/GR (610) and A6/MA (22). The sorting can be oriented according to the absence or occurrence, frequency and type of mica, the amount, visibility and type of the temper material, the type of the matrix, the type of the inner and outer surface treatment, the thickness and the colors of the sherds. Of course these characteristics could vary within a vessel, i.e. also between the sherds belonging to one vessel. The sorting is a time consuming, difficult and subjective venture. Dirt on the fragment surfaces aggravates the sorting.

For each VU, I documented attributes according to BINDER ET AL. (2010) in combination with additional common characteristics (cf. STEHLI 1973, 60; LINSTÄDTER 2004, 82-87; cf. **Tab. 207**) in a database that is available in NESPOS (2013) associated with the DOI 10.12853/RESDB.NESPOS.0001. The recording system of BINDER ET AL. (2010) is specialized for W Mediterranean Early Neolithic sites. So far approximately 700 vessels and sherds of ca. 30 sites from Liguria to Catalonia have been recorded.

The recording of the pottery attributes was less strict than for the lithic artifacts (cf. **4.1. Recorded attributes**). In some cases a determination was impossible, e.g. a very small rim fragment was not sufficient to determine the opening diameter of the vessel or the vessel form. Or a small fragment was entirely decorated but the structure of the decoration could nevertheless not be defined (cf. **Tab. 207**).

5.2. Correction and data set

I recorded five pottery assemblages (CNP/AL, Car/GR, A6/MA and partly Got/MA) in Spanish museums. Additionally, I put information on the two vessels from Cacín/GR and Ani/MA (cf. **3.1.2.2. Granada** and **3.1.2.3. Málaga**) as well as several sherds from Got/GR from the literature into the database (cf. **SITE GAZETTEER**: **Cueva de las Goteras/Málaga**). The datasets were checked concerning the interconnected features listed in **Tab. 208**. Several datasets were detected that lack attributes (**Tab. 209**). But nevertheless, these could be evaluated using the other attributes. However, two completely empty datasets had to be rejected (VUs 81 and 122 of Car/GR). **Tab. 210** lists the evaluated datasets in the present study. In **5.4. Descriptive analyses** the assemblages are ordered according to the number of recorded VUs in descending values as in **Tab. 210**.

	N°	ATTRIBUTE	COMMENT
site related data	+	*ID unité**	Identification number recorded for each single VU (cf. **Tab. 210**).
	1	*Nombre**	Number of sherds due to the VU.
	2	*Typ de tesson*	Sherd type. Two types were added: 12 *Bord+panse+fond* and 13 *entière vase* for entirely preserved vessels (cf. **Tab. 214**).
	3	*Décoré?*	This attribute is ticked off, when the VU is decorated.
	4	*Site*	Abbreviation of sites (cf. **Tab. 210**).
	5	*Phase*	Cultural stage.
	+	*Couche geologique*	Layer.
	6	*Ch, st, US (square)*	Square, level or stage.
	+	*Musée*	Museum in which the pottery is stored.
raw material	+	*Groupe bino*$^{\Delta}$	Preliminary rough raw material groups defined macroscopically (cf. **Tab. 211** 'pre-group').
	7	*Famille petro*$^{\Delta}$	Detailed information concerning the raw material. Never completed in this study (cf. BINDER ET AL. 2010, 30-31; 30 Fig. 1).
	8	*matières premières […]*$^{\Delta}$	
	9	*Inclusion d'origine anthropique* $^{\Delta}$	Anthropogenic temper material present? If both rounded and angled temper materials were visible, this attribute is ticked off.
	10	*Mélange?*$^{\Delta}$	This attribute is ticked off, when several temper materials were mixed.
	11	*Inclusions 1, 2, 3 + quantité*$^{\Delta}$	Up to three components of the temper materials can be listed and their amounts be named.
	+	*Skelett and sand: quantité + forme*$^{\Delta}$	Ratio and type of temper materials (except sands) or sand, respectively.
	+	*mineraux*$^{\Delta}$	List of components.
technical attributes	12	*Epaisseur maximal**	Maximum and minimum wall thicknesses in mm.
	+	*Epaisseur minimal**	
	13	*Irrégulière?*	This attribute is ticked off, when maximum and minimum wall thickness are unequal.
	+	*Diametre ouverture (cm) **$^{\Delta}$	Diameter of the vessel opening in cm (definable only for certain rim sherds).
	14	*Montage*$^{\Delta}$	Building technique (coil technique etc.).
	15	*Finition 1, 2, 3*	Up to three different outer surface treatments can be entered (cf. **Tab. 216**).
	16	*Forme type*$^{\Delta}$	Vessel form type (**Tab. 217**). The types were adapted to the Moroccan vessel forms (as in Ifri Oudadane; LINSTÄDTER 2004, 98 Fig. 38): bottles with straight or flared neck (7) and pot with strait, flared or without rim (6). Additionally large diameters of the vessel openings occur especially in CNP/AL (cf. **Fig. 48**), thus type 9 *assiette/plat* was added for very open, plain vessels with the largest diameters of the vessel at the opening.
	17	*Fragment type*	Type of the fragment.
	18	*Couleur exterieur*	Color of the inner and outer surface and in the fracture according to the Munsell Soil Color Charts (here after Oyama/Takehara 1967).
	19	*Couleur interieur*	
	20	*Couleur nucleus*	
	+	*Dureté*	Hardness.
The following attributes 21-27 were registered for decorated VUs.			
decoration	21	*Technique décorative 1-6*	Up to six decoration techniques can be entered (cf. **Tab. 220**). If one decoration technique appears in multiple variances on the vessel, it is only entered once.7C *Peigne Impression pivotante* was added.
	22	*Mélange technique?*	This attribute is ticked off, when several decoration techniques are mixed. Characters encode mostly similar techniques: A = impressed decorations, B = incised decorations, C = rocker stamp decoration. Sculptured decorations are an exception.
	23	*Nombre de techniques**	Number of decoration techniques listed in 21.
	24	*Nombre d'outile**	Number of tools used for decoration techniques in 21.
	25	*Position*	Position of the decoration on the vessel (cf. **Tab. 219**). Decoration occurred also on wall and handle expressed in the additional code XI *Préhension+Panse*.
	26	*Structure*	Structure of the decoration (cf. **Tab. 219**), i.e. is the decoration attached in zones? On very small fragments zones are often no more definable. Then the structure equals 0.
	27	*Motifs1-6*	Up to six motifs can be entered (cf. **Tab. 218**).
	+	*Nombre de motifs**	Number of motifs listed in 27.
other	+	*completed*	Recording of VU completed: yes/no.
	+	*remarks*$^{\Delta}$	Remarks, notes ...
	+	*citation image*$^{\Delta}$	Literature references for figures of the VU.

Tab. 207 Selected features of the recording system of BINDER ET AL. 2010 with additions, changes and comments (*attributes have to be completed by numbers; $^{\Delta}$attributes have to be entered only if necessary or determinable).

ATTRIBUTE	DEPENDENT ATTRIBUTES
If ….	Then …
Typ Tesson: Bord (2, 4, 9, 10 12, 13)	Diametre Ouverture/Forme Type/Fragment Type > 0
Decoré: Oui	Technique decorative > 0 Nombre (technique/outiles) > 0 (exept by coloration etc.) Position/Structure > 0 Motifes 1 – 6/Nombre de Motifes > 0 (exept by coloration etc.)
Epaisseur min < Epaisseur max Epaisseur min ≠ Epaisseur max Epaisseur min = Epasisseur max	Irrégulière: Oui (ticked off) Irrégulière: Oui (ticked off) Irrégulière: Non
Technique decorative 2 – 4 > 0 and various techniques (A, B, C)	Melange de Technique: Oui (ticked off) Nombre (Technique/outiles) > 0 (exept by coloration and sculptured decoration) and according attributes to line "Decoré: Oui"
Motifs 1 > 0	Nombre Motifs > 0

Tab. 208 Consistent features by recording artifacts.

VUs	SITE	MISSING VALUES
1	HC	Without diameter of the vessel opening.
3	HC	Without fragment type.
6	HC	Small rim fragment: diameter of the vessel opening, form and fragment type not determinable.
12	Car	Rim without from type.
24	Car	Rim without diameter of the vessel opening, form and fragment type.
26	Car	Rim without diameter of the vessel opening, form and fragment type.
48	Car	Rim without diameter of the vessel opening, form and fragment type.
54	Car	Rim without diameter of the vessel opening and form.
67	Car	Rim without diameter of the vessel opening, form and fragment type.
72	Car	Rim without diameter of the vessel opening, form and fragment type.
79	Car	Rim without form type
81	Car	Vessel probably younger, not Early Neolithic and therefore excluded from the study.
122	Car	Only partly completed until „*couche geologique*", but without sherd type and therefore excluded from the study.
150	Car	Rim fragment to small do determine the diameter of the vessel opening.
163	Car	Rim without diameter of the vessel opening and form type.
164	Car	Rim without form type.
166	Car	Rim without diameter of the vessel opening, form and fragment type.
200	Car	Rim without diameter of the vessel opening and form type.
207	Car	Rim without diameter of the vessel opening and form type.
223	Car	Rim without diameter of the vessel opening, form and fragment type.
240	Car	Rim without diameter of the vessel opening, form and fragment type.
252	Car	Rim without from type.
259	Car	Rim without diameter of the vessel opening, form and fragment type.
287	Car	Rim without form type.
297	Car	Rim without diameter of the vessel opening, form and fragment type.
304	Car	Rim without diameter of the vessel opening, form and fragment type.
316	Car	Rim without diameter of the vessel opening, form and fragment type.
337	CNP	Rim without form type.
380	CNP	Rim without form and fragment type.
383	CNP	Rim without minimum wall thickness, diameter of the vessel opening, form and fragment type.
385	CNP	Rim without diameter of the vessel opening and form.
386	CNP	Rim without diameter of the vessel opening, form and fragment type.
387	CNP	Rim without diameter of the vessel opening, form and fragment type.
388	CNP	Rim without diameter of the vessel opening, form and fragment type.
426	CNP	Rim without form type.
427	CNP	Rim without diameter of the vessel opening and form.
433	CNP	Rim without diameter of the vessel opening, form and fragment type.
434	CNP	Broken rim fragment without thickness, diameter of the vessel opening, form and fragment type.
440	CNP	Rim without diameter of the vessel opening and form.
458	CNP	Rim without form type.
463	CNP	Rim without diameter of the vessel opening and form.
464	CNP	Rim without diameter of the vessel opening and form.
468	CNP	Rim without diameter of the vessel opening and form.
471	CNP	Rim without diameter of the vessel opening and form.
473	CNP	Rim without form type.
475	CNP	Rim without diameter of the vessel opening, form and fragment type.
476	CNP	Rim without diameter of the vessel opening and form.

Tab. 209 Datasets with missing values. VUs 81 and 122 were excluded from the present study.

VUs	SITE	MISSING VALUES
481	CNP	Rim without form type.
483	CNP	Rim without diameter of the vessel opening and form.
485	CNP	Rim without diameter of the vessel opening and form.
486	CNP	Without thickness, color and hardness.
491	CNP	Rim without form type.
494	CNP	Rim without diameter of the vessel opening and form.
496	CNP	Rim without form type.
498	CNP	Rim without diameter of the vessel opening, form and fragment type.
500	CNP	Rim without diameter of the vessel opening and form.
513	CNP	Rim without diameter of the vessel opening and form.
519	CNP	Rim without diameter of the vessel opening, form and fragment type.
520	CNP	Rim without diameter of the vessel opening and form.
525	CNP	Rim without diameter of the vessel opening and form.
530	CNP	Rim without diameter of the vessel opening and form.
545	CNP	Rim without diameter of the vessel opening and form.
554	CNP	Rim without diameter of the vessel opening and form.
568	CNP	Rim without diameter of the vessel opening and form.
593	CNP	Wall thicknesses not available. The handle is at least 7mm thick, but this value does not correspond to the original wall thickness of the vessel.
646	CNP	Rim without diameter of the vessel opening, form and fragment type.
690	CNP	Rim without diameter of the vessel opening and form.
691	CNP	Rim without diameter of the vessel opening and form.
692	CNP	Wall thicknesses not available. *Asa pitorro* is 23-35mm thick, but this value does not correspond to the original wall thickness of the vessel.
821	CNP	Rim without diameter of the vessel opening, form and fragment type.
873	CNP	Rim without diameter of the vessel opening, form and fragment type.
899	CNP	Rim without diameter of the vessel opening, form and fragment type.
901	CNP	Wall thicknesses not available. The handle is maximal 9mm thick, but this value does not correspond to the original wall thickness of the vessel.
906	CNP	Rim without diameter of the vessel opening and form.
919	CNP	Rim without diameter of the vessel opening, form and fragment type.
938	CNP	Rim without diameter of the vessel opening, form and fragment type.
943	CNP	Rim without form type.
949	CNP	Rim without diameter of the vessel opening, form and fragment type.
956	CNP	Rim without diameter of the vessel opening and form.
963	CNP	Rim without diameter of the vessel opening and form.
964	CNP	Rim, only partly completed until “square”.
967	CNP	Rim without diameter of the vessel opening, form and fragment type.
970	CNP	Rim without diameter of the vessel opening, form and fragment type.
974	CNP	Rim without diameter of the vessel opening, form and fragment type.
988	CNP	Rim without form type.
990	CNP	Vessel (rim, body and base) recorded from the literature without wall thicknesses, diameter of the vessel opening, form, fragment type, color and hardness.
1010	Got	Recorded from the literature (references see database), therefore minimum and maximum wall thicknesses, colors, and surface treatment are missing.
1011	Got	
1012	Got	
1145	Car	Vessel (rim, body and handle) recorded from the literature without wall thicknesses, colors and hardness.

Tab. 209 continued.

SITE	PROVINCE	VUs	SELECTION CRITERIA	n
CNP	AL	317-990		674
Car	GR	9-316	without VU 81 and 122	307
A6	MA	991-1000		9
Got	MA	1007-1013		7
HC	MU	1-6		6

Tab. 210 Pottery assemblages and VUs (Σ=1004) included in the present study.

5.3. Raw materials: Mineralogical and chemical analyses of pottery and clay deposits

Analyses of pottery and clay components are not new in archaeology, but these have still only been exemplarily conducted and are far from becoming a conventional method. The components due to the clay genesis (cf. AGUAYO ET AL. 1998, 173-174) at distinct locations (with a unique "fingerprint" cf. ARNOLD 2005; ORTEGA-HUERTAS ET AL. 1991; RECIO/TORRES 1994) or due to anthropogenic interference should shed light on the number of clay types used, the location of the clay deposits, temper materials, firing temperature and atmosphere and a possible congruency of raw material and vessel form. Distances between site and clay origins could reveal circulations due to contacts between or mobility in certain regions.

Besides the apparently objective mineralogical and chemical approaches, ARNOLD (2005) pointed out probable difficulties that could be followed back to the individual prehistoric potter and the society: Various – amongst others technological – conditions could have influenced the selection of distinct clays and the production. The paste could even be mixed of various external clays and temper materials. Actually "[…] the categories of pottery materials as well as other items exist in the mind of [prehistoric] humans" and are not natural (ARNOLD 2005, 16).

Especially in S Spain, scientists have studied mineralogical and chemical pottery and clay relatively frequently and repetitively. The following paragraphs briefly summarize different approaches and results.

Using x-ray diffraction and chemical analyses, NAVARRETE (1976; ET AL. 1991) studied, amongst other things, the mineralogical ingredients of Early Neolithic pottery (of e.g. Car/GR cf. **SITE GAZETTEER**: **Cueva de la Carigüela/Granada**) and determined amounts of philosilicates, mica, quartz, carbonates, feldspaths, markers for temperature, hematite and amphibole (cf. **Tab. 245**). The clay matrix and temper were identified by optical description. Finally NAVARRETE (1976) concluded that farming communities processed their pottery primarily from clay of a metamorphic origin from the regional lithology. People picked the raw material for specific reasons: Pots were produced using clay with large amounts of philosilicates and clay with medium to small amounts of calcite was used for jars. Bowls were made from clay with higher amounts of calcite. Settlers tempered with quartzite, feldspaths, calcites, mica, schist and small flint chips. They used clay with large amounts of mica for graphite pottery. The mineral components are rounded and thus originate from a fluvial deposit. Early Neolithic firing temperature varies between 710 and 780°C implying similar firing techniques (with similar temperatures) throughout the Neolithic.

GALLART MARTI (1980) studied and compared the mineralogical composition, production technique, form, decoration, surface treatment, coloration and firing of samples from several Valencian Neolithic sites. She used also x-ray diffraction and electron microscopy.

MARTÍNEZ FERNÁNDEZ and GAVILÁN CEBALLOS (1997) analyzed the ceramic of the Neolithic Cueva de los Murciélagos de Zuheros in Córdoba using binocular, x-ray diffraction, element x-ray diffraction, differential thermal and thermogravimetric analyses. Generally, clay raw materials stem from the vicinity of the site, but several sherds also imply a regional origin from a 35-40km distant deposit.

AGUAYO (1998) analyzed the mineralogical content of pottery fragments from Ronda la Vieja in Málaga (2nd millennium AD) and clay from neighboring deposits using x-ray diffraction and looked for foraminifera binocularly. People obviously used several clay deposits in the immediate vicinity and a little bit further away of the Ronda depression (AGUAYO ET AL. 1998, 186). A relation of distinct clays and certain vessels forms is probable.

Within the survey project in Almería *"Los inicios de la metalurgia en la Cuenca del río Almanzora"* directed by M.D. Cámalich Massieu and D. Martín Socas (cf. CÁMALICH MASSIEU/MARTÍN SOCAS 1999) during which they also discovered and excavated CNP/AL, ECHALLIER (1999) conducted petrografic analyses of Chalcolithic pottery from Campos and attested several origins and places of manufacture for the ceramic (ECHALLIER 1999, 220; 221 plate XIX). Besides local products, pottery clay stems from further distant places such as the Sorbas area, Sierra de las Estancias or Baza and the Guadix area. The movement of the pottery indicates int*ra*-cultural exchange of goods with similar vessel types of various clays as transport media.

CAPEL ET AL. (2006) used x-ray diffraction and UV-VIS spectroscopy to analyze the red ocher decorations (*almagra*) exemplarily of pottery from Granada (amongst others Cueva de la Carigüela; cf. CAPEL MARINEZ/NAVARRETE ENCISO/REYES CAMACHO 1983; CAPEL MARTINEZ ET AL. 1986). The color depends mostly on the redox firing atmosphere. Further variations are due to the position of the vessels in the kiln, the firing time and intensity, the fuel, the kiln type and the firing temperature.

CLOP GARCIA (2000; 2005; 2011; 2012) microscopically petrographically studied thin sections of pottery samples and sediments from Valencian Neolithic sites. He was interested in raw material provenance, relation to pottery decoration, standardized production and anthropogenic tempering. About 84% of the pottery was made of local sediments, but each site presented various slightly different clay origins with specific contents in the general provenance area of Serpis valley with quartz and micrite (limestone; CLOP GARCIA 2011, 36-39). Additions of temper materials, as grog or crushed calcite were very common during the W Mediterranean Early Neolithic (CLOP GARCIA 2012).

BLÁZQUEZ GONZÁLEZ (2011) analyzed late Early Neolithic decorated pottery of Los Castillejos in Montefrío, Granada (attribute comparison, X-ray fluorescence).

With the available samples, neither CLOP GARCIA (2011, 45) nor ECHALLIER (1999; for Campos/Almería) could prove a relation between distinct raw materials and certain vessel forms, functions or decorations (cf. also JORGE/DIAS/DAY in press), whereas NAVARRETE (1976) and AGUAYO (1998) identified congruencies.

5.3.1. Cabecicos Negros/Almería: Mineralogical analyses

The analyses summarized in the following were conducted and interpreted by H. Müller-Sigmund and M. Harmath of the Institute for Geosciences of the University of Freiburg i.Br./Germany (cf. MÜLLER-SIGMUND ET AL. 2012).

5.3.1.1. Sample material and approach

LINSTÄDTER and MÜLLER-SIGMUND (2012) developed a work flow consisting of seven steps from sample selection to the determination of actual raw material source (cf. LINSTÄDTER/MÜLLER-SIGMUND 2012). So far in this study, only steps one to four have been conducted, without performing raw material surveys and finally identifying the exact location of each raw material source.

I took samples of 12 VUs in the Museum of Almería according to three rough preliminary groups (cf. last column of **Tab. 211**): pottery of 1. a rather light grayish-slightly olive colored paste with lots of biotite and other temper is represented by 344 VUs in total, 2. a reddish-brown paste with lots of metamorphic temper particles (265 VUs) and a third category with hardly any macroscopically visible temper fragments (52 VUs). In addition, eight VUs had overlapping characteristics of pre-group 1 and 2, and five VUs did not fit into any of these categories.

VESSEL UNIT	GRAIN SIZE (MAX. in mm)	quarz	quarzite	carbonate	biotite	pyroxene	plagioclase	vulcanite	metamorphite	muscovite	graphite	turmaline	hematite	garnet	DESCRIPTION	MATERIAL/TYPE	RAW MATERIAL ORIGIN		pre-group
VU 327	0.42x0.26	x			x	x	x	x							coarse-grained, equally dispersed	4 dacitic/rhyodacitic	local	Vera basin	1
VU 338	0.65x0.84	x			x	x	xx			x			x		fine-grained, equally dispersed	3 andesitic	regional	Cabo de Gata	1
VU 346	0.7x0.6	x			xx		xx	x							coarse-grained, not equally dispersed	4 dacitic/rhyodacitic	local	Vera basin	1
VU 398	2.1x2.65		xx		x		x	x	x						fine-grained with single larger particles, equally dispersed, partially linear oriented	1c metamorphic & garnets	regional		2
VU 402	4.9x1.1		xx		x				x	x	x				very coarse-grained, not equally dispersed, but linear oriented	1a metamorphic	local	Betic basement/ hinterland Vera basin	2
VU 403	5.6x1.4		xx				x ?		x	x	x				very coarse-grained, not equally dispersed, but linear oriented	1a metamorphic			2
VU 411	3.15x2.1		xx						x	x	x				very coarse-grained, not equally dispersed, but linear oriented	1a metamorphic			2
VU 412	0.98x0.63		xx		x		x	x	x	x		x		x	fine-grained, equally dispersed	1a metamorphic			2
VU 871	2.52x0.98		x	x	x				x	x		x	x		coarse-grained, not equally dispersed; Calcite: fine-grained with single larger coarse particles	1b metamorphic & carbonate	local		2
VU 920	1.0x0.4		x		x										coarse-grained, equally dispersed with bright biotit, titanite, rutile, volcanic glass	2 lamproitic	local	Antas river valley	2
VU 432	0.62x0.65	x		x											fine-grained, equally dispersed	5 w/o	?	?	3
VU 444	Ø 0.22x0.16	x		x			x								fine-grained, equally dispersed	5 w/o	?	?	3

Tab. 211 Composition, description and raw material origin of the various temper materials detected in the vessel units (VUs) by H. Müller-Sigmund and M. Harmath. The last column contains my preliminary classification in groups (cf. **5.3.1.2. Temper types and raw material origins** and footnote **3**).

Müller-Sigmund and Harmath studied thin sections of each of these sherds microscopically to obtain information about texture, temper material, proportions of paste, temper and grain size. Subsequently they used Electron Microprobe to analyze the mineral composition (LINSTÄDTER/MÜLLER-SIGMUND 2012, 3). On geological maps of the surrounding area, MÜLLER-SIGMUND ET AL. (2012) could identify probable formations containing these minerals, i.e. the provenance of the clay.

5.3.1.2. Temper types and raw material origins

Based on the mentioned previous pottery studies and especially those of JORGE/DIAS/DAY (in press; with further citations therein) and ARNOLD (2005; middle range theory with threshold distances), one can expect occurrences of locally available clay and temper in the Early Neolithic pottery of CNP/AL and a composition due to the associated lithology.

Another issue in this context is the absence of production residues and kilns or rather sparse preservation of features due to probable firings in campfires or fire pits (JORGE/DIAS/DAY in press). E.g. in Cueva de la Carigüela and Los Castillejos/GR such hearths and possibly ovens are documented (cf. **SITE GAZETTEER**). But currently no Early Neolithic contexts in SE Spain provide specialized kilns for ceramic firing. Thus, people assumingly fired their pottery in the open fires. Prehistoric logistic capability neglects an import of complete, numerous pottery assemblages onto sites and assumptions concerning exterior production-sites. Alternatively JORGE/DIAS/DAY (in press and citations therein) suggest an opportunistic clay collecting in the surrounding areas of various "places 'already frequented for other purposes'" and subsequent "small-scale, piecemeal pottery production […] at any given moment" to fulfill "immediate […] requirements" and "related to the pursuit of […] activities" in the surrounding of the sources, i.e. several little import-events.

Besides expectable local temper materials corresponding to the immediate lithology, H. Müller-Sigmund and M. Harmath also identified additional regional temper types in the pottery of CNP/AL and could differentiate between a total of five general temper types with subdivisions (pers. comm. H. Müller-Sigmund cf. Müller-Sigmund et al. 2012) summarized in the following **Tab. 212**:

TEMPER MATERIAL		DESCRIPTION + VUs
Metamorphic temper material	**1a**	VUs 402, 403, 411 (**Fig. 39**) and 412 consist of green schist facies with platy graphite-rich micaschists and quartzite fragments (**Tab. 211**) originating in the Betic Cordillera basement and the mountainous hinterland of the Vera basin (cf. yellow marked area of Betic Basement in **Fig. 38**; Néraudeau et al. 2001). The material was transported to the site via Antas river. Possibly these components reflect a natural composition without hints of anthropogenic temper (cf. below).
	1b	VU 871 (**Fig. 40**) consists of green schist facies metamorphic rocks and contains in addition big, coarse crystalline *carbonate* nuggets (**Tab. 211**) that could originate from a lime layer or vein. This raw material obviously stems from a slightly different origin within the dispersal of the micaschists (cf. yellow marked area of Betic Basement in **Fig. 38**).
	1c	VU 398 (**Fig. 40**) contains *grossular and almandine*, abundant large white mica clasts (muscovite; colorful interference colors), biotite, epidote and angular quartz (**Tab. 211**) due to a more variable metamorphic context. Müller-Sigmund (pers. comm.) assumes a certainly different, more remote origin probably from a distinct location within the deposits of the green schist facies, but concretely locating it in the Betic basement needs further investigation (cf. yellow marked area of Betic Basement in **Fig. 38**).
Lamproitic temper material	**2**	VU 920 (**Fig. 41**) consists of lamproitic temper material with brown angular to sub rounded (probably perlitic) volcanic glass fragments and abundant titan-magnesium-rich biotite phenocrysts mixed with few quartzitic fragments (**Tab. 211**). These components could be due to an intentional tempering of river sediments with small single quartz grains. The glassy lamproit has an extraordinarily high silicic acid content, in line with analyses by Venturelli et al. (1984) of this rock type in the immediate vicinity of the site and additional outcrops within a few kilometers distance (cf. blue marked areas of lamproites in the Antas river valley in **Fig. 38**).
Andesitic temper material	**3**	VU 338 (**Fig. 42**) consists of andesitic temper material with paragenesis of augite, orthopyroxene (hyperstene), titanium-rich biotite and zoned magmatic plagioclase (**Tab. 211**). Melt inclusions indicate a provenance from andesitic volcanic rocks 20-40km S of CNP at Cabo de Gata[3] (cf. violet marked area of Cabo de Gata volcanics and two-pyroxene andesite locations in **Fig. 38**). Major outcrops of two-pyroxene andesites occur at El Borronar, Los Frailes, Los Lobos, Las Negras, El Plomo and Mesa de Roldán (Toscani et al. 1990). This has to be a manuport either of the raw material or of vessels.
Dacitic/rhyodacitic temper material	**4**	VU 327 and 346 (**Fig. 43**) consist of dacitic/rhyodacitic temper material with biotite and corroded magmatic quartz (**Tab. 211**) originating from volcanic local origins (cf. pink marked areas of dacites and rhyodacites in the Antas river valley in **Fig. 38**).
w/o temper material	**5**	VUs 432 and 444 (**Fig. 44**) consist of residual clay without temper clasts (**Tab. 211**). It is apparently naturally argillaceous and did not stem from the river or contain quartz. Re-crystallization of carbonate could indicate a higher firing temperature and thus a younger age.

Tab. 212 Temper materials detected in the vessel units (VUs) by H. Müller-Sigmund and M. Harmath (cf. **Tab. 211**).

How do these professional temper types of **Tab. 212** fit to the three preliminary groups (cf. last column of **Tab. 211**)?

Based on the assumptions that I tried to select a most divers sample consisting of a representative cross-section of the assemblage and that the ratios of temper materials in the sample represent applicable existent ratios, I transferred the ratios of raw materials from the samples to the determined pre-groups. So I extrapolated the estimated ratios for the assemblage as displayed in **Tab. 213**. These are hypothetical and followed the subsequent steps:

- Macroscopically I could not differentiate VUs of andesitic (3 cf. **Tab. 212**) and dacitic/rhyodacitic (4) temper material and both are subsumed in pre-group 1 (**Tab. 213**). I did neither distinguish metamorphic (1) and lamproitic (2) temper materials that were categorized as pre-group 2. Distinguishing the subdivision of metamorphic temper materials macroscopically in metamorphic (1a), metamorphic with garnets (1c) or with carbonate (1b) was also impossible. But I managed a faultless assignment in the pre-groups 1 and 2. Additionally, I identified 52 VUs made of residual clay without temper clasts in pre-group 3 (equals 5. In **Tab. 212**).

[3] The origin of the Andesitic temper material from Cabo de Gata is doubtable and has to be verified by future analyses (pers. comm. H. Müller-Sigmund)!

- Pre-group 1 is represented by three samples from andesitic and dacitic/rhyodacitic temper material in a ratio of 1:2. For the whole assemblage, I categorized 344 VUs in pre-group 1. So considering the ratio of 1:2 – i.e. 115 to 229 VUs, I estimate (with many reservations) that 115 VUs are made of andesitic vs. 229 VUs of dacitic/rhyodacitic temper material.
- I took seven samples of pre-group 2. Müller-Sigmund and Harmath determined those as various metamorphic and lamproitic temper material. The ratio within the sample is 6:1. Within the whole assemblage, 265 VUs remained from pre-group 2. Thus, regarding the mentioned ratio, 227 VUs should be of metamorphic temper material and 38 of lamproitic temper material.
- Within the metamorphic temper, Müller-Sigmund and Harmath differentiate local metamorphic temper material amongst others with carbonate (1a+b) and regional metamorphic material with garnets (1c). These occur in a ratio of 5:1 in the sample. Applied to the whole assemblage, I assume 189 VUs of local metamorphic material (1a+b) and 38 VUs due to regional metamorphic temper material with garnets (1c).
- So the regional clays andesitic temper material (cf. footnote **3**) and metamorphic temper material with garnets are represented by 115 and 38 VUs, respectively. Thus, 23.2% (153 VUs) of the assemblage has a regional origin.
- 76.9% consists accordingly of local material. The provenance of the rest without temper material is not determinable.

TEMPER MATERIAL	VUs *n*	VUs *%*
pre-group 1	344	52.0%
pre-group 2	265	40.1%
pre-group 3	52	7.9%
dacitic/rhyodacitic (4)	229	34.6%
metamorphic (1a-c)	227	34.3%
andesitic (3)	115	17.4%
lamproitic (2)	38	5.7%
w/o (5)	52	7.9%
Σ assemblage	661	100%
n.s.*	13	*1.9%*

Tab. 213 CNP/AL. Pre-grouping of vessel units (VU; cf. **Tab. 211**) and hypothetical estimation of temper material ratios in the whole pottery assemblage according to the assumptions described in the adjoining paragraph (The numbers in parenthesis refer to the mineralogical subdivisions by Müller-Sigmund and Harmath listed in **Tab. 212**; *percentage of non-specified (n.s.) temper material refers to total amount of 674 VUs).

However, these are only estimations and an unambiguous re-determination of the concrete VUs is only possible by resorting them according to the determined mineralogical subdivisions of **Tab. 212**.

Generally, people accessed at least three clay deposits (metamorphic and volcanic) in the vicinity of CNP/AL (**Fig. 38**) and within the common "preferred distance" of sedentary potters (ARNOLD 2005, 16). Although those tempers were river transported by the Antas river along the site, the green schist metamorphic temper material and volcanic clasts (lamproitic and dacitic/ryodacitic temper) do not appear mixed in the sherds (MÜLLER-SIGMUND ET AL. 2012), i.e. people picked the raw material up near its deposit before a fluvial mixture could take place (pers. comm. H. Müller-Sigmund). Furthermore, this circumstance may even indicate an anthropogenic tempering. As only one distinct type of temper material is present per sherd – i.e. per clay – one can assume a gathering or even previous intentional production of these temper material, whereas natural compositions are characterized by a mixture of components (pers. comm. H. Müller-Sigmund according to P. Lapuente). Smallest flint chips in VUs of Car/GR could also indicate intentional tempering in the Early Neolithic of SE Spain (VUs 78, 131, 137 and 158 cf. database; cf. NAVARRETE 1976 and **SITE GAZETTEER: Cueva de la Carigüela/Granada**). However, it may be that people produced pottery nearby chipping floors, where chips were scattered, and thus people intermixed them by mistake.

The raw materials with different metamorphic garnets and otherwise of andesitic material (cf. footnote **3**) provide links to more distant, regional clay deposits (MÜLLER-SIGMUND ET AL. 2012). Such distant origins occur regularly in archaeological (Early) Neolithic contexts (cf. NAVARRETE 1976, NAVARRETE ET AL. 1991 and WIGAND 1978, 278-280 for Car/GR, MARTÍNEZ FERNÁNDEZ/GAVILÁN CEVALLOS 1997 for Cueva de los Murciélagos de Zuheros in Córdoba; CLOP GARCIA 2011 for Valencian sites, MANEN/CONVERTINI 2012 for the W Mediterranean, VERA RODRÍGUEZ/MARTÍNEZ FERNÁNDEZ 2012: 12-15km transport of temper material; cf. JORGE/DIAS/DAY in press) and exceed ARNOLD's (2005, 16) threshold distances of sedentary groups with a maximum of 7km-radius around the settlement by far.

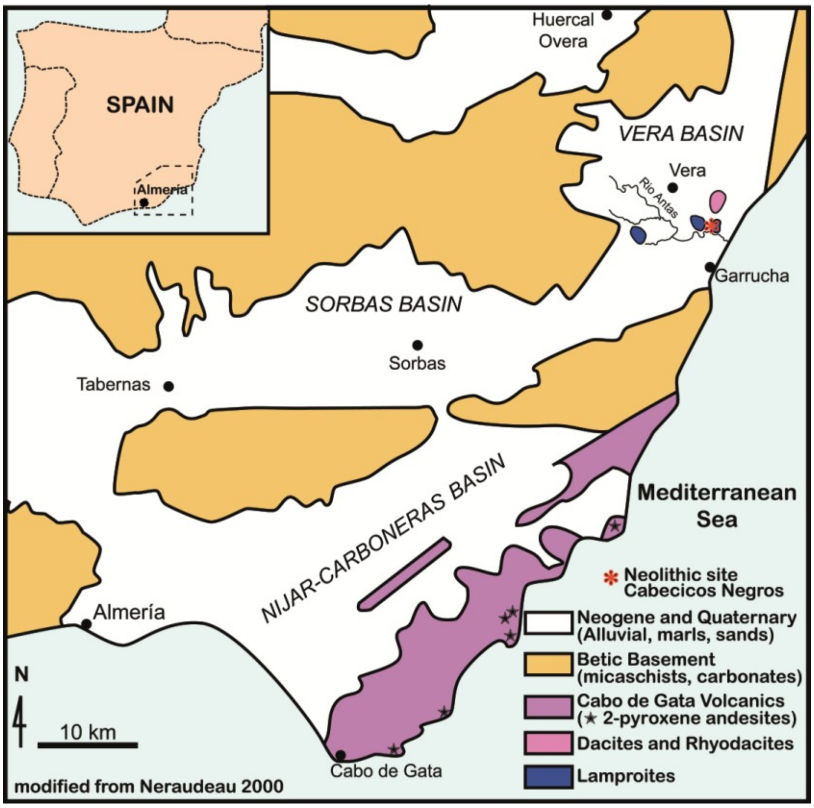


Fig. 38 Location of CNP/AL in its surrounding geological setting with probable clay sources of the pottery (MÜLLER-SIGMUND ET AL. 2012, modified from NÉRAUDEAU ET AL. 2000, 46 Fig. 2; cf. cf. footnote **3** and dispersal of metamorphic surface exposure in WIGAND 1978, 380 Fig. 36).

The distance of 20-40km could be covered within a few days; especially a route along the coast or rivers could facilitate the journey (cf. WIGAND 1978, 13; 15 Fig. 3). In the interior people had to overcome foothills.

Generally these distant temper materials imply – analogue with other indicators (cf. **3.1.2.5. Evaluated sites and archaeological characterization**) – a rather mobile, semi-nomadic lifestyle within a relatively large territory persisting in the Early Neolithic groups (cf. MANEN/CONVERTINI 2012, 366). People could have exploited these regional clay deposits once to produce certain special vessels. This could be due to aesthetic preferences for the glittering mica tempering.

Alternatively – congruently with MANEN/CONVERTINI (2012), who deemed a circulation of pottery – a group could have brought these vessels or goods transported in these pots with them from a previously occupied camp in the vicinity of the associated clay deposit to CNP/AL. One could even assume a special-task group moving in distant regions for consumption, fulfilling certain duties and meanwhile producing pottery according to their immediate needs and with available local resources. However, what people did in detail in the driest area remains ambiguous and is contradictory to the settlement gap there (cf. **3.1.2.5. Evaluated sites and archaeological characterization**). Subsequently people returned to the main group carrying with them pots made of these clays (possibly containing gathered goods) with them (cf. JORGE/DIAS/DAY in press). Furthermore, these finds could prove contacts to other groups. People from other groups could have brought these vessels (/goods) with them during a visit (WIGAND 1978, 284). People possibly exchanged vessels or goods transported in these vessels for other goods or obligations. Such exchanges have to be considered small-scale and between individuals (JORGE/DIAS/DAY in press cf. “trade system” by WIGAND 1978, 281). Or, apart from that, individuals could have moved and became integrated or “married” into the new group bringing the vessels/goods in the vessels with them (JORGE/DIAS/DAY in press).

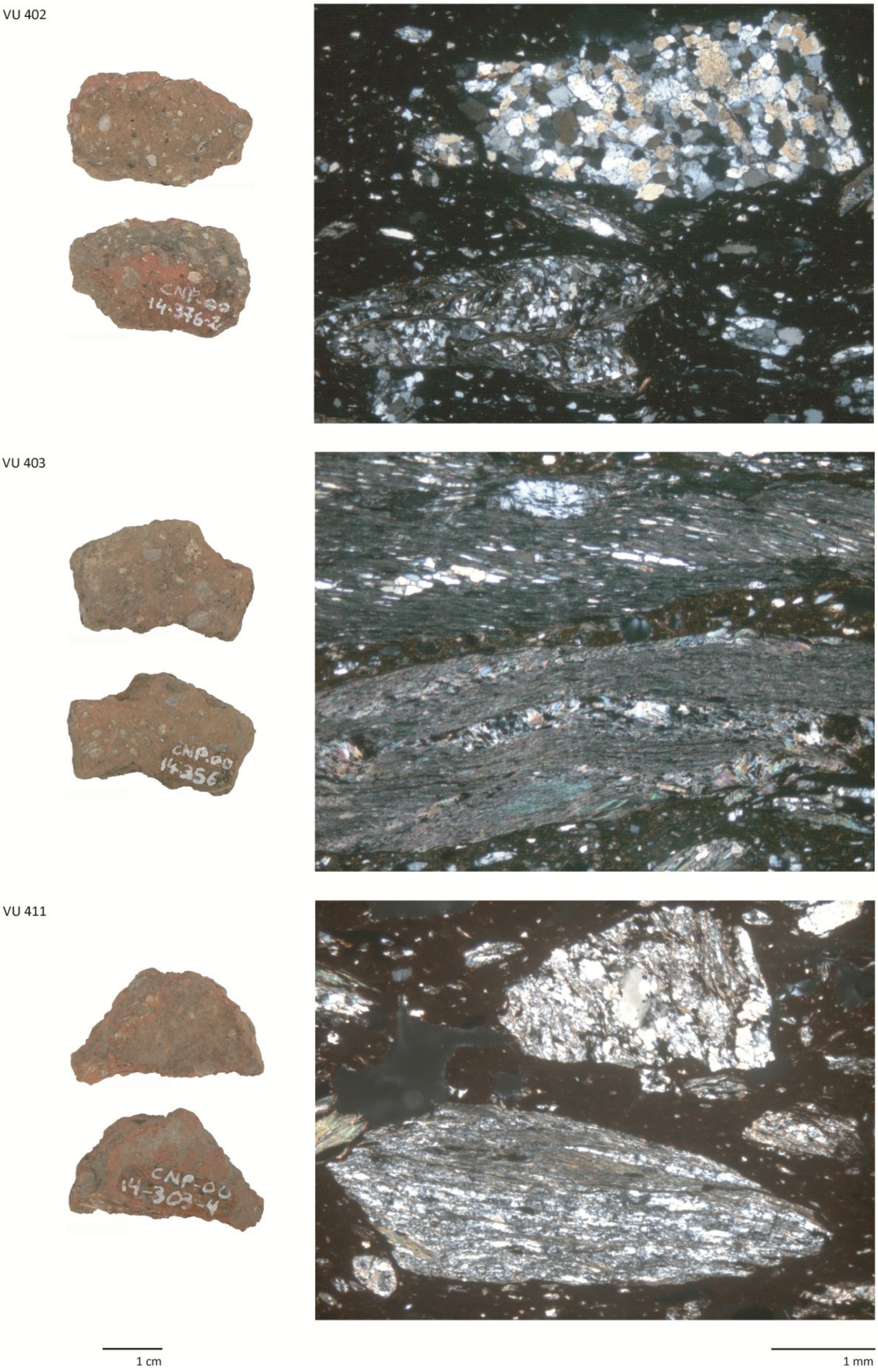


Fig. 39 CNP/AL. Exterior (top) and interior (bottom) of each pottery sample from vessel units (VUs) 402, 403 and 411 of metamorphic temper material and corresponding thin section micrographs with crossed polars (by H. Müller-Sigmund).

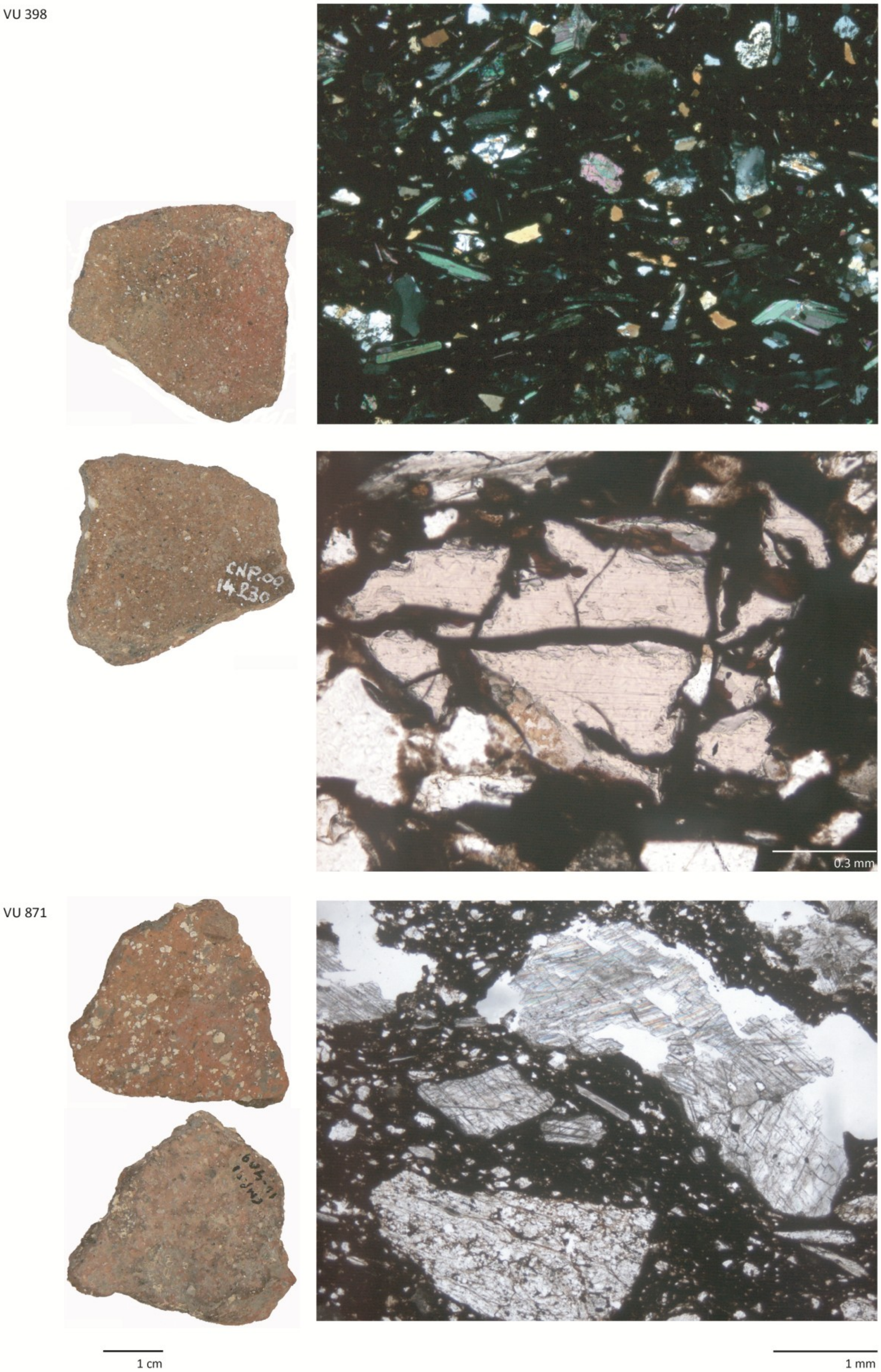


Fig. 40 CNP/AL. Exterior (top) and interior (bottom) and corresponding thin section micrographs of each pottery sample from vessel units (VUs) of metamorphic temper material: VU 398 with garnets (in crossed polars and close-up of pinkish almandine in the middle; Müller-Sigmund et al. 2012) and 871 with carbonate (by Müller-Sigmund).

VU 920

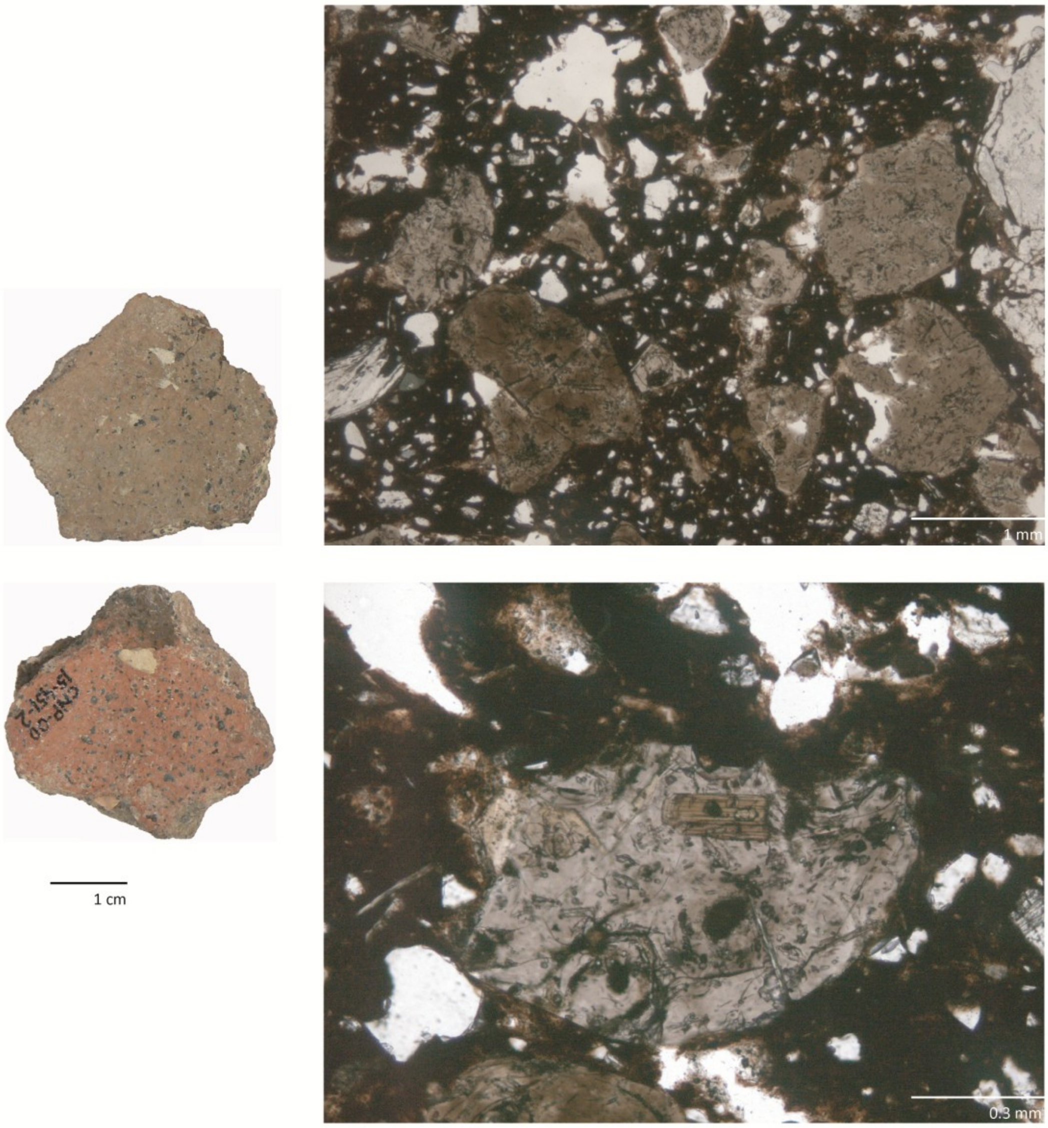


Fig. 41 CNP/AL. Exterior (top) and interior (bottom) of pottery sample from vessel unit (VU) 920 of lamproitic temper material and corresponding thin section micrographs (MÜLLER-SIGMUND ET AL. 2012).

VU 338

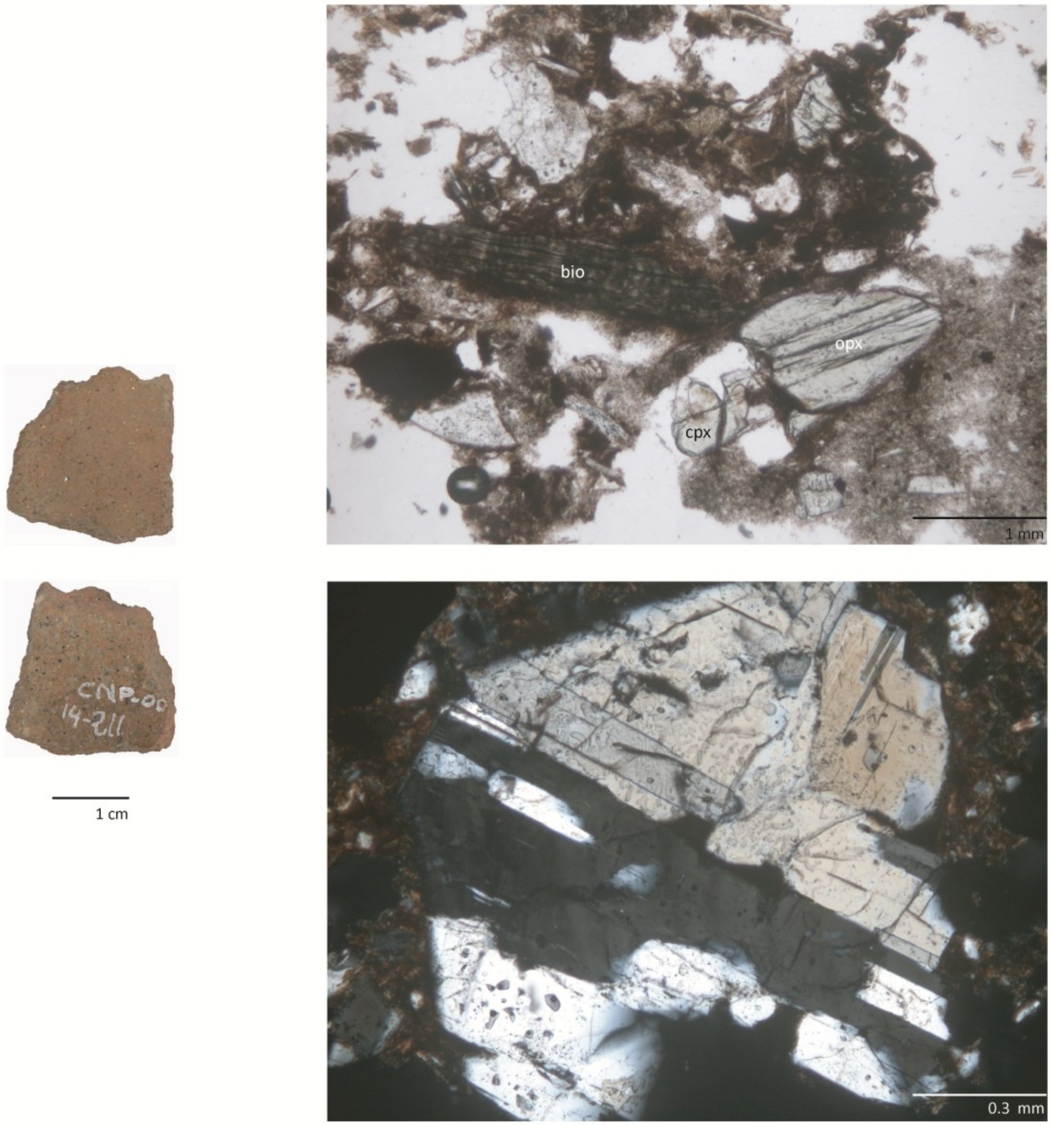


Fig. 42 CNP/AL. Exterior (top) and interior (bottom) of pottery sample from vessel unit (VU) 338 of andesitic temper material and corresponding thin section micrograph of typical mineral clasts and close-up of plagioclase clast (MÜLLER-SIGMUND ET AL. 2012).

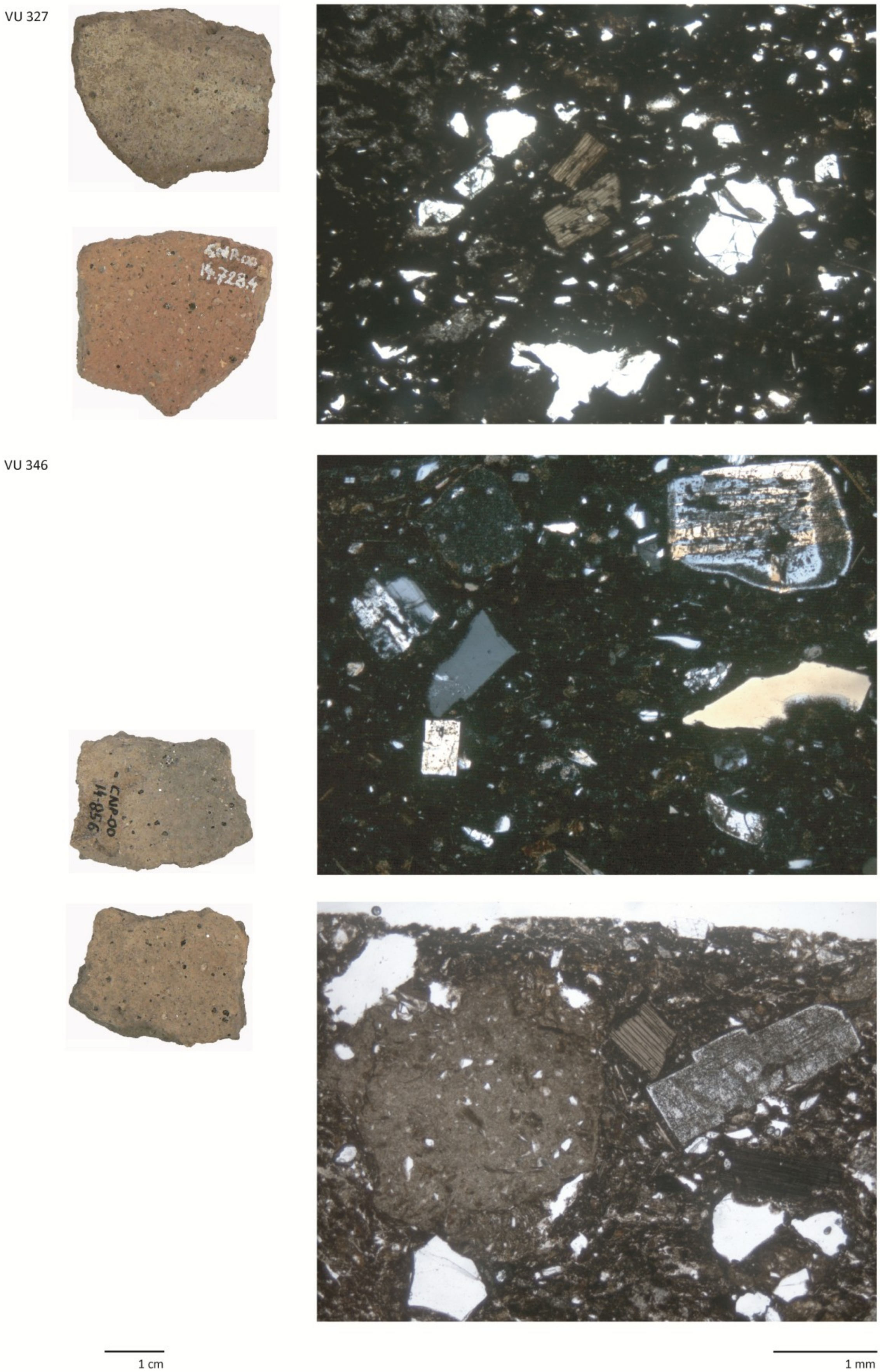


Fig. 43 CNP/AL. Exterior (top) and interior (bottom) of each pottery sample from vessel units (VUs) 327 and 346 of dacitic/rhyodacitic temper material and corresponding thin section micrographs (by H. Müller-Sigmund).

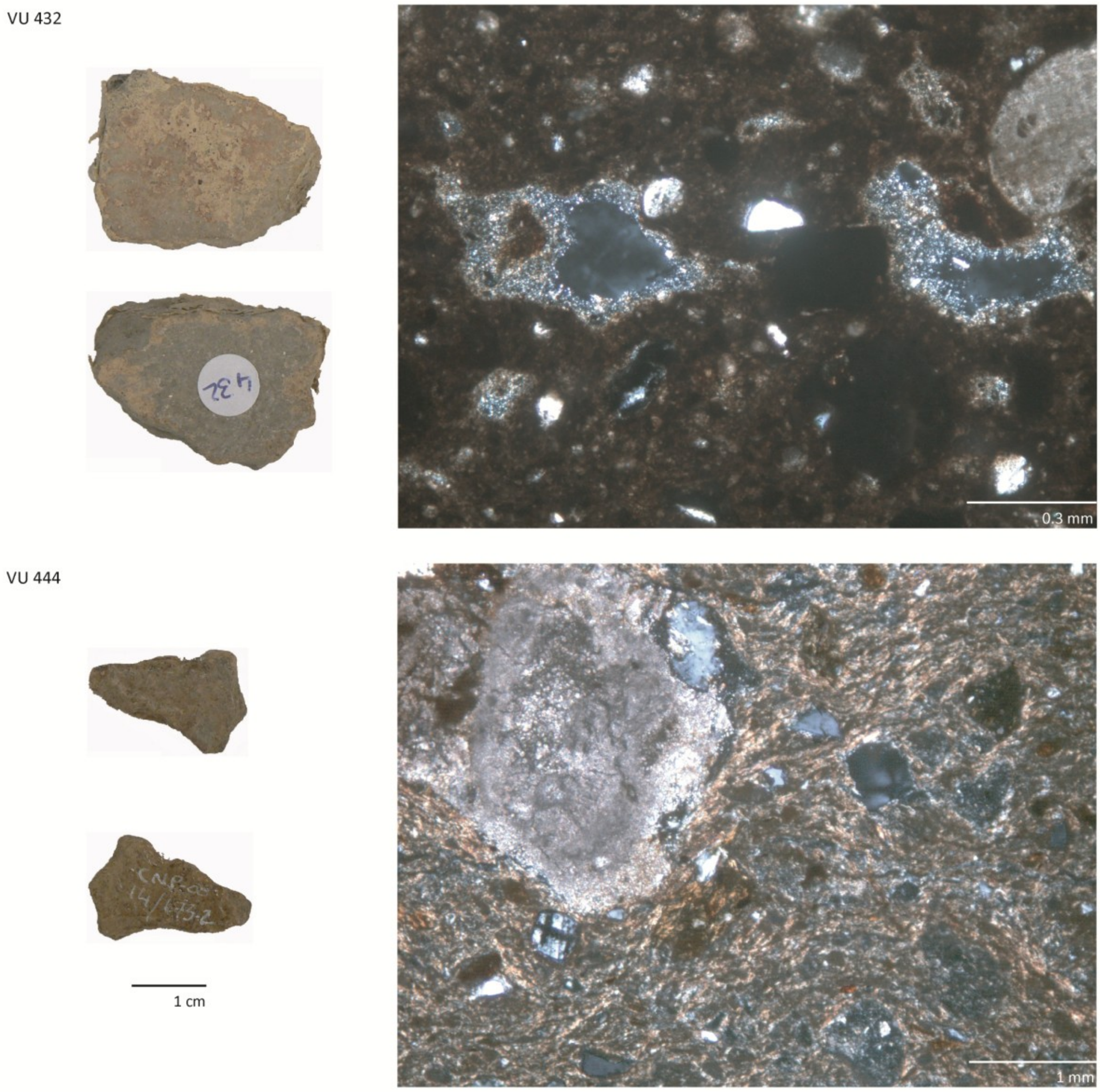


Fig. 44 CNP/AL. Exterior (top) and interior (bottom) of each pottery sample from vessel units (VUs) 432 and 444 of residual clay without clasts and corresponding thin section micrographs with crossed polars (by H. Müller-Sigmund).

5.4. Descriptive analyses

The descriptive evaluation of the recorded pottery attributes (cf. **Tab. 207**) follows the studies of LINSTÄDTER (2004, 93-99) and MANEN (2002). In the present study, I ignore the colors of the ceramic fragments as the coloring is very variable. Especially open firing of the pottery and many other factors during the whole production process influence the colors. The colors can hardly provide new, reliable insights (cf. LINSTÄDTER 2004, 94).

The preserved VUs consist predominantly of wall sherds (**Tab. 214**). Additionally, rim fragments are present in small amounts of about 20% in the large assemblages of CNP/AL and Car/GR. These fragments provide further information about the former diameter of the vessel opening. Determination of a vessel shape is also connected to the preservation of larger fragments such as profile sherds, rim and wall or base sherds. Very few handles are present.

SHERD TYPE	CNP/AL		Car/GR		A6/MA		Got/MA		HC/MU		Σ	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
profile	6	0.9%									6	0.6%
rim+wall	117	17.4%	66	21.5%					1	16.7%	184	18.3%
base+wall	2	0.3%	5	1.6%							7	0.7%
rim	3	0.4%	2	0.7%	1	10.0%			1	16.7%	7	0.7%
wall	503	74.6%	214	69.7%	4	40.0%	5	71.4%	2	33.3%	728	72.5%
base	2	0.3%	2	0.7%							4	0.4%
handle	2	0.3%	1	0.3%							3	0.3%
handle+wall	19	2.8%	6	2.0%	1	10.0%					26	2.6%
rim+wall	3	0.4%	5	1.6%	1	10.0%			1	16.7%	10	1.0%
rim+wall+handle	15	2.2%	6	2.0%	1	10.0%	2	28.6%	1	16.7%	25	2.5%
rim+wall+base	2	0.3%									2	0.2%
complete vessel					2	20.0%					2	0.2%
Σ	674	100%	307	100%	10	100%	7	100%	6	100%	1004	100%

Tab. 214 Present sherd types of the VUs in pottery assemblages listed according to decreasing absolute numbers VUs.

Most sherds are medium hard (**Tab. 215**). Obviously hard fragments outnumber brittle and soft sherds. Already the ceramic generally appears durable, even in the initial states of pottery production and usage.

HARDNESS	CNP/AL		Car/GR		A6/MA		Got/MA		HC/MU		Σ	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
very hard	68	10.2%	69	22.5%			1	33.3%	2	33.3%	140	14.1%
medium hard	581	87.0%	196	64.1%	10	100%	2	66.7%	4	66.7%	794	79.9%
brittle and soft	19	2.8%	41	13.4%							60	6.0%
Σ	668	100%	306	100%	10	100%	3	100%	6	100%	994	100%
hardness n.s.*	6	0.9%	1	0.3%			4	57.1%			10	1.0%

Tab. 215 Hardness of the sherds per VU (*hardness not specified (n.s.) refers to total assemblages of CNP/AL=674, Car/GR=307 and Got/MA=7).

Wall thicknesses vary in CNP/AL between 0.8-2cm (**Fig. 45**) and in Car/GR between 0.5-1.5cm (**Fig. 46**). CNP/AL presents several VUs with maximum values above 15mm representing a higher amount of coarser, more massive or larger vessels on-site than in Car/GR. The few pottery fragments of HC/MU, A6 and Got/both in MA present even smaller wall thicknesses of maximum 1.5-1cm (**Fig. 47**).

In CNP/AL and Car/GR, people smoothened the surface of their pottery using mainly only one technique (**Tab. 216**). 89.8% of the VUs in CNP/AL are treated with *lissage* and *raclage*, both as single and as combined surface treatment. In contrast in Car/GR more sherds were smoothened by *raclage* or *raclage* combined with *brunissage* or *lissage*. The few VUs of A6 and Got/both in MA disperse over many of the possible attributes, whereas pottery of HC/MU presents a small dominance of *lissage*.

SURFACE TREATMENT	CNP/AL		Car/GR		A6/MA		Got/MA		HC/MU		Σ	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
one surface treatment	357	58.8%	151	49.8%	4	40.0%	2	40.0%	5	83.3%	519	55.7%
*brunissage**	24	6.7%	6	4.0%	3	75.0%					33	6.4%
*lissage**	178	49.9%	22	14.6%	1	25.0%			5	100%	206	39.7%
*raclage**	155	43.4%	123	81.5%			2	100%			280	53.9%
two surface treatments	243	40.0%	138	45.5%	5	50.0%	2	40.0%	1	16.7%	389	41.8%
*lissage/brunissage**	4	1.6%	3	2.2%			1	50.0%			8	2.1%
*raclage/brunissage**	27	11.1%	80	58.0%	4	80.0%	1	50.0%			112	28.8%
*raclage/lissage**	212	87.2%	55	39.9%	1	20.0%			1	100%	269	69.2%
three surface treatments	7	1.2%	14	4.6%	1	10.0%	1	20.0%			23	2.5%
*brunissage/lissage/raclage**	7	100%	14	100%	1	100%	1	100%			23	100%
Σ VUs with surface treatment	607	100%	303	100%	10	100%	5	100%	6	100%	931	100%
surface treatment n.s.**	62	9.2%									62	6.2%
w/o surface treatment**	5	0.7%	4	1.3%			2	28.6%			11	1.1%

Tab. 216 Treatment of the outer pottery surface per VU (according to Binder et al. 2010, 32-33; *refers to number of VUs with one, two or three surface treatments respectively; **without (w/o) and surface treatment not specified (n.s.) refer to total assemblages of CNP/AL=674; Car/GR=307; Got/MA=7; Σ = 1004).

The diameters of the vessel openings in Car/GR are gradually dispersed between 5-29cm (**Fig. 49**) and for the vessels of CNP/AL even up to 38cm (**Fig. 48**). The diameters of the openings represent the whole range of vessels forms from small globular vessels up to storage vessels or platters (cf. **Tab. 217**). In smaller assemblages for each two VUs, the diameter of the vessel opening could be determined: 10cm and 16cm in Got; twice 12cm in A6/both in MA and 18cm and 24cm in HC/MU.

Although none of the vessels of CNP/AL and Car/GR is entirely preserved, the forms of 13.2% or 19.9%, respectively, of the VUs could be still determined (**Tab. 217**). But generally the determination of the form is difficult as often only small fragments are preserved. So, e.g. a small upper fragment of a former small globular vessel could be accidentally determined wrongly as the upper most part of a bottle.

FORM TYPES	CNP/AL		Car/GR		A6/MA		Got/MA		HC/MU		Σ	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
1 storage vessels	7	7.9%	1	1.6%							8	5.0%
2 type 2 bowles (*jatte*)	9	10.1%	9	14.8%							18	11.3%
3 type 3 bowles (*coupe*)	7	7.9%	3	4.9%							10	6.3%
4 jars	6	6.7%	16	26.2%	2	33.3%					24	15.1%
5 small globular vessels	12	13.5%	11	18.0%	1	16.7%					24	15.1%
6 pots	19	21.3%	13	21.3%			2	100%	1	100%	35	22.0%
7 Bottles	8	9.0%	2	3.3%	3	50.0%					13	8.2%
8 small bowls (*bol*)	18	20.2%	6	9.8%							24	15.1%
9 plates	3	3.4%									3	1.9%
Σ VUs with form	89	100%	61	100%	6	100%	2	100%	1	100%	159	100%
form n.s.*	585	86.8%	246	80.1%	4	40.0%	5	71.4%	5	83.3%	845	84.2%

Tab. 217 Vessel forms (according to Binder et al. 2010, 35-39; *VUs with form n.s. (not specified) refer to the total amount of the assemblage of CNP/AL=674; Car/GR=307; A6/MA=10; Got/GR=7; HC/MU=6 or the total of all assemblages Σ=1004).

The whole range of vessel types is present in both CNP/AL and Car/GR. For the inventory of CNP/AL I classified even an additional new type (the plate/platter; cf. **Tab. 207**). Various kinds of pots and bowls dominate. In CNP/AL especially pots and small bowls are characteristic and represent about

40% of the inventory, whereas jars, pots and small globular vessels dominate the assemblage of Car/GR with 65.5%. A single pointed base is preserved in CNP/AL (VU 990) besides fragments of flat/slightly rounded bases. Only single vessel forms could be determined in the other inventories.

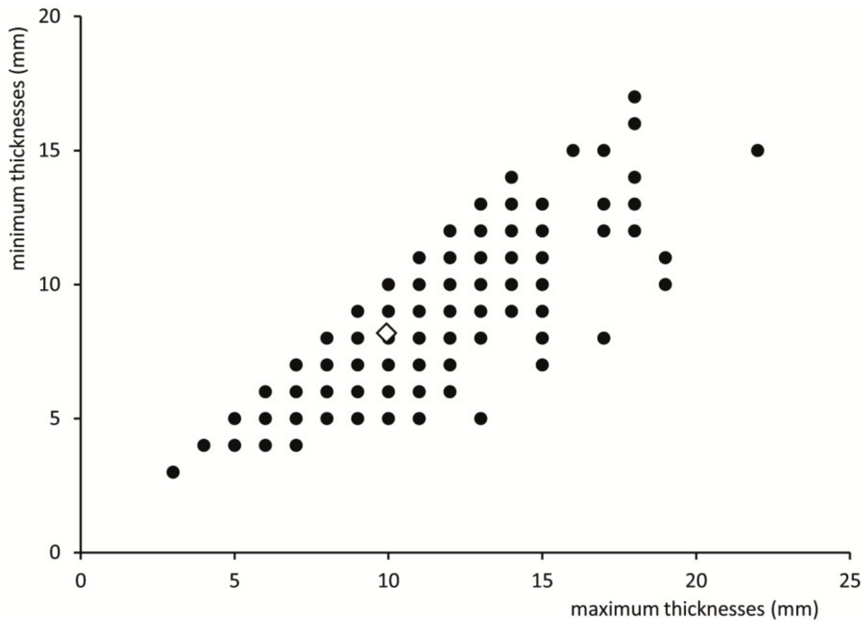


Fig. 45 CNP/AL. Maximum and minimum wall thicknesses of 666 VUs with available values in mm and mean value (empty rhomb: mean maximum thickness=9.9±2.617mm and mean minimum thickness=8.2±2.067mm).

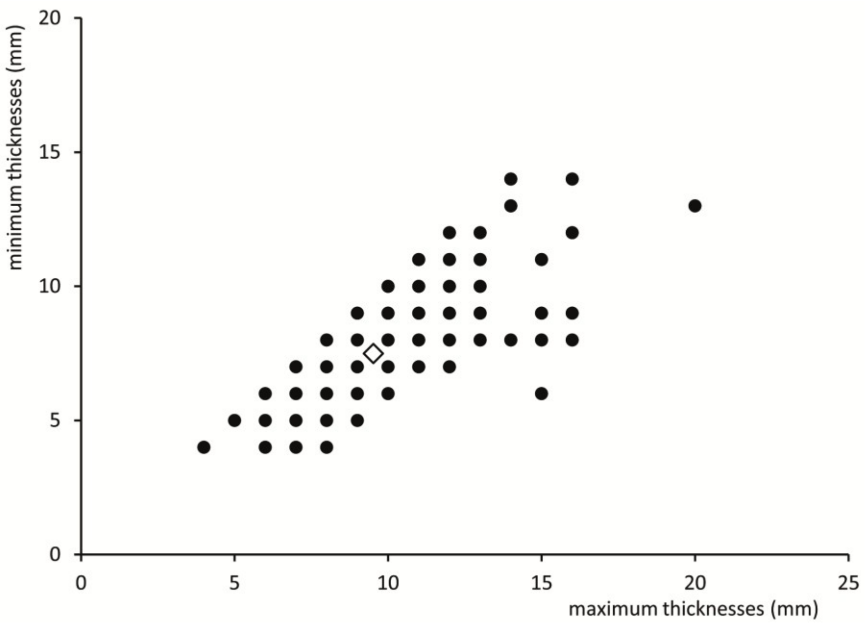


Fig. 46 Car/GR. Maximum and minimum wall thicknesses of all 306 VUs in mm and mean value (empty rhomb: mean maximum thickness=9.5±2.446mm and mean minimum thickness=7.5±1.860mm).

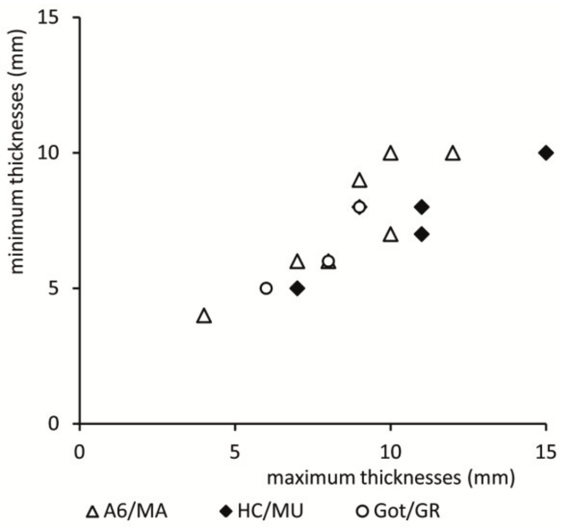


Fig. 47 Maximum and minimum wall thicknesses of VUs originating from A6/MA (empty triangle), HC/MU (black rhomb) and Got/GR (empty circle).

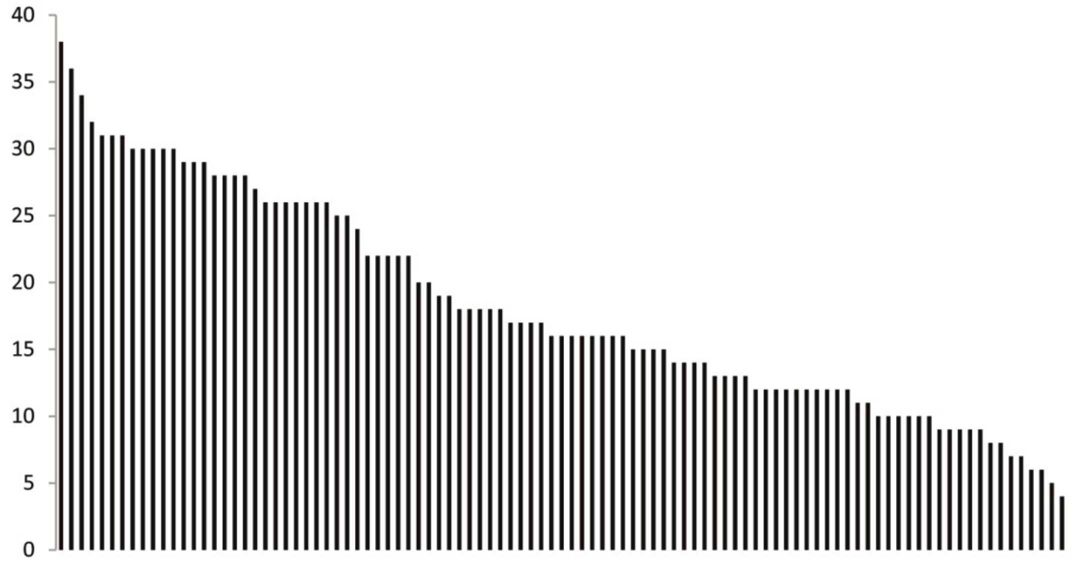


Fig. 48 CNP/AL. Diameters of the vessel openings in cm (Σ rim fragments with determinable openings=99 VUs; mean=18.2±8.139cm).

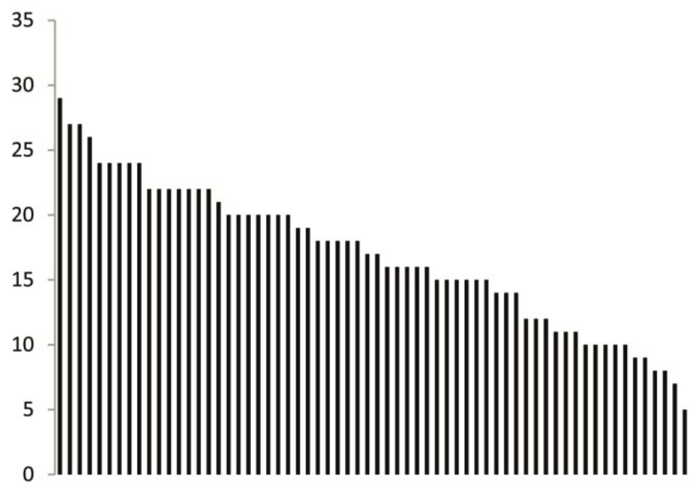


Fig. 49 Car/GR. Diameters of the vessel openings in cm (Σ rim fragments with determinable openings=64 VUs; mean=16.9± 5.570cm).

The amount of decorated pottery differs between CNP/AL, Car/GR as well as in the other inventories (**Tab. 219**; cf. **Fig. 52** to **Fig. 62**). 16.6% of the VUs in CNP/AL and 34.5% of those in Car/GR are decorated foremost on the walls (more than 80%), using only one decoration technique and one tool (each 60-70%). The decoration is attached mostly zoned in a horizontal pattern (cf. A11 in BINDER ET AL. 2010, 38 Fig. 13). The specimens of the other inventories are predominantly decorated. Several attributes appear sporadically.

In CNP/AL, impressed decorations dominate (**Tab. 220**). These ornaments were mostly achieved using a no longer specifiable tool (cf. **Fig. 50**). People also achieved impressions using the Cardium shell (8%). Almost 30% of the VUs were incised using a point and sculptured bands were applied on 12.3%.

Impressed decorations also dominate in Car/GR (**Tab. 220**), but they are less striking than in CNP/AL. About 40% of the VUs are decorated by impressions and 34.2% by sculptured decorations. People made impressions using various different tools and mostly comb (**Fig. 51**). Cardium decorations account for 8.7% and as frequent as in CNP/AL.

All the other inventories also predominantly have impressed decorations – as far as they consist of a representative amount of VUs (**Tab. 220**; cf. **Fig. 52** to **Fig. 62**). People of A6, Got/both in MA and HC/MU used the Cardium shell (cf. pottery decorations occurring in **Cueva (de) Nerja/Málaga**/**SITE GAZETTEER**).

The dominant motifs (cf. BINDER ET AL. 2010, 39 Fig. 14) differ slightly between the assemblages (**Tab. 218**; cf. **Fig. 52** to **Fig. 62**). Simple, multiple-shaped dots (A1) and lines or bundles of lines (E1) occur on more than 30% of the decorated VUs in CNP/AL. The inventory of Car/GR is clearly dominated by lines (E1). Besides that, B1 is present to a remarkable amount in both inventories, too. The mentioned motifs A1, B1 and E1 dominate also on the decorated VUs of A6/MA and HC/MU. In Got/MA the total of 12 present motifs disperses over six expressions.

Thus, so far the pottery assemblages represent a number of similarities and internal variances concerning Early Neolithic pottery attributes possibly representing the needs or desires of the settlers.

MOTIFS	CNP/AL		Car/GR		A6/MA		Got/MA		HC/MU		Σ	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
●▲◖ A1	58	33.7%	16	9.1%	4	28.6%	1	8.3%	2	16.7%	81	21.0%
|||| B1	28	16.3%	45	25.7%	3	21.4%	2	16.7%	3	25.0%	81	21.0%
= B3	5	2.9%	9	5.1%	1	7.1%	2	16.7%	1	8.3%	18	4.7%
///\\\ D1	14	8.1%	19	10.9%	1	7.1%	3	25.0%	1	8.3%	38	9.9%
<<<<< D2	4	2.3%	9	5.1%	1	7.1%			1	8.3%	15	3.9%
XXXXX D5	7	4.1%	3	1.7%	1	7.1%					11	2.9%
—— E1	56	32.6%	74	42.3%	3	21.4%	2	16.7%	4	33.3%	139	36.1%
V ▲ V H3							2	16.7%			2	0.5%
Σ motifs	172	100%	175	100%	14	100%	12	100%	12	100%	385	100%

Tab. 218 Frequency of decoration motifs in the pottery assemblages. VUs (vessel units) may be counted several times, because several motifs can appear on one VU (motifs according to BINDER ET AL. 2010, 39 Fig. 14).

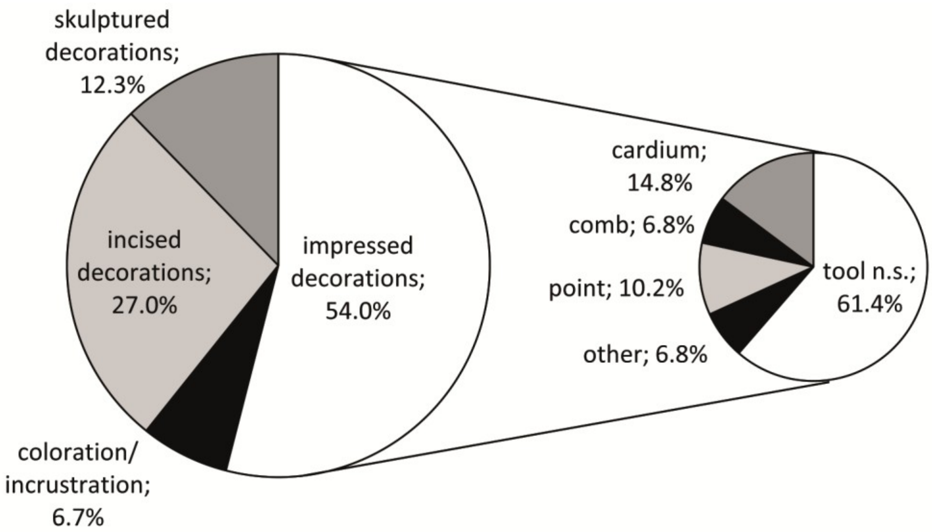


Fig. 50 CNP/AL. Decoration techniques (cf. **Tab. 220**).

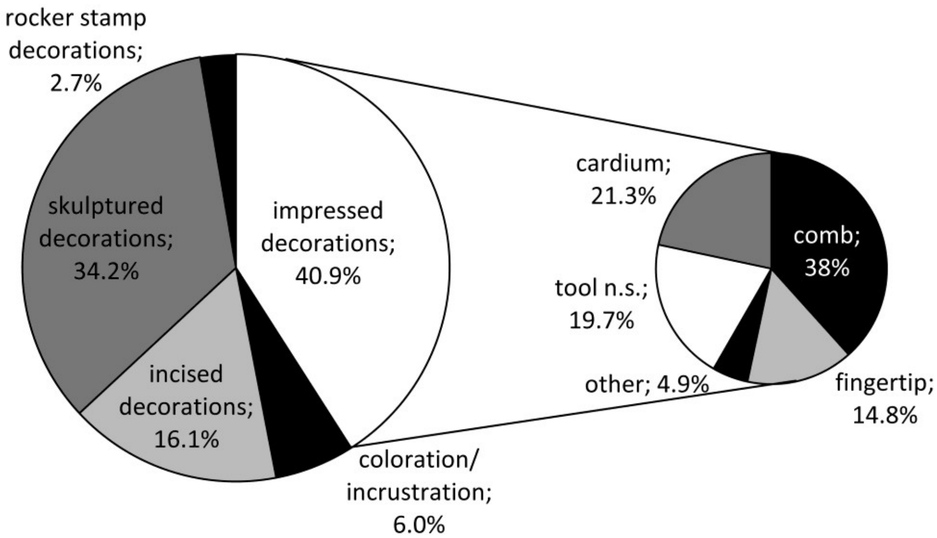


Fig. 51 Car/GR. Decoration techniques (cf. **Tab. 220**).

DECORATION		CNP/AL		Car/GR		A6/MA		Got/MA		HC/MU		Σ	
		n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
decorated		112	16.6%	106	34.5%	5	50.0%	7	100%	6	100%	236	23.5%
technique	1 decoration technique /VU*	71	63.4%	74	69.8%	2	40.0%	7	100%	4	66.7%	158	66.9%
	2 decoration techniques/VU*	39	34.8%	29	27.4%	2	40.0%			2	33.3%	72	30.5%
	3 decoration techniques/VU*	2	1.8%	3	2.8%	1	20.0%					6	2.5%
tool	w/o tool*			31	29.2%	1	20.0%					32	13.6%
	1 tool /VU*	87	77.7%	61	57.5%	2	40.0%	7	100%	4	66.7%	161	68.2%
	2 tools/VU*	22	19.6%	12	11.3%	1	20.0%			2	33.3%	37	15.7%
	3 tools/VU*	3	2.7%	2	1.9%	1	20.0%					6	2.5%
position	rim decorated (I)*	3	2.7%	2	1.9%						0.0%	5	2.1%
	wall decorated (II)*	91	81.3%	91	85.8%	3	60.0%	6	85.7%		0.0%	191	80.9%
	rim+wall decorated (IV)*	15	13.4%	6	5.7%			1	14.3%		0.0%	22	9.3%
	handle decorated (IX)*	1	0.9%	1	0.9%						0.0%	2	0.8%
	handle+wall decorated (XI)*	2	1.8%	4	3.8%	2	40.0%				0.0%	8	3.4%
	rim+wall+handel decoreted (XII)*			2	1.9%						0.0%	2	0.8%
structure	zoned (A)*	10	8.9%	4	3.8%			1	14.3%		0.0%	15	6.4%
	horizontallly zoned (A1)*			1	0.9%						0.0%	1	0.4%
	... in horizontal patterns (A11)*	81	72.3%	72	67.9%	1	20.0%	2	28.6%		0.0%	156	66.1%
	... in vertical pattern (A12)*			3	2.8%						0.0%	3	1.3%
	... A11/A12 combined (A13)*	4	3.6%	13	12.3%	2	40.0%				0.0%	19	8.1%
	zoned with wavy line (A3)*							1	14.3%		0.0%	1	0.4%
	non-zoned (B)*	5	4.5%	4	3.8%						0.0%	9	3.8%
	restricted/concentrated (C)*	11	9.8%	4	3.8%	2	40.0%	2	28.6%		0.0%	19	8.1%
	structure n.s.	1	0.9%	5	4.7%			1	14.3%		0.0%	7	3.0%
non-decorated		562	83.4%	201	65.5%	5	50.0%					768	76.5%
Σ VUs		674	100%	307	100%	10	100%	7	100%	6	100%	1004	100%

Tab. 219 Decorated and non-decorated vessel units (VUs) of the pottery assemblages (*attributes of decoration techniques, tools, positions or structures per VU refer to the decorated VUs; attributes according to BINDER ET AL. 2010, 39-40).

DECORATION			CNP/AL		Car/GR		A6/MA		Got/MA		HC/MU		Σ	
code	tool	technique	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
1A	cardium preprendicular	impressed	8	4.9%	2	1.3%			2	33.3%	1	7.7%	13	3.8%
3A	cardium in 45° angle	impressed	5	3.1%	11	7.4%	2	15.4%			2	15.4%	20	5.8%
6A	non-dented shell	impressed			1	0.7%					1	7.7%	2	0.6%
7A	comb	impressed	6	3.7%	23	15.4%	1	7.7%	1	16.7%			31	9.0%
7B		incised	4	2.5%	1	0.7%							5	1.5%
7C		rocker stamp			4	2.7%							4	1.2%
8A	soft tipped point	impressed	3	1.8%									3	0.9%
8B		incised	1	0.6%									1	0.3%
9A	point	impressed	6	3.7%	1	0.7%	1	7.7%					8	2.3%
9B		incised	31	19.0%	20	13.4%	2	15.4%	1	16.7%			54	15.7%
10A	curved tool	impressed	4	2.5%	1	0.7%							5	1.5%
11A	tool n.s.	impressed	54	33.1%	12	8.1%	3	23.1%	2	33.3%			71	20.7%
11B		incised	8	4.9%	3	2.0%							11	3.2%
12A	fingertip	impressed	1	0.6%	9	6.0%					4	30.8%	14	4.1%
13	finger-nail	impressed	1	0.6%	1	0.7%					1	7.7%	3	0.9%
14A	skulptured band		20	12.3%	44	29.5%	2	15.4%			4	30.8%	69	20.1%
14B	*crètes*				1	0.7%							1	0.3%
14C	*pastilles*				6	4.0%	1	7.7%					7	2.0%
15	coloration		5	3.1%	7	4.7%	1	7.7%					13	3.8%
16	incrustration		6	3.7%	2	1.3%							8	2.3%
Σ Cardium decorations (1A+3A)			13	8.0%	13	8.7%	2	15.4%	2	33.3%	3	23.1%	33	9.6%
Σ impressed decorations (1 to 12A+13)			88	54.0%	61	40.9%	7	53.8%	5	83.3%	9	69.2%	170	49.6%
Σ incised decorations (7 to 11B)			44	27.0%	24	16.1%	2	15.4%	1	16.7%			71	20.7%
Σ rocker stamp decorations (C, i.e. only 7C)					4	2.7%							4	1.2%
Σ skulptured decorations (14A to C)			20	12.3%	51	34.2%	3	23.1%			4	30.8%	77	22.4%
Σ coloration/incrustration (15+16)			11	6.7%	9	6.0%	1	7.7%					21	6.1%
Σ decorations			163	100%	149	100%	13	100%	6	100%	13	100%	343	100%

Tab. 220 Frequency of decoration techniques in the pottery assemblages. VUs (vessel units) may be counted several times, because several decorations can appear on one VU (decoration techniques according to BINDER ET AL. 2010, 40 Fig. 15).

Fig. 52 Selection of pottery with impressed decoration analyzed in this study (cf. **Tab. 221**).

Fig. 53 Selection of pottery with impressed decoration analyzed in this study (cf. **Tab. 221**).

Fig. 54 Selection of pottery with impressed decoration analyzed in this study (cf. **Tab. 221**).

Fig. 55 Selection of pottery with impressed decoration analyzed in this study (cf. **Tab. 221**).

Fig. 56 Selection of pottery with sculptured decorations analyzed in this study (cf. **Tab. 221**).

VU 591

VU 585

1 cm

Fig. 57 Selection of pottery with impressed decoration analyzed in this study (cf. **Tab. 221**).

Fig. 58 Selection of pottery with impressed decoration analyzed in this study (cf. **Tab. 221**).

Fig. 59 Selection of pottery with incised decoration analyzed in this study (cf. **Tab. 221**).

VU 259

Fig. 60 VU with incised decoration and colored interior (cf. **Tab. 221**).

Fig. 61 Selection of pottery with incised decoration analyzed in this study (cf. **Tab. 221**).

Fig. 62 Colored pottery (cf. **Tab. 221** and **Fig. 44**).

VU	site	decoration						struc-ture	Fig.	VU	site	decoration						struc-ture	Fig.
		techniques			motifs							techniques			motifs				
11	Car	9B			E1	B1		A11	Fig. 59	279	Car	3A			B1	H3		A13	Fig. 52
178	Car	9B	16		E1	B1		A11	Fig. 59	281	Car	3A			D1	B1		A13	Fig. 52
183	Car	14A			E1			A11	Fig. 56	282	Car	3A	11A		E1	B1	H3	B	Fig. 55
191	Car	9B	11B	15	E1	D5		A11	Fig. 61	289	Car	7A	14C		B1	A1		A11	Fig. 56
194	Car	7A			B1	E1		*n.s.*	Fig. 54	307	Car	7A			B1			A13	Fig. 52
217	Car	9B			E1			A11	Fig. 59	337	CNP	11A	14A		B1	E1		A11	Fig. 58
252	Car	3A			D2	B3		A1	Fig. 53	349	CNP	8B			E1			A11	Fig. 59
254	Car	1A	3A		B3			A11	Fig. 52	353	CNP	14A	8A	9B	E1	A1		A11	Fig. 58
255	Car	7A			D2	E1		A11	Fig. 54	358	CNP	7B	11A		E1	A1		A11	Fig. 58
257	Car	7A	11A		D2	D1	B1	B	Fig. 54	380	CNP	9A			A1			A11	Fig. 58
259	Car	7A	9B	15	D2	D1	E1	A13	Fig. 60	381	CNP	1A	9B		E1	B1		A11	Fig. 59
260	Car	3A	11A		B1	E1		A13	Fig. 54	428	CNP	9B			D5			A	Fig. 61
261	Car	3A	15		D2	D1	E1	B	Fig. 55	432	CNP	15						B	Fig. 62
262	Car	9B	15		E1	D5		A11	Fig. 61	443	CNP	3A	11A	16	D2	E1		A11	Fig. 53
263	Car	3A			E1	D1	H3	A11	Fig. 55	444	CNP	3A	15		D2	E1		A11	Fig. 53
264	Car	3A			D2	D1	B1	A13	Fig. 55	462	CNP	11A			A1			A11	Fig. 58
265	Car	14A	9B		E1	B1		A11	Fig. 54	464	CNP	11A	14A		E1	A1		A11	Fig. 56
266	Car	14A	12A		E1	B1		A11	Fig. 56	515	CNP	11A			B1			A11	Fig. 58
268	Car	9B	11A		A1	E1		A13	Fig. 59	526	CNP	9B	11B		D1	E1		A11	Fig. 59
271	Car	9B	11A		A1	D5	B1	A11	Fig. 61	585	CNP	10A			A1			A11	Fig. 57
272	Car	3A			H3	B1		A12	Fig. 52	591	CNP	9A	9B		A1	E1		A11	Fig. 57
273	Car	7A			D1	E1		A11	Fig. 53	593	CNP	9B			E1	D5	D2	C	Fig. 61
274	Car	7A			E1	D1		A11	Fig. 53	594	CNP	11A	14A		E1	A1		A11	Fig. 58
275	Car	7A			E1	B1		A13	Fig. 53	596	CNP	14A	11A		E1	A1		A11	Fig. 56

Tab. 221 List of the VUs displayed in **Fig. 52** to **Fig. 62** (cf. database available in NESPOS 2013 associated with the DOI 10.12853/RESDB.NESPOS.0001). For decoration techniques, motifs and decoration structure cf. **Tab. 218** to **Tab. 220**.

5.5. Similarities in pottery decoration: Sequence as defined by correspondence analyses (CA)

Pottery decoration techniques and motifs occur variously combined on the VUs. When applying CAs, one can expect clusters of similar VUs. However, the dispersal and determination of the underlying gradient is a matter of interpretation or needs to be verified by further evidence.

Applied statistics are supposed to provide objective data. Prior data processing and preparation offer a relatively broad range of possible opportunities for data selection, disqualification of outliers, combination, input in and thus results of the CA. Additionally, the results have to be interpreted exploratively according to their catalysts. The latter could be chronological, spatial, social or other *already existing, elaborated* models.

Using correspondence analyses (CA), I analyzed the similarity in the pottery decoration (decoration technique and motif) on the level of the VUs. The following short introductory comment is based upon personal explanations and the CA-blog manuscript by ROTH (2011a with references therein). The CAs were conducted in R Statistical Computing (R DEVELOPMENT CORE TEAM 2011) with the package "ca" (GREENACRE/NENADIC 2010). The R-script, underlying data and specific values are provided in **Appendix to the statistic evaluation of the pottery**.

5.5.1. Definition and general approach

A CA orders units/VUs according to the similarity or similar occurrences of their attributes or attribute composition/decorations. In archaeology, this method has been applied to types, features, sites etc. and their characteristics. It must be pointed out that the final distribution can be due to different causes, such as chronology (usually parabola dispersal, in detail see ROTH 2011a), origin (sites, levels or features), traditions, preferences etc. For the pottery decorations, vessel forms, decoration structures or varying producers could also be imaginable reasons. A condition for the interpretation is the correlation and integration of results within existing models verified by other parameters such as absolute dating, stratigraphy or conclusions from other finds and so on.

Underlying matrices for the CA consist of occurring attribute combinations, i.e. of absolute frequencies of cases or presence and absence (1/0) of attributes. In this study, the combinations of absent and present ceramic decoration techniques and motifs on VUs are analyzed. VUs are listed in rows. Columns comprise decoration technique, motifs, etc. Outliers such as scarce attribute compositions and single attribute occurrences have to be eliminated (in sub rows/columns) because they would differ completely from the apparently very similar rest and would dominate and distort the CA result.

The attribute combinations in rows and columns were then related to an ideal "average row/column" by their dissimilarity/distance and arranged within a seriation table. The dissimilarities were captured and united in a multidimensional scatter plot. The associated axes are supposed to provide the best possible cover of the included information variation, i.e. comprise the biggest expansion of the scatter plot and thus allow most or substantial attributes and cases to be represented on the first and second main axis. The information was subsumed by a minimum of new variables (axes) and thus reduced (for the exact processing and calculation see ROTH 2011a). The first axis displays the biggest variety and the following axes comprise decreasing dissimilarity. VUs with several decorations and a big difference to the "average cell" (a high mass) severely influence the arrangement and location of the axes and are thus well represented on the particular axes.

Finally the data is summarized and plotted in a two-dimensional graph along the main axes. Clusters and sequences can be interpreted. Principal and standard coordinates of VUs (row point) and decoration attributes (motifs, techniques etc.; column point) scale both phenomena in the same system. Thus, VUs and decoration attributes can be evaluated together and concerning their proximity and position: Neighboring VUs imply a similar attribute composition, whereas nearby column points indicate a corporate occurrence on VUs. The positions of row (VUs) and column points (pottery decorations) represent the occurrence of distinct pottery decorations on vicinally located VUs. Marginal VUs are dominated by single neighboring attributes. Data sets similar to the "average" are located near the zero point (for underlying theory see ROTH 2011a).

Finally the CA-result displays a relative order according to a certain triggering gradient.

5.5.1.1 Evaluation of CA-results: Specific values

Specific values, i.e. their amount, concerning the CA-axes and especially concerning VUs and attributes displayed on the first and second axes have to be considered weighted within the interpretation of the CA-biplot (for a detailed explanation see ROTH 2011a). The specific values are enclosed in **Appendix to the statistic evaluation of the pottery** and the subsequently mentioned abbreviations can also be found there.

The amount of principal inertia concerning each axis provides information on the quality of the CA, i.e. how much of the variation/dissimilarity in the point scatter is displayed on each axis. The inertia of axis 1 and 2 should explicitly exceed the values that can be expected with the equal distribution over all axes (e.g. 7 axes: 100%/7=14.3% per axis cf. **Fig. 63**).

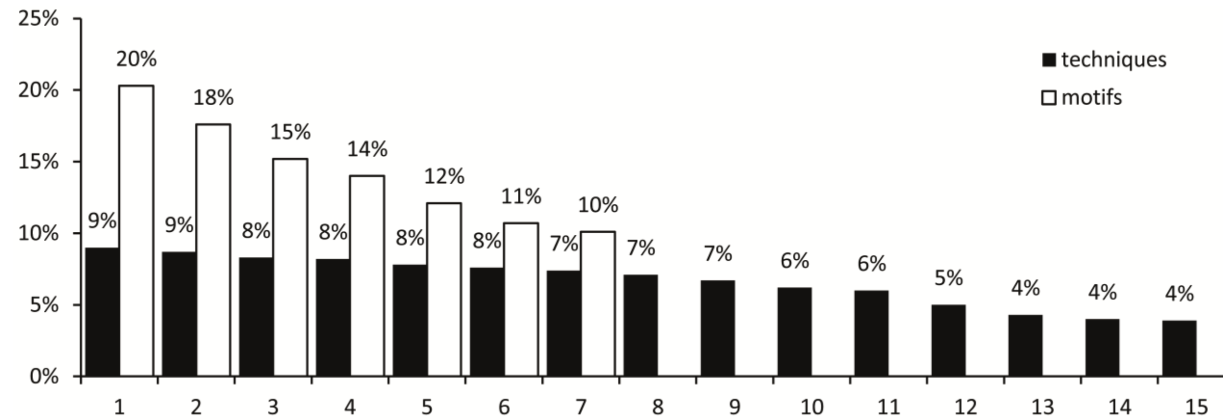


Fig. 63 Percentages of inertia on CA-axes of pottery decoration techniques (black) and axes of motifs (white).

The mass expresses the impact a cell has on the CA. Its influence rises according to its dissimilarity to the average (in ‰; high mass signifies high impact).

The quality (qlt in ‰; sum of correlation of axis 1 and 2) of the representation provides information on the amount of inertia/dissimilarity as captured by axis 1 or 2. Comparably high values imply good representation on the first and second main axes, i.e. dissimilarities of these cells are well represented and the position of the points should be given more weight in the interpretation of the biplot. Qlt consists of the correlation of row or column inertia with the inertia of axis 1 (cor1) or 2 (cor2), which in turn specify the quality regarding one of those axes.

The inertia (inr) of each VU and attribute describes its distance to the "average cell": the higher the inertia (in ‰, between 1 and *here:* number of columns -1), the higher the dissimilarity. A low inertia expresses similarity. Each row and column contributes with its inertia to the total inertia of axis 1 (ctr1) and 2 (ctr2, sum of both=inr). High values signify high contribution, whereas a low inertia implies hardly any contribution to the distinct axis.

For additional and detailed information, I refer to the CA-blog manuscript by G. ROTH (2011a).

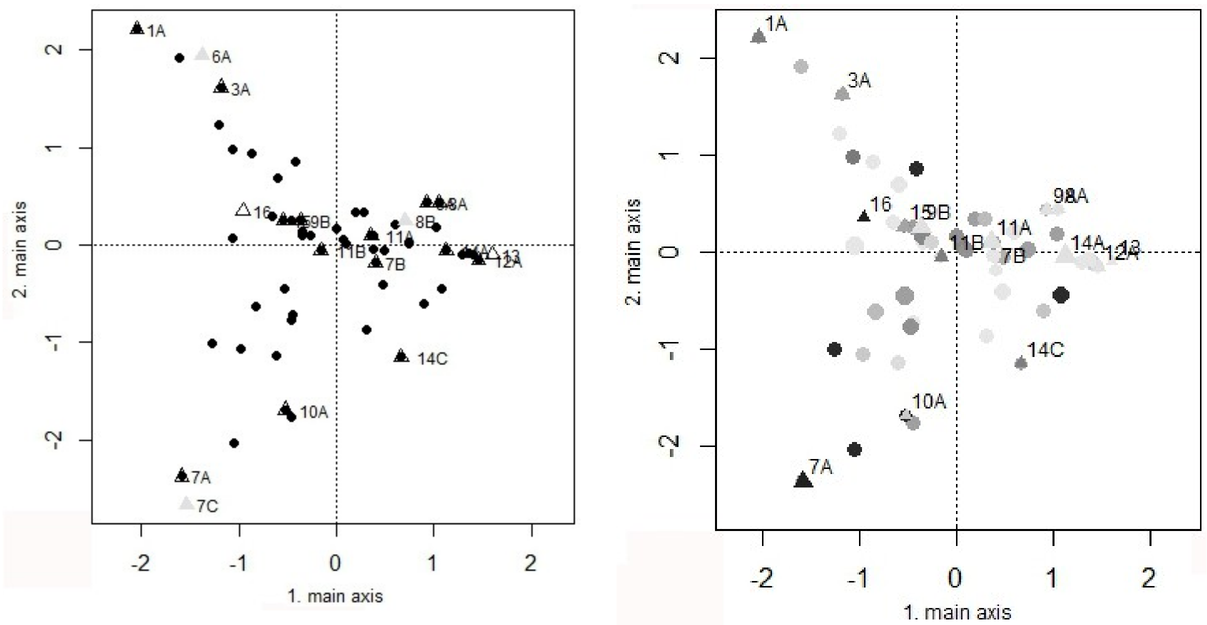
5.5.2. CA of SE Spanish pottery decoration

Pottery decoration techniques and motifs in combination with each other and with decoration structure and vessel forms are analyzed.

5.5.2.1. CA of pottery decoration techniques

Decoration techniques 8B (*point mousse trainé*) and 14B (*plastique crètes*) appear only once on VUs 48 and 349. These VUs were eliminated from the dataset for the CA. The CA was applied on 234 VUs and 18 techniques. Further outliers with very few occurrences were also kept in sub rows and -columns and did though not influence the CA-results (decoration techniques 7C /comb rocker stamp and 6A/impressions by a non-denticulated shell and accordingly VUs 166, 190 and 308).

Despite these omissions, the inertia of axis 1 and 2 is only 17.6% (9% and 8.7% see **Fig. 63**, black bar plot). This dispersal already indicates a weak result: Only relatively little information could be summed up within axis 1 and 2. The current data set of decoration techniques appears to be difficult to order, and thus the result calls for cautious interpretation.



A B

Fig. 64 CA-biplots of pottery decoration techniques on VUs (quadrant I of the coordinate systems equals the top right corner and quadrants II-IV are numbered from there on anticlockwise). **A** – VUs (black dots, principal row coordinates) are plotted within the decoration techniques (triangles, standard column coordinates). Outliers and individual occurrences are plotted in light gray and do not influence the result. **B** – Similar scatter as in A, but weighted: The intensity of grayscale implies the contribution of the dots and triangles to the first and second main axis, while their size indicates their mass.

The biplot (**Fig. 64**) displays a big accumulation spreading out in two directions influenced on the one hand by 7A (comp impression) and on the other hand by 1A and 3A (Cardium impressions). These two attributes pull the main group with all other decoration techniques apart. It appears that the cluster possibly follows the tool used for decoration: In the top of quadrant II (x<0 and y>0) lie different shells and near its zero point colorations, whereas decorations applied by hand are located in quadrant IV (x>0 and y<0) and comb in quadrant III (x<0 and y<0). So far, a trend is shown by the tools used. Any further trigger remains ambiguous.

Thus, with the current amount of data a CA on decoration techniques is not reasonable. But with additional sites a CA on the level of sites and amounts of decoration techniques could provide interesting results as MANEN (2002) already evaluated for SE France.

5.5.2.2. CA of pottery decoration motifs

Except for VUs with coloration and without motif (VUs 432, 445, 541), all other decorated VUs were included in the motifs' CA. All motifs occurred several times, between eight and 140 times on VUs, and could thus all be included. Almost 40% of the CA-variation is captured on the first two axes with inertias of 20.3% and 17.6% (cf. white bar plot in **Fig. 63**) and promise sufficient quality of the CA.

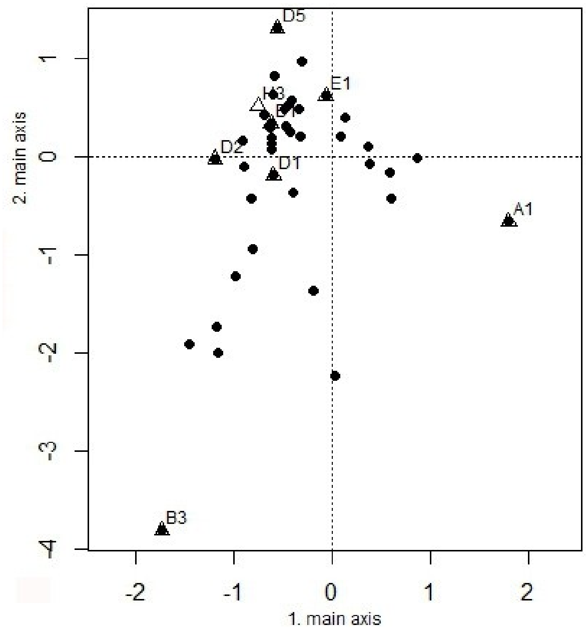
The biplot of the first and second main axes (**Fig. 65Fig. 66**) shows a slightly parabola-like dispersal from one side with horizontal linear motif B3 (on 19 VUs) along a peak (around D5) with an agglomeration of motifs (D1, D2, B1, H3, E1) with parallel occurrences and similar VUs to the other branch of the parabola on the right and the motif A1 (single dots on 81 VUs). This tendency remains constant when the less occurring motifs D5 (on 11 VUs) and H3 (on eight VUs), and thus VU 428, are excluded.

The VUs often lie one upon the other (**Fig. 65C**). VUs 128 and 306 of Car/GR are underneath the focal point between the branches of the "parabola". These VUs are the only VUs with both motifs B3 and A1 (apart from VU 999 additionally with motifs B1 and E1). Both VUs have a high quality of representation (VU 128 with 916‰ vs. VU 306 with 801‰) especially concerning axis 2 (ctr2 916 vs. 787).

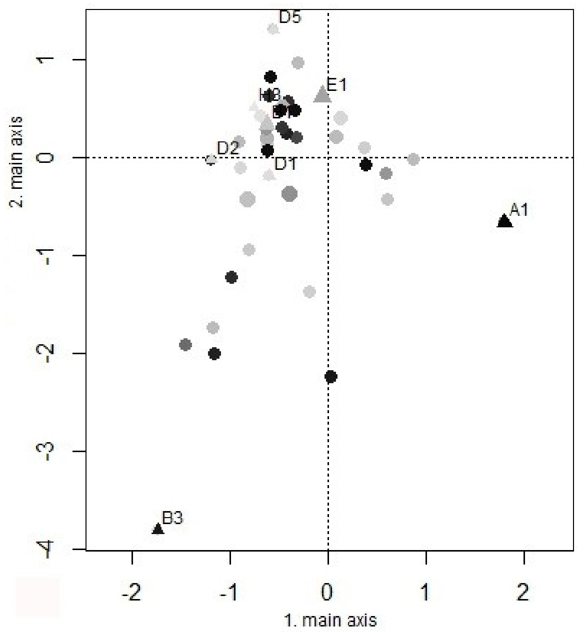
Obvious gradients driving the dispersal could be an internal Early Neolithic chronology or affiliation of VUs to sites and thus spatial differences. Currently with the available VUs, I cannot verify whether this collocation is driven by time. The only site with an Early Neolithic internal stratigraphy (from bottom to top levels XVI to XIV) and valid absolute datings is Car/GR. But, as displayed in **Fig. 66**, the VUs present a similar preference of motifs regardless of the level. E1 predominates on more than 60% of the VUs in level XVI, XV, XIV or in total, followed by B1 (>40%), D1 and A1 (each 10-20%). Thus, based on the present data available in this study, an internal chronological division of the Early Neolithic can not be supported by a CA. Further pottery recording with this catalogue of attributes (cf. **Tab. 207**) and analyses from sites along the Mediterranean Spanish coasts promise outputs comparable to the studies of MANEN (2002).

With the available data, a spatial gradient seems unlikely: No clusters corresponding to E and W nor provinces can be identified. In contrast the VUs dedicated to the sites are scattered over the whole CA-dispersal (cf. **Fig. 67**).

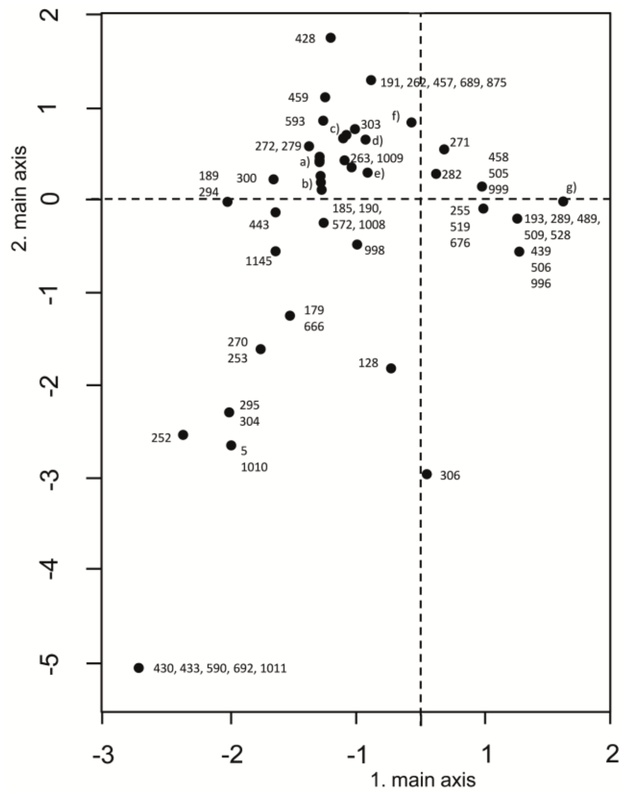
Finally the CA result seems to be predominantly shaped by the 105 Car/GR VUs. A CA of only the 109 VUs of CNP/MA shows a completely different dispersal (**Fig. 68** cf. with CA of Car/GR in **Fig. 66** and motif-CA of all VUs displayed in **Fig. 65**) and motif B3 is obviously an outlier due to missing combinations with any other motifs (VUs 430, 433, 590, 666 and 692 have only B3-motif).



A



B



C

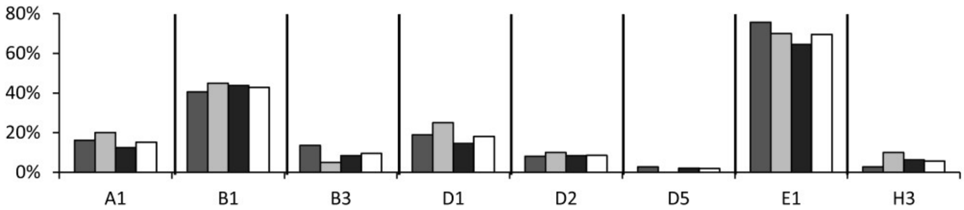
Fig. 65 CA-biplots of pottery decoration motifs on VUs. **A** – VUs (black dots, principal row coordinates) are plotted within the motifs (triangles, standard column coordinates). **B** – Similar scatter as in A, but weighted: The intensity of grayscale implies the contribution of the dots and triangles to the first and second main axis, while their size indicates their mass. **C** – Overlapping VUs are displayed in standard coordinates: a) 48, 72, 151, 166, 184, 221, 223, 307, 308, 310, 429, 488, 508, 515, 559, 564, 566, 569, 688, 1007/1/256, 444, 570; b) 257, 264/259, 261/281, 315; c) 690/1012; d) 2, 3, 11, 178, 180, 181, 182, 187, 194, 219, 258, 260, 265, 266, 267, 275, 276, 287, 290, 291, 337, 381, 455, 490, 510, 532, 561, 571, 582, 589, 993; e) 76, 192, 273, 274, 280, 286, 312, 389, 435, 524, 526, 573, 597; f) 30, 35, 54, 59, 60, 62, 101, 103, 116, 159, 176, 183, 186, 217, 269, 277, 278, 283, 284, 285, 292, 293, 298, 299, 301, 302, 305, 309, 313, 314, 349, 408, 426, 437, 493, 577, 583, 902, 985; g) 6, 14, 81, 268, 296, 297, 311, 347, 353, 358, 379, 384, 431, 464, 516, 521, 525, 546, 565, 568, 574, 591, 594, 596, 903.

Neither the plotting of axis 1 vs. 2 nor of 2 vs. 3 produced useful results. Points scatter broadly without obviously visible clustered dispersal.

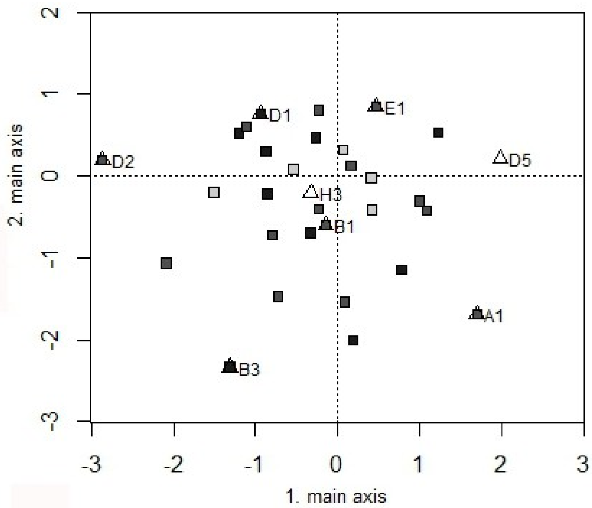
A CA of VUs and motifs in combination with either positive connoted decoration structure or vessel form provided rather weak CA results with 20-25% inertia on axes 1 and 2 of 15-16 columns and broad point accumulations without sequence. The same is true for combinations of several attributes such as decoration, techniques, motifs, decoration structure or vessel forms.

Thus, VUs and motifs provide a promising CA dispersal, but currently the trigger remains ambiguous.

MOTIF	A1		B1		B3		D1		D2		D5		E1		H3		Σ VU/
Car	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	level*
■ XIV (top)	6	16.2%	15	40.5%	5	13.5%	7	18.9%	3	8.1%	1	2.7%	28	75.7%	1	2.7%	37
□ XV	4	20.0%	9	45.0%	1	5.0%	5	25.0%	2	10.0%	0	0.0%	14	70.0%	2	10.0%	20
■ XVI (bottom)	6	12.5%	21	43.8%	4	8.3%	7	14.6%	4	8.3%	1	2.1%	31	64.6%	3	6.3%	48
□ Σ motifs	16	15.2%	45	42.9%	10	9.5%	19	18.1%	9	8.6%	2	1.9%	73	69.5%	6	5.7%	105



A



B

Fig. 66 Car/GR. Amounts (**A**) and CA (**B**) of motifs on VUs associated with the Early Neolithic levels XVI to XIV (from bottom to top; excavation Pellicer 1960; *reference amount).

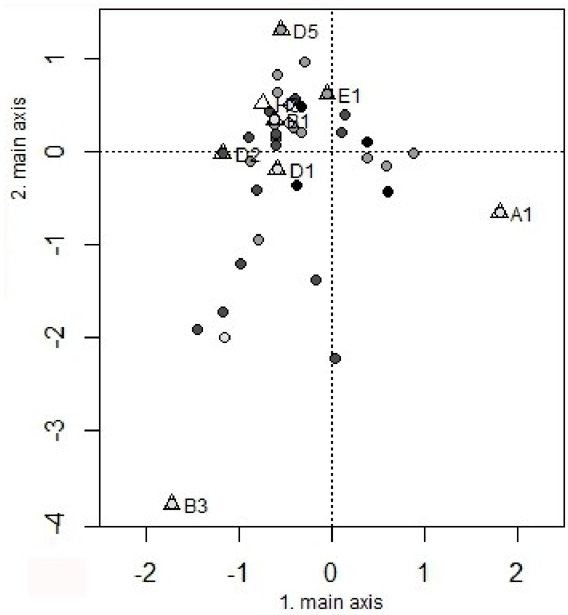
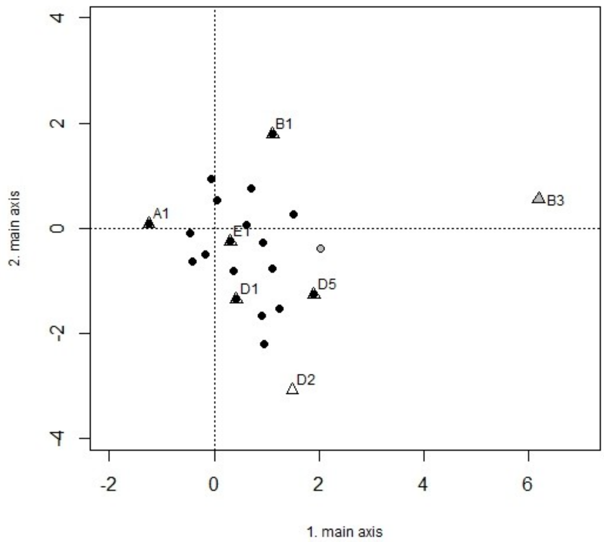


Fig. 67 CA-biplot of pottery decoration motifs on VUs. VUs (dots, principal row coordinates) are colored according to their affiliation to a site and plotted within the motifs (triangles, standard column coordinates): A6/MA in black-gray, Car/GR in dark gray, CNP/AL in gray and Got/GR in light gray. The lightest gray dots of HC/MU are superimposed and mostly not visible (cf. **Fig. 65**C VUs 1-6).



A

MOTIF	*n*	%
A1	58	53.2%
B1	28	25.7%
B3	5	4.6%
D1	14	12.8%
D2	4	3.7%
D5	7	6.4%
E1	56	51.4%
Σ VU*	109	

B

Fig. 68 CNP/AL. CA (**A**) and amounts (**B**) of motifs on VUs (*reference amount). Outliers B3 and associated five VUs (overlapping empty circles) are plotted in without influencing the biplot.

5.6. Conclusion: The pottery assemblages as indicators of the Neolithization process

Pottery as a clear Neolithic element could offer insights into the active agents of the Neolithization and – regarding its attributes – possibly also into the dispersal route or regional groups.

Pottery was dispersed in the whole working area, technically perfected and manifold and frequently utilized since its introduction in SE Spain, and it completely lacks a transitional character. In the assemblages studied here, the ceramic was apparently skillfully built and presents the full range of forms and decorations and implies a consolidated and common use. Thus, this could be a concrete contribution of Early Neolithic settlers in the Neolithization process. However, the scale of migration remains ambiguous: At the very least, single immigrating individuals are necessary to account for the versatility of pottery use and formal variety that is reflected in the record. Furthermore, Early Neolithic groups could have colonized the area with their extensive knowledge and accomplished skills. Or intermediate scenarios are possible.

The mineralogical analyses of samples from CNP/AL and raw material studies by H. Müller-Sigmund and M. Harmath (Institute for Geosciences of the University of Freiburg i.Br./Germany) offer great potential for approaching the mobility or networks between various raw material origins (**5.3. Raw materials: Mineralogical and chemical analyses of pottery and clay deposits**). To some extent, people gathered clays of metamorphic and volcanic resources in the surroundings of CNP/AL and tempered it, possibly intentionally. Additionally, regional deposits were exploited. Currently, clay variances point to sources in 20-40km distance at Cabo de Gata (cf. footnote **3**: clay source needs to be verified!). This could imply either a regional mobility and semi-sedentary lifestyle of the settlers or a circulation of (goods transported in) vessels between those regions. However, a combination of both scenarios is possible, too, i.e. an inclusion of individuals from other groups or the “mix” and subsequent re-partition of several groups.

As can be seen in the comparison of attributes (**5.4. Descriptive analyses**), the pottery assemblages currently present both commonalities and a number of variances. These differences possibly represent the needs or favors of the settlers of the different sites. Overall similarities exist within this range according to wall thicknesses, diameters of the opening, vessel forms, decoration structure, technique (dominance of impressed decoration) and motifs. Nevertheless, neither grouping nor local unities become apparent.

The same is true for the correspondence analyses (cf. **5.5. Similarities in pottery decoration: Sequence as defined by correspondence analyses (CA)**). Thus, a spread of the pottery or certain pottery characteristics remains incomprehensible. No internal chronology or regional dispersals of certain ceramic attributes became feasible.

In summary, I conclude that the mobility and semi-sedentariness emerging from the clay origins and the consolidated overall impression arising from the pottery finds indicate the small-scale immigration of groups or individuals with professional pottery skills. With regard to the lithic tradition, they assumingly merged into one community with Epipaleolithic mobile groups.

6. New radiocarbon dates

Not only are there very few absolute radiocarbon datings to determine the Neolithization in SE Spain (cf. **2.2. Chronology**), but also very few appropriate samples are available: No organic remains are preserved (Got/MA and HC/MU) or the preserved fragments are too small (AM and CZ/MU) or insufficient for dating (CNP/AL, pers. comm. D. Martín Socas; AL/MU). Other organic remains stem from dubious stratigraphies or are no more assignable to specific levels (CA/AL; CH, Hoz/both in MU). The available bone fragments of CA/AL are very small, and I could not determine their original levels. In AL/MU, a dating of a Magdalenian sample produced a totally wrong age due to a translocation or contamination. So a dating of further samples appears pointless (pers. comm. M. Martínez Andreu). In CH and Hoz/both in MU the stratigraphy remains ambiguous (concerning all mentioned sites cf. **SITE GAZETTEER** with references).

Finally, I collected only bone samples from A6/MA and Car/GR. Those were sub-sampled, treated and dated in the AMS laboratory of Cologne/Germany (Institute for Geology, J. Rethemeyer). The samples are listed with the Cologne laboratory number (COL) in **Tab. 222** and **Tab. 223**.

ZILHÃO (2011, 47-48) evaluated the quality of samples. The ranks 1 to 4 indicate "unambiguous indicators of the presence of at least specific elements of the Neolithic package" (ZILHÃO 2011, 49). Currently, on the Iberian Peninsula, there are very few samples of such a high rank dating to the Neolithic period and older than 7300 calBP (ZILHÃO 2011, 50 Fig. 3.1). In the working area, he mentioned only one age of Ner/MA. Additionally only half of the samples presented here are of rank 1 (samples with COL-1550; COL-1560, COL-1561, COL-1563 to COL-1567), while the rest is of lower ranking (samples with COL-1551 to COL-1559 and COL-1562). Besides the samples of domesticated sheep and goat, also the bones of cattle and pig are likely to stem from domesticated sources, because of their small size (pers. comm. R. Hutterer).

The subsamples COL-1554, COL-1551 and COL-1558 did not contain any collagen and were treated as carbonates (pers. comm. J. Rethemeyer). Finally only the samples listed in **Tab. 224** provided sufficient amounts of carbon for datings.

Most Early Neolithic samples of Car/GR (COL-1561.1.1, COL-1560.1.1, COL-1567.1.1, COL-1566.1.1 cf. **Tab. 224**) support the previous absolute chronological determination and vary between 7440-7060 calBP (outermost extreme values including the standard deviations). The two similar ages of COL-1561.1.1 and COL-1567.1.1 validate the data correctness. The already existing age of Car/GR without cultural affiliation (Pta-9163: 6260±20 14Cyrs BP, 7210±30 calBP; FERNÁNDEZ ET AL. 2007, 81 Tab. 3) fits within this scatter. In contrast the other two ages (Pta-9162: 5690±30 14Cyrs BP, 6470±40 calBP and Beta-141049: 5470±90 14Cyrs BP, 6250±110 calBP; FERNÁNDEZ ET AL. 2007, 81 Tab. 3) are too young (cf. **2.2. Chronology**).

COL-1565.1.1 of the lowest Neolithic level XVI with a calibrated age of 7620±30 calBP (cf. **Tab. 224**) is apparently too old. This could be due to contamination, too. Only with additional similar old datings can an earlier beginning of the Early Neolithic be postulated and future research will unfold this. With a dating in the 7th millennium calBP, the Early Neolithic sample COL-1562.1.1 is obviously an outlier, too. The age would fit to a younger Neolithic occupation, which is also evident in Car/GR. So, this bone could have been somehow dislocated from superior levels. Furthermore, the two ages COL-1563.1.1 and COL-1564.1.1 of a supposedly Middle Neolithic origin (levels XII and XIII; cf. **SITE GAZETTEER**: **Cueva de la Carigüela/Granada** with references) are by far too old. The explanations mentioned before could be also true for these two samples. Alternatively, COL-1564.1.1 could indicate a wrong relative classification of level XIII. Thereby one should have the Valencian relative Neolithic chronology with Neolithic I and II (cf. **2.1. Overview** and **2.2. Chronology**) in mind. Transferred to Car/GR, it would mean a cancelation of the Middle Neolithic and different division, i.e. the mentioned sample could be added to the Early Neolithic I. Therefore, the material culture of the Middle Neolithic has to be considered.

COL N°	YEAR	SECTION	LEVEL	STAGE	W (g)	SPECIES	DEPOSITORY
COL-1550	1983	*Tramo A corte 1*	7, NV 60-75 cm	E NEO	17,6	Cattle	*MM, No Inv 12350 caja 24*
COL-1551	1983	*Tramo A corte 2*	7	E NEO	5,2	Horse ?	*MM, No Inv 12350 caja 24 (caja 20)*
COL-1552	1983	*Tramo A corte 2*	7	E NEO	2,9	?	*MM, No Inv 12350 caja 24 (caja 19)*
COL-1553	1986	*Tramo A corte 1*	8, NV 75-80 cm *cerramiento cueva ?*	EPI	12,7	?	*MM, No Inv 12350 caja 24*
COL-1554	1986	*Tramo A corte 1*	8, NV 60-75-80 cm, *cerramiento del Tramo A*	EPI	8,4	?	*MM, No Inv 12350 caja 24*
COL-1555	1986	*Tramo A corte 1*	*contacto* 8-9, NV 75-80 cm, *cerramiento de cueva*	EPI/MAGDA	33,1	Horse ?	*MM, No Inv 12350 caja 24*
COL-1556	1983	*Tramo A corte 2*	8	E NEO/EPI	1,2	Rabbit	*MM, No Inv 12351 caja 25 (caja 21)*
COL-1557	1983	*Tramo A corte 2*	*contacto* 8-9, *contacto tierra gris-roja inferior*	E NEO/EPI	11,1	?	*MM, No Inv 12351 caja 25 (caja 23)*
COL-1558	1983	*Tramo A corte 2*	6, *tierra gris-oscura o "gran nivel de hogares" o "2a nivel de hogares"*	M NEO	7,1	?	*MM, No Inv 12351 caja 25 (caja 15)*
COL-1559	1983	*Tramo A corte 1*	6, NV 40-60 cm, *tierra gris-oscura o "gran nivel de hogares"*	M NEO	7,6	?	*MM, No Inv 12351 caja 25 (caja 16)*

Tab. 222 Abrigo 6/MA: Selection of samples for radiocarbon datings (COL N° = number of AMS Cologne; cultural stages E or M NEO = Early or Middle Neolithic, EPI = Epipaleolithic, MAGDA = Magdalenian; W = weight in gram; MM = Museo de Málaga; stages after RAMOS FERNÁNDEZ 2004b, 52 Fig. 1; determination of species by R. Hutterer).

COL N°	YEAR	SECTION	LEVEL	STAGE	W (g)	SPECIES	DEPOSITORY
COL-1560	1960	*pasillo* D/area G ?	XIV	E NEO	16,6	Sheep	*MG, caja 2040*
COL-1561	1960		XIV	E NEO	13,8	Pig	*MG, caja 2040*
COL-1562	1960		XVI	E NEO	10,8	Sheep/goat	*MG, caja 2034*
COL-1563	1960		XII	M NEO	19,5	Sheep/goat	*MG, caja 2069*
COL-1564	1960		XIII	M NEO	9,6	Sheep	*MG, caja 2072*
COL-1565	1960	CIII, corridor N-1	XVI	E NEO	35,6	Cattle	*MG, caja 2073*
COL-1566	1960	CIII, corridor N-1	XV	E NEO	4,5	Sheep/goat	*MG, caja 2073*
COL-1567	1960	CIII, corridor N-1	XV	E NEO	11,2	Sheep	*MG, caja 2073*

Tab. 223 Cueva de la Carigüela/GR: Selection of samples for radiocarbon datings (COL N° = number of AMS Cologne; cultural stages E or M NEO = Early or Middle Neolithic; W = weight in gram; MM = Museo de Málaga; stages after NAVARRETE 1976 and MARTÍNEZ FERNÁNDEZ 1985; determination of species by R. Hutterer).

	DATING					SAMPLE		SITE	EXCAVATION			STAGE
Lab-N°	14C-yrs BP	± 1σ	Δ13C ‰*	calBP	± 1σ	MATERIAL	SPECIES		YEAR	SECTION	LEVEL	
COL-1559.1.1	11673	53	-25.2	**13570**	**90**	bone	?	**A6**	1983	A trench 1	6	M NEO
COL-1552.1.1	10620	48	-23.1	**12660**	**40**	bone	?	**A6**	1983	A trench 2	7	E NEO
COL-1556.1.1	5759	38	-19.5	**6570**	**60**	bone	rabbit	**A6**	1983	A trench 2	8	E NEO/EPI
COL-1563.1.1	6950	40	-23.6	**7780**	**50**	bone	sheep/goat	**Car**	1960	corridor D/area G ?	XII	M NEO
COL-1564.1.1	6316	39	-22.4	**7240**	**50**	bone	sheep	**Car**	1960	corridor D/area G ?	XIII	M NEO
COL-1561.1.1	6224	32	-22.4	**7140**	**80**	bone	pig	**Car**	1960	corridor D/area G ?	XIV	E NEO
COL-1560.1.1	6350	32	-18.3	**7290**	**30**	bone	sheep	**Car**	1960	corridor D/area G ?	XIV	E NEO
COL-1567.1.1	6225	39	-16.0	**7140**	**80**	bone	sheep	**Car**	1960	CIII, corridor N-1	XV	E NEO
COL-1566.1.1	6482	39	-23.9	**7390**	**50**	bone	sheep/goat	**Car**	1960	CIII, corridor N-1	XV	E NEO
COL-1562.1.1	5611	31	-21.3	**6380**	**50**	bone	sheep/goat	**Car**	1960	corridor D/area G ?	XVI	E NEO
COL-1565.1.1	6749	39	-24.3	**7620**	**30**	bone	cattle	**Car**	1960	CIII, corridor N-1	XVI	E NEO

Tab. 224 Radiocarbon dates of Abrigo 6 Complejo del Húmo (A6)/Málaga and Cueva de la Carigüela (Car)/Granada sorted according to descending stratigraphic levels and stages (M/E NEO=Middle/Early Neolithic; EPI=Epipaleolithic) with conventional 14C-age (uncalBP, Stuiver/Polach 1977) and calibrated values (calBP; calibrated with CalPal, Weninger/Jöris/Danzeglocke 2011) and standard deviations (σ; *measured with AMS, not comparable to stable isotope ratio-MS measurement due to different isotopic fractionation, pers. comm. J. Rethemeyer).

Unfortunately the age determinations of samples from A6/MA are without exception difficult. Even during the pretreatment of the bones, it became obvious that most of the samples lack a sufficient amount of collagen or afterwards carbon (cf. samples in **Tab. 222** with **Tab. 224**). The ages listed in **Tab. 224** and their affiliation to cultural levels demonstrate strong inconsistencies. COL-1559.1.1 and COL-1552.1.1 are both far too old with Magdalenian ages, even though they originated from Middle and Early Neolithic levels. In contrast, the third dating COL-1556.1.1 of the Epipaleolithic-Early Neolithic transition is much younger than expected. These ages are all likely to be wrong, possibly as a result of bioturbation (sample bones are without anthropogenic traces and rabbit bone) or other post depositional displacement processes. Suitable cultural levels (Magdalenian or Middle Neolithic, respectively, cf. **Tab. 17**; RAMOS FERNÁNDEZ 2004b, 52 Fig. 1) are present in the rock shelter. Apart from that, a contamination is of course also possible, or an incorrect determination of the cultural levels.

Altogether the treatment of 18 samples (**Tab. 222** and **Tab. 223**) provides only a very low yield of 11 new ages (**Tab. 224**), whereof finally only four (COL-1561.1.1, COL-1560.1.1, COL-1567.1.1 and COL-1566.1.1) correspond to the relative chronology. This unfolds general problematic preservation conditions and is probably also one reason for the scarce number of absolute datings in the research area.

Nevertheless those new ages support the time frame of the Neolithization further (**Fig. 69** cf. **Fig. 3**).

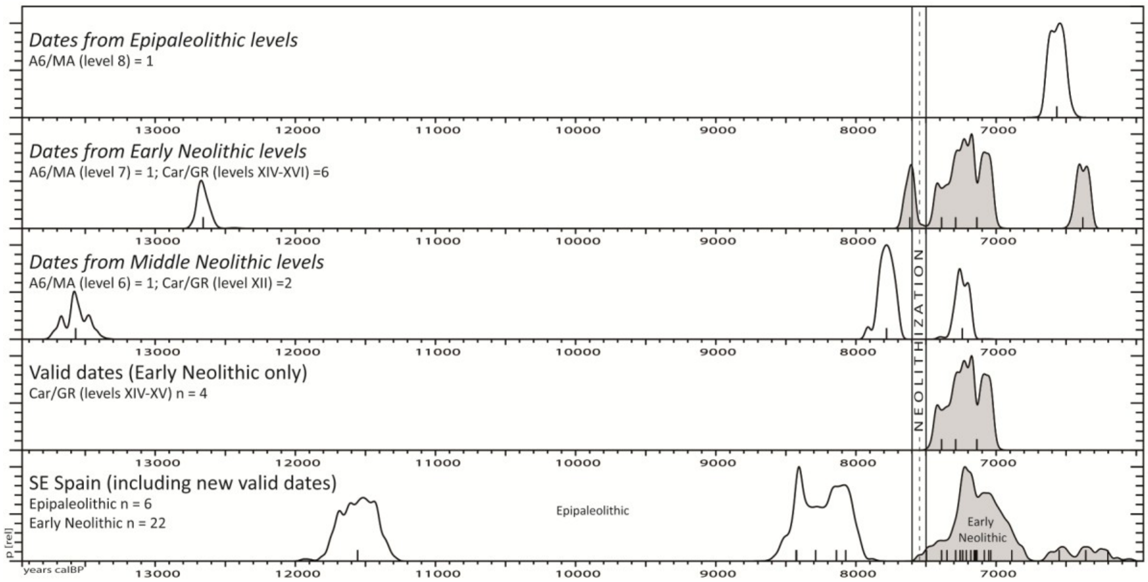
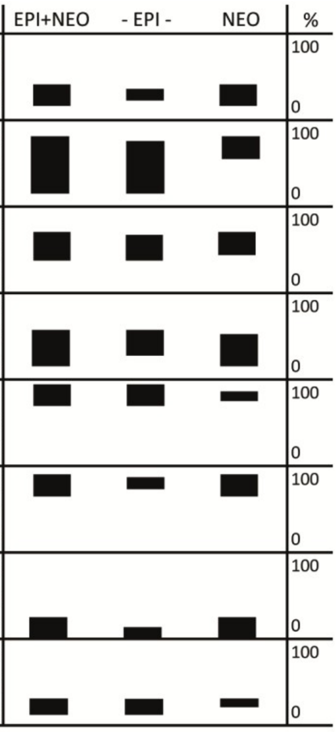


Fig. 69 Calibration of the new dates (cf. **Tab. 224**) and inclusion in the existing ages and relative chronological scheme (calBP; calibrated with CalPal, WENINGER/JÖRIS/DANZEGLOCKE 2011; datings gathered till 06/2011; references see **Tab. 1** to **Tab. 3** and cf. **2.2. Chronology** with **Fig. 3**). Early Neolithic graphs are shaded.

7. Results

7.1. Archaeological evidence: Results of the lithic and pottery analyses

%-RATIOS		EPI+NEO	EPI	NEO
cortex	*min*	14.2%	20.9%	14.2%
	max	39.8%	34.6%	39.8%
	Ø	28.1%	28.4%	27.3%
heat treatment	*min*	13.2%	13.2%	52.8%
	max	78.5%	73.1%	78.5%
	Ø	43.0%	34.1%	63.6%
flakes	*min*	35.6%	35.6%	41.9%
	max	68.1%	64.8%	68.1%
	Ø	56.1%	54.8%	59.1%
blades	*min*	13.0%	25.8%	13.0%
	max	56.2%	56.2%	51.2%
	Ø	32.3%	34.3%	27.6%
non-modified flakes	*min*	67.9%	67.9%	73.1%
	max	92.4%	92.4%	84.1%
	Ø	82.2%	83.7%	78.5%
artifacts with diffuse bulb	*min*	65.7%	74.4%	65.7%
	max	90.9%	90.9%	77.9%
	Ø	72.5%	83.2%	72.2%
artifacts with impact ring	*min*	0.6%	0.7%	0.6%
	max	9.8%	7.9%	9.8%
	Ø	3.4%	3.2%	3.8%
tools	*min*	9.1%	9.1%	18.1%
	max	28.0%	27.9%	28.0%
	Ø	19.4%	17.3%	24.2%
Ø L blades (*mm*)	*min*	19.00	19.00	22.20
	max	45.40	28.30	45.40
Ø WI blades (*mm*)	*min*	7.4	7.4	9.1
	max	19.6	12.6	19.6
Ø WE blades (*g*)	*min*	0.6	0.6	0.6
	max	7.8	1.9	7.8



Tab. 225 Minimum, maximum and mean (Ø) amounts and ranges (bars) in all assemblages, only Epipaleolithic (EPI) and only Early Neolithic assemblages (NEO, L = length; WI = width; WE = weight).

The attribute comparisons of the lithic assemblage give the impression of general variable expressions of the examined characteristics (**4.5. Comparative characterization of the reduction sequences**). The amounts of blanks, tools, technological attributes, etc. fluctuate. The extreme and mean amounts are listed in **Tab. 225** and accordingly the bars show the range. However, the amounts overlap each other broadly and are apparently similar. Only the amounts of heat treatment demonstrate a strong increase in the Early Neolithic assemblages. Nevertheless, generally such variances could occur within one cultural facies[4] and depend on various mechanisms such as exchange, availability of sources, character of the sites, individual preferences, etc.

The applied statistical tests (Chord-, Hellinger-distance matrices, Adonis algorithm and Mantel test) indicate a weak but significant correlation of the location of the site in the E or W of the working area and thereby changes in the blank and tool composition (r^2=0.25-0.3 with 1 being a good correlation; **4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra**).

[4] Exemplarily comparable ratios fluctuate also broadly in between settlements of Rhenish Linear Pottery: 18.3-58.7% artifacts with cortex; 3.8-27.6% artifacts with thermal treatment; 31.1-79.1% flakes; 19.2-61.1% blades; 6.9-72.2% tools. The variability is likely due to the systematic flint exchange (cf. ZIMMERMANN 1995).

The analyzed pottery assemblages present technically perfect and variable expressions of pottery forms and decorations. The mineralogical determination of temper types in CNP/AL points to at least seven different raw material origins (by H. Müller-Sigmund and M. Harmath of the Institute for Geosciences of the University of Freiburg i.Br./Germany; **5.3. Raw materials: Mineralogical and chemical analyses of pottery and clay deposits**). People picked metamorphic, dacitic/rhyodacitic and lamproitic temper material from the local surrounding in the Betic basement, the Vera basin and the Antas river valley. Alternatively VUs consist of andesitic and metamorphic temper material with garnets. These materials originate from regional sources in 20-40km distance in Cabo de Gata (cf. footnote **3**: clay source needs to be verified!) or further in the hinterland of the Betic basement. Extrapolated to the whole assemblage, approximately 25% of the VUs stem from regional origins.

The **5.4. Descriptive analyses** (concerning pottery) and the correspondence analyses (**5.5.2. CA of SE Spanish pottery decoration**) did not provide any clustering and the trigger of the CA-dispersal remains unknown.

7.2. The Neolithization of SE Spain

Subsequently I address the questions listed in **1. Approach and research questions**. A regional Neolithization model – focused on *the research area* – is elaborated. It is based on the above mentioned currently available archaeological evidence and is detailed further in each listed subdivision.

1. Neolithic elements and the lifeway probably dispersed, partially filtered, via networks (Network model), reciprocal, small-scale exchange between individuals, meetings (Social model ?) and by people moving (Cardial model/Maritime Pioneers; Dual model; concerning the models cf. **Tab. 7** and **Fig. 71**). Several hints for such processes are given (cf. **4.4.1.6. Exchange** and **5.3. Raw materials: Mineralogical and chemical analyses of pottery and clay deposits**). People exchanged the new goods and spread the technological knowledge not only orally but also as a part of a small-scale migration. People from one group using Neolithic elements could have moved on and introduced pottery and pottery techniques completely elaborated without an initial phase of trial and error. The move of people could be due to marriage or due to joining together or other splitting and re-union process of groups. The mobility of the groups supports the dispersal of the Neolithic:
    1.1. The diachron occupation of the same sites, similar site types, similar topographic site-locations, the integration in a ritual landscape, subsistence, mobility, lithic technology and typology demonstrate a continuity and tradition between Epipaleolithic and Early Neolithic (Network model, Dual model). Additionally, increasing or partial sedentariness, variable animal husbandry, farming to varying extents and pottery are completely new elements that occur only in Early Neolithic inventories. The pottery appears completely elaborate without having prototypes in the Epipaleolithic, whereas the essential innovations of animal husbandry and agriculture were not consolidated in the Early Neolithic (Cardial model, Maritime Pioneers cf. **Tab. 7**; **Fig. 71**).
    But generally, Epipaleolithic and Early Neolithic are *not* separated by a rupture in the archaeological record. Moreover, the Epipaleolithic residue in the Early Neolithic is obvious, and people gradually adapted the new Neolithic lifestyle during the Early Neolithic stage (Dual model, Network model, Social model cf. **Tab. 7**; **Fig. 71**). The Neolithization of the working area obviously did not cause immediate, revolutionary changes as in other regions

(e.g. the German Rhineland) but initiated a gradual change. This elongated process is also likely to be related to difficult environmental conditions.

In conclusion, the Early Neolithic of SE Spain can currently be considered as the transitional period from hunting and gathering to Fullneolithic farmers – instead of the Epipaleolithic as an intermediate stage. The acceptance and impact of the Neolithic lifestyle on the landscape increased in subsequent Neolithic and following periods.

1.1.1. The sites are heterogeneously dispersed over the working area. First of all, the number and occurrence of Epipaleolithic and Early Neolithic sites varies. Epipaleolithic assemblages are 1.5-times more frequent than Early Neolithic assemblages. The ratio is 3:2. Nevertheless, four sites with more or less continuous occupations from Epipaleolithic to Early Neolithic demonstrate a certain spatial continuity. (But Ner/MA demonstrates a 200 to 300-year gap, and in the other sites absolute chronological depth in between the stages is questionable; cf. **3.1.2.5. Evaluated sites and archaeological characterization**).

    Epipaleolithic sites dominate in Murcia. In contrast, only two Early Neolithic sites – and not Epipaleolithic sites at all – are known from Granada. A general settlement gap is detected between Almería and Granada (this is likely to be due to the difficult environmental conditions or the state of research).

    Epipaleolithic and Early Neolithic groups settled in several differing topographical situations. Typical Epipaleolithic or Early Neolithic locations of sites do *not* exist. People occupied places near the coast, on foothills or in river valleys in the hinterland. Open-air sites are located on hill tops (cf. **3.4. Paleoenvironmental contextualization of the sites**).

    Regarding the site type, caves and rock shelters are mainly present in the records (about four times as much as open-air sites). The open-air sites belong *mostly* to an Early Neolithic context, but this situation is probably caused by research foci and preservation conditions. Du/MA is the only preserved example of an Epipaleolithic open-air settlement.

    Regardless of the type, people obviously occupied the places seasonally and repetitively in the manner of ephemeral camps to exploit available resources (e.g. prey, plant food, rocks, malacofauna, clay and temper materials) and to practice crafts. Mineralogical analyses of pottery fragments confirm the exploitation of predominantly local, but also regional, sources with a distance of up to 40km.

    People lived in the long-term, traditional *ritual landscape* with cave art, i.e. caves, and rock shelters with Paleolithic rock art were re-occupied. However, only Early Neolithic communities maintained this with additional own paintings.

    Subsistence was based on hunting, gathering and exploitation of marine resources. In the Early Neolithic sites people also kept animals and farmed to different intensities. So in this regard, Epipaleolithic and Early Neolithic sites are similar with varying supplementations in Early Neolithic sites. Thus, obviously various grades of mobility and (partial) sedentariness are mirrored in the record. Corresponding features are rarely preserved, fragmented and difficult to interpret (cf. **3.1. Sites**, **SITE GAZETTEER** and **5.3. Raw materials: Mineralogical and chemical analyses of pottery and clay deposits**).

1.1.2. Besides similar lithic assemblages, pottery appears in the working area only in Early Neolithic inventories.

Ground stone tools occur regularly in assemblage of both stages. Stone arm rings are a striking difference in Early Neolithic assemblages: Fragments are regularly present in six of the eigth compared assemblages and completely absent during the Epipaleolithic (cf. **3.1.2.5. Evaluated sites and archaeological characterization** with **Tab. 20**). Generally objects of personal adornment are slightly more frequent in Early Neolithic assemblages. Axes or adzes also occur solely in Early Neolithic assemblages, yet they are rare within only three inventories.

1.1.3. Obviously the initial pottery occurred quickly without a (tangible) time-gradient in the whole research area. Moreover, it occurred in a consolidated manner. Indications of a stepwise introduction of pottery are missing, and a subdivision of the Early Neolithic is – based on the present data in the research area – impossible. A small-scale immigration of groups or skilled potters from neighboring regions is likely (cf. **5. Pottery**).

1.1.4. Epipaleolithic and Early Neolithic lithic assemblages do not strictly differ, but fluctuate within a stage and diachrone: The stages of the *chaîne operatoire* are similarly represented in the studied assemblages and obviously similar mobility patterns exist: Nodules are barely present. People conducted blank production on all sites in situ and imported additionally (pre-)prepared cores, blanks and tools. Besides knapping, people also conducted handcrafts and repaired tools on-site. Tools with several tool endings and non-modified artifacts with macroscopically visible use traces imply an intensive realization.

The blank and tool spectra do not vary chronologically (cf. **4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra**). A clearly visible Early Neolithic innovation is one sickle in CNP/AL (cf. **4.4. Descriptive analyses: Reconstruction of the reduction sequence (*chaîne operatoire*)**).

2. The present study unfolds tendencies that have to be verified by future research. However, generally a culture-environment interaction is likely and changes in the environmental conditions prepared the way for subsistence changes in the working area (**3.3.3. Culture-environment interaction**). SE Spain is a difficult habitat subdivided into several microregions with differing environmental conditions. The climate is Mediterranean arid with severe fluctuations of fresh water availability that depends mostly on precipitation. The Neolithization is roughly parallel to an aridification phase between 7800 and 7300 calBP (**3.3. Early to Middle Holocene climate and vegetation**). This climate and inhospitable mountainous landscapes (**3.2. Topography** and **3.4. Paleoenvironmental contextualization of the sites**) could have prevented radical, revolutionary changes and the quick acceptance of the Neolithic in SE Spain.

2.1. No apparent clusters are visible (**4.4. Descriptive analyses** [lithic artifacts] and **5.4. Descriptive analyses** [pottery]). Statistics did not provide significant results (**4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra** and **5.5.2.2. CA of pottery decoration motifs**).

However, the location of the site in the W or the E of the research area seems to cause differences in blank and tools spectra. This finding could support a direction of the Neolithization from E to W – according to the current dispersal models (cf. **2.3. The Neolithization of the W Mediterranean in its European context**). Additionally, blank and tool spectra tend to vary due to their bioclimatic zone (cf. **5.5. Grouping by intra-assemblage similarities: Distances within blank and tool spectra**). But future research has to validate this interpretation.

2.2. The correspondence analyses clustered the pottery decoration, but the trigger remains ambiguous (cf. **4.5.2.2. CA of pottery decoration motifs**).

2.3. Current available evidence allows a characterization of the transitional phase – i.e. the Early Neolithic – as a growth-phase (r) within an adaptive cycle on the macro-scale (**Fig. 71**; cf. **2.3. The Neolithization of the W Mediterranean in its European context**): Similar material culture (lithic artifacts, pottery), broad networks (indicated by pottery raw materials), small scale immigration (indicated by Neolithic innovations) and innovations (pottery, pastoralism, agriculture, sickles, increasing heat treatment of lithic artifacts) are typical characteristics of an r-phase (cf. **Tab. 8**). Apparently, hunter-gatherer introduced migrators (fussion) and new technologies and created a new combined hunting-gathering*+farming* lifestyle as best adaptation to the difficult environment with micro-regions of different conditions and aridification phases. This indicates a high resilience and a pioneering spirit (cf. *pre-adaptation* AURA TORTOSA ET AL. 2001, 34). Furthermore, a probable specialization in handcrafts (e.g. in CNP/AL) may to some extent imply the slow gradual transition to the K-phase, when the Neolithic lifestyle became dominant. However, also the previous Epipaleolithic remains provide slight hints of an r-phase: Generally similar material culture and sites, no specialization, assumed networks, integration in a *ritual landscape* and tolerance/resilience to innovations.

Further evidence characterising a complete cycle is currently not available. In particular there is a lack of comparable data of several succeeding, accurately classified, short periods (i.e. of a generation or the like cf. example in **Tab. 8**).

3. The dating of collected samples produced a low number of new ages. However, four valid additional 14C-ages spread between 7500-7000 calBP and support the beginning and time frame of the Early Neolithic (**6. New radiocarbon dates**).

   The dating attempts reflect existing issues. Organic material is hardly available or it is not unambiguously assignable to a distinct level. Apart from that, one has to consider post-depositonal displacements or contamination.

Thus, networks, partial migration, adoption of Neolithic elements by hunter-gatherers, exchange and transcontinental contacts promoted the Neolithization of SE Spain (Network, Dual, Cardial, Maritime Pioneer, Social, and African origin model cf. **Tab. 7** and **Fig. 71**).

7.3. Context and outlook

If one puts the regional Neolithization of SE Spain in a broader context, one can, of course, still consider that domesticated animals and seeds reached the W Mediterranean – i.e. initially Liguria and SE France – via exchange. The initiation of agriculture was due to oral transfer of ideas. But currently a proportional agency of early farming communities and migration is more likely and favored by the Dual Model as an explanation of the supra-regional phenomenon (cf. **2.3. The Neolithization of the W Mediterranean in its European context**): On the one hand the care of domestic animals and the initiation and maintenance of annual agricultural cycles (i.e. field preparation, seeding, harvesting etc.) was labor-intensive and required long-term regularity and endurance. In contrast, Epipaleolithic settlers conducted their maintenance activities in a more flexible way planning and foreseeing over several months, e.g. at preparations for drought periods or for the winter. Assumingly, all this requires at least a few migrating people to demonstrate, integrate and consolidate the process in the hunter-gather way of life. These migrators do not have to originate from the Middle East, but could have come from a connecting region (the Balkans, Greece, Italy, S France or the Spanish Levant), where the Neolithic was already established. Furthermore, the expression of the Early Neolithic lifestyle was different in the NE neighboring region of the working area in Valencia. The lifestyle was apparently more consolidated and stronger regional patterns existed. Apart from that, differing processes (migration, adaptation, etc. cf. **2.3. The Neolithization of the W Mediterranean in its European context**) can be considered for other regions.

For the working area, the currently available archaeological evidence indicates that hunter-gatherers predominantly adapted Neolithic innovations during the Early Neolithic period. In the same manner, (as described in items **1.** and **1.1.** in **7.2. The Neolithization of SE Spain**) the Neolithic dispersed further on to Morocco, E Andalusia and Portugal and became possibly recomposed (Recomposition of the Neolithic package cf. **2.3. The Neolithization of the W Mediterranean in its European context**).

In fact, in NE Morocco, assemblages differ not only chronologically but apparently also in relation to their location on the coast, in the interior, or in various bioclimatic zones. Future research comparing SE Spain with the Moroccan dataset (LINSTÄDTER/WAGNER in press) will shed further light on transcontinental influences.

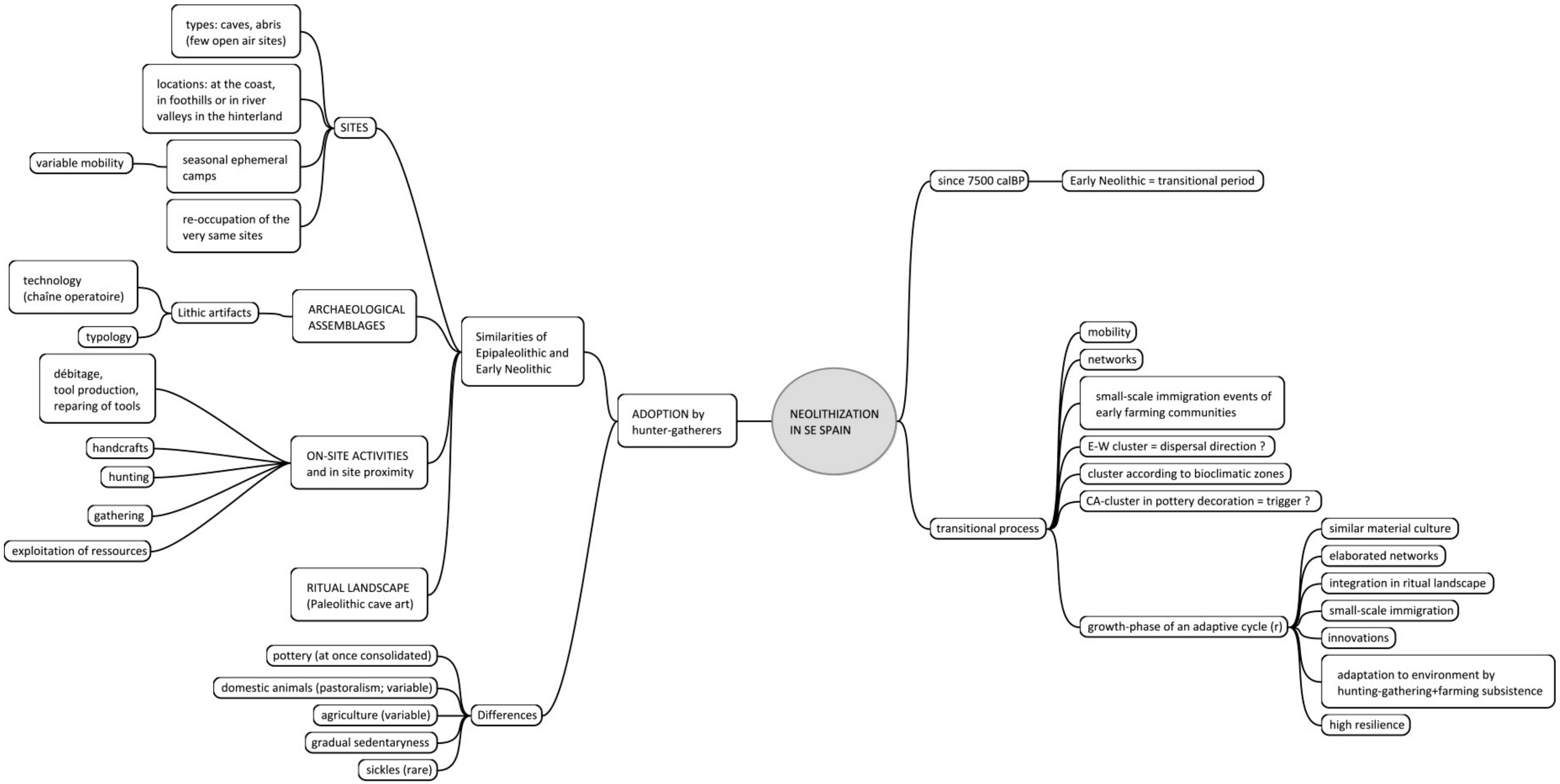


Fig. 70 Summary of results relating to research questions in **Fig. 2**.

8. Summary

Continuity vs. Discontinuity

Epipalaeolithic and Early Neolithic in the Mediterranean Southeast of the Iberian Peninsula

PhD-thesis in the frame of CRC 806 "*Our Way to Europe*", project C2 "*Early Holocene Contacts between Africa and Europe and their Palaeoenvironmental Context*" funded by the *DFG*.

Keywords: Neolithization, SE Spain, attribute comparison, culture-environment interaction, pottery mineralogy, radiocarbon ages.

This study deals with the Neolithization process on a regional scale in SE Spain. The narrow chronological and spatial focus on the Epipaleolithic-Early Neolithic transition in Murcia, Almería, Granada and Málaga is a unique characteristic of this study. I studied 10 lithic inventories and vessel units (VUs) of five pottery assemblages of Epipaleolithic and Early Neolithic origin and recorded them systematically in a database (cf. **4.1. Recorded attributes** [lithic assemblages] and **5.1. Recorded attributes** [pottery]) available in NESPOS 2013 associated with the DOI 10.12853/RESDB.NESPOS.0001. Attribute comparisons and selected statistical analyses are used to detect continuity or discontinuity in the assemblages of this transition.

Specific questions about the Neolithization process – especially concerning the agency – are addressed in **1. Approach and research questions**. The short **2.1. Overview** of the research locates this study within related studies conducted in the working area. The cultural chronology is confusing with a variety of circulating denominations and different structuring approaches. The lack of radiocarbon ages is severe: In the research area only six dates are available from Epipaleolithic context (**2.2. Chronology**). Eighteen reliable ages stem from Early Neolithic contexts.

Several Neolithization models (**2.3. The Neolithization of the W Mediterranean in its European context**) offer various scenarios to model the transition. Intermediate positions and combinations of these models provide additional perspectives. These models and combinations were tested against to archaeological evidence from the working area. It can be assumed that environmental conditions and differing bioclimatic zones influenced the transition (**3.2. Topography**; **3.3. Early to Middle Holocene climate and vegetation** cf. **3.4. Paleoenvironmental contextualization of the sites**).

The recorded inventories consist of variable numbers of artifacts ranging from only 91 up to 1613 lithic artifacts or from six to 674 VUs. The following sites provide Epipaleolithic (EPI) and/or Early Neolithic (NEO) lithic assemblages: Cueva del Algarrobo, Abrigo del Monje, Cueva Higuera, Cueva de los Zagales, Barranco de la Hoz/all EPI and Murcia; Cueva Ambrosio (EPI) and Cabecicos Negros (NEO)/both in Almería; Cueva de la Carigüela (NEO)/Granada and Abrigo 6 (EPI and NEO)/Málaga (cf. **4.2. Correction and data set** [lithic assemblages]). I recorded VUs of the following Early Neolithic contexts: Hondo de Cagitán/Murcia, Cabecicos Negros/Almería; Cueva de la Carigüela/Granada; Abrigo 6 and Cueva de las Goteras/Málaga (cf. **5.2. Correction and data set** [pottery]). The selection of these finds is discussed in **3.1. Sites**, and the sites are presented detailed in the **SITE GAZETTEER**.

As far as the lithic attributes are concerned, Epipaleolithic and Early Neolithic industries show variable frequencies within a stage and diachrone (**4.3. Raw material** and **4.4. Descriptive analyses: Reconstruction of the reduction sequence (*chaîne operatoire*)** with a summary in **4.5. Comparative characterization of the reduction sequences**). So far *no* chronological rupture is obvious. The lithic

assemblages point to a continuous transition, i.e. with the beginning of the Neolithic, hunter-gatherers obviously adopted Neolithic elements. This must not be the only mechanism, but it was most likely the dominating process.

An alternative grouping of the lithic blank and tool assemblages according to coastal-/interior site-location or bioclimate did not provide clear results. I tested this with Chord- and Hellinger-distance matrices, the Adonis algorithm and Mantel test in R Statistical Computing (**4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra** with references). The trend is that the location in the E or W of the research area was relevant for variations in blank and tools spectra. Possibly this is connected to potential Neolithization directions (cf. **2.3. The Neolithization of the W Mediterranean in its European context**) from the NE to the S/SW of the Iberian Peninsula.

Compared with the lithic analyses, the foundation for pottery analyses can be described as poor: Only five reliable assemblages were available. Only two include a sufficient data amount of several hundred VUs. Nevertheless, pottery production and style was apparently fully consolidated and people used different raw materials: The mineralogical analyses of samples from CNP/AL conducted by H. Müller-Sigmund and M. Harmath (Institute for Geosciences of the University of Freiburg i.Br./Germany) unfolded great potential (**5.3. Raw materials: Mineralogical and chemical analyses of pottery and clay deposits**). The pottery discovered in CNP/AL stems from at least seven different origins. People mainly collected the clay and temper material close to the site. Furthermore, probably about 25% of the VUs carry temper material that could stem from a 20-40km distant sources at Cabo de Gata (cf. footnote **3**: clay source needs to be verified!) and another distant origin in the Betic Cordillera. This demonstrates mobility and inter-regional contacts.

Pottery attribute comparisons show overall similarities, but also differences (**5.4. Descriptive analyses**). However, no regional groups and no other grouping have become obvious so far. Correspondence analyses (CAs) of the pottery decorations are also ambiguous (**5.5.2. CA of SE Spanish pottery decoration**). Even though decoration motifs disperse nicely in clusters, the trigger behind the dispersion could not be determined. Nevertheless, comparisons with other sites and especially with the Moroccan assemblages are auspicious.

The clay origins and the consolidated overall impression of the pottery indicate a small-scale immigration of groups or individuals. With regard to the lithic tradition, they assumingly merged with Epipaleolithic mobile groups.

The before mentioned low number of radiocarbon ages is apparently caused by various issues. Despite a large sampling effort in this study only A6/MA and Car/GR provided sufficient, reliable samples and about 20 of those were dated in the AMS laboratory of Cologne/Germany (Institute for Geology, J. Rethemeyer). However, only four ages are reliable (**6. New radiocarbon dates)**. They range roughly between 7500-7000 calBP, verifying the initiation time of the Neolithic in SE Spain.

Within the Neolithization of the whole Mediterranean, migratory processes of early farming communities were certainly involved and left behind spots with a consolidated Neolithic lifestyle on the route to the W. However, in SE Spain, Early Neolithic re-occupations of several very same sites as in the Epipaleolithic, similar site types, *ritual landscape*, subsistence, mobility and tradition in lithic technology and typology demonstrate continuity and a strong Epipaleolithic residue in the Early Neolithic (cf. **7.2. The Neolithization of SE Spain**). Amongst the Neolithic elements, only pottery was really consolidated, whereas animal husbandry, farming and sedentariness occurred only marginally and heterogeneously. On the one hand, these unstable occurrences might be an indication of an introduction of these elements predominately by networks and exchange and only to a small extent by people moving from neighboring regions, group splitting and re-union processes. On the other hand hunter-gatherer groups may have adopted these elements. Rough environmental conditions could have prevented the quick acceptance of the Neolithic in SE Spain and permitted a gradual change. Variable micro-regions string locally together and severe fluctuations in fresh water supply and aridification phases (e.g. around 7800-7300 calBP) are characteristic. All these qualities match within the r-phase (growth) of an adaptive cycle on a macro-scale (cf. item **2.3.** in **7.2. The Neolithization of SE Spain**). The newly combined hunting-gathering+*farming* lifestyle and adaptation to the difficult environment imply a high resilience.

In conclusion, the Early Neolithic in SE Spain seems to be the true transitional intermediate stage from hunting-gathering to subsequently Fullneolithic farming. The Neolithization of SE Spain combines various elements of available models (Network, Dual, Cardial, Maritime Pioneers, Social and African origin model, cf. **Tab. 7** and **Fig. 71**). Similarities to NE Morocco are indicated and will have to be tested in future research with the Moroccan dataset to shed further light on transcontinental influences.

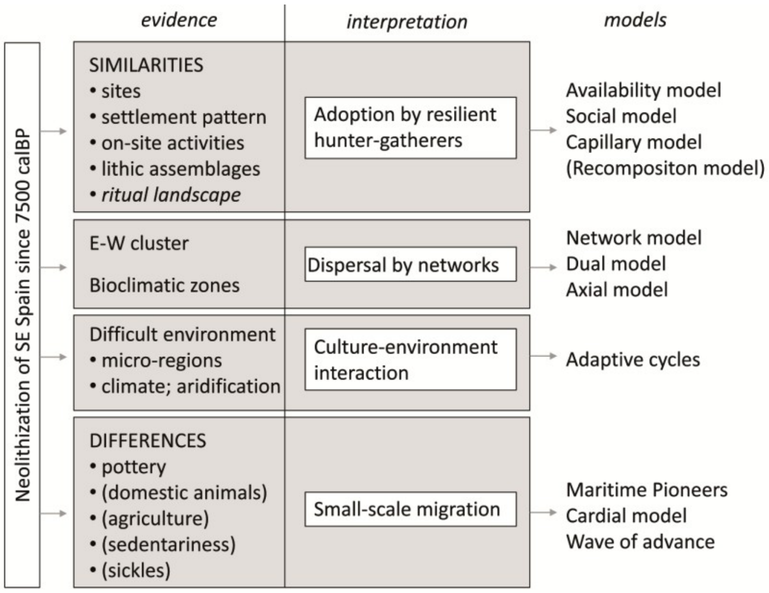


Fig. 71 Neolithization of SE Spain: Evidence and models (cf. **Fig. 70**, **Tab. 7** and **Tab. 8**).

SITE GAZETTEER

Abrigo 6 del Complejo del Humo/Málaga
Abrigo del Monje/Murcia
Abrigos del Pozo/Murcia
Barranco de la Hoz/Murcia
Cabecicos Negros-El Pajarraco/Almería
Cueva (de) Ambrosio/Almería
Cueva del Algarrobo/Murcia
Cueva Bajondillo/Málaga
Cueva de la Carigüela/Granada
Cueva de la Higuera/Murcia
Cueva de las Goteras/Málaga
Cueva (de) Nerja/Málaga
Cueva de los Zagales/Murcia
El Duende/Málaga
Hondo de Cagitán/Murcia
Los Castillejos/Granada

Tab. 226 Alphabetical list of the sites included in the **SITE GAZETTEER**.

In the following gazetter, site-related information provides an overview of the studied and compared assemblages listed in **Tab. 226**. The information categories listed in **Tab. 227** were registered; information is summarized on the literature references given. The assemblages recorded are generally characterized in overview tables and comments concerning the recording are given. The datasets are also included in the database that is available in NESPOS (2013) associated with the DOI 10.12853/RESDB.NESPOS.0001.

The database NESPOS PLEISTOCENE PEOPLE AND PLACES (2013) is another comprehensive data source. The site-related attributes of **Tab. 227** correspond to the site database assembled by other project members in the C1-project (cf. **Collaborative Research Center 806**).

Site and location		Name short: ID site:
Longitude:	Latitude:	
Altitude asl:	Orientation:	Distance to coastline:
Type of site:		
Publications:		
Observations:		
RECORDING		
Relevant stages:	Depository:	
Recorded artifacts:	Lithic IDs:	Pottery VUs:
Remarks:		
Summary tables of lithic and/or pottery assemblages recorded.		
SETTING		
DESCRIPTION		
RESEARCH		
CHRONOLOGY		
14C-ages:	Stratigraphy:	References:
Remarks:		
ARTIFACTS		
Lithic assemblage: (incl. references of figures).		
Pottery assemblage: (incl. references of figures).		
Ground stone tools: (incl. references of figures).		
Bone industry: (incl. references of figures).		
Faunal remains/fauna:		
Botanic remains:		
Other:		
FEATURES		
INTERPRETATION		

Tab. 227 Information summarized in the **SITE GAZETTEER**.

Abrigo 6 del Complejo del Humo/Málaga

La Araña

Name short: **A6**
ID site: **8**

Longitude:
4°19'5.60"W (UTM 382340)

Latitude:
36°42'48.34"N (UTM 4064113)

UTM-zone 30S

Altitude asl:
10-11m

Orientation:
to E

Distance to coastline:
today approx. 100m

Type of site:
cave

Publications:
RAMOS FERNÁNDEZ 2004a, b; RAMOS FERNÁNDEZ ET AL. 2005; http://www.complejohumo.org/abrigo_vi.html.

Observations:
A6 is located in the Archaeological Park "La Araña"/Parque Prehistórico de Málaga.

RECORDING

Relevant stages:
Epipaleolithic, Early Neolithic

Depository:
Málaga, Museo de Málaga

Recorded artifacts:
Lithic artifacts, pottery

Lithic IDs:
8000-8999 and 80000-89999

Pottery VUs:
991-1000

Remarks:
Only very few Early Neolithic vessels are present in the museum of Málaga. I.e. the amount of Early Neolithic pottery is very small or not all pottery is stored there yet. Apparently, the sherds do not contain mica.
Labeling of the artifacts: CH = Complejo del Humo; A6 = Abrigo 6; TA C1 = Tramo A; corte 1; NV 53 = ?; N 1478 = ?; (+ specification of the level on the labels).

EPIPALEOLITHIC

LITHIC ARTIFACTS		number			weight				
		Σ (n)	*%*	*ratio (% Σn)*	*Σ (g)*	*%*	*Ø (g)*	*SD*	*ratio (% Σg)*
Σ (reference amount)		491	100.0%		3021.2	100.0%	6.2	22.945	
chips		4		0% 100%					0% 100%
blanks	flakes	279	56.8%		1364.8	45.2%	4.9	9.404	
	blades	144	29.3%		277.9	9.2%	1.9	1.683	
	art. debris	53	10.8%		407.4	13.5%	7.7	8.975	
	pebbles	5	1.0%		732.9		146.6	173.386	
	cores	10	2.0%		238.2	7.9%	23.8	20.233	
	total with cortex	170	34.6%		2052.4	67.9%	12.1	38.019	
	non-mod. pieces	429	87.4%		2590.1	85.7%	6.0	24.286	
	burin spalls	3	0.6%		3.5	0.1%	1.2	0.058	
	tools	59	12.0%		427.6	14.2%	7.2	9.637	
flakes & blades	total	423	86.2%		1642.7	54.4%	3.9	7.823	
	complete*	150	35.5%		761.0	46.3%	5.1	11.625	
	dorsal reduction**	125	46.0%		400.7	34.0%	3.2	3.261	
		index	*ratio*		*index*	*ratio*			
	n flakes : n blades	1.9	02:01		4.9	05:01			
operation chain	0 RM procurment	5	1.0%		732.9	24.3%	146.58	173.3857	
	1 decortification	38	7.7%		206.0	6.8%	5.4	3.667	
	2 core preparation	37	7.5%		281.8	9.3%	7.4	19.305	
	3 débitage	248	50.5%		568.4	18.8%	2.3	2.230	
	4 repreparation	16	3.3%		84.9	2.8%	5.3	7.261	
	5 tools&use	190	38.7%		1189.8	39.4%	6.3	32.577	
	6 discarding	356	72.5%		1809.2	59.9%	5.1	10.408	

Tab. 228 A6 EPI/MA. Epipaleolithic lithic assemblage (weight in gram (g); *referring to total flakes and blades; **referring to flakes and blades with proximal ends: 272 pieces/1179.9g).

EARLY NEOLITHIC

LITHIC ARTIFACTS		number			weight				
		Σ (n)	*%*	*ratio (% Σn)*	*Σ (g)*	*%*	*Ø (g)*	*SD*	*ratio (% Σg)*
Σ *(reference amount)*		601	100.0%		3719.1	100.0%	6.2	9.651	
chips		21		0% 100%					0% 100%
blanks	flakes	409	68.1%		1927	51.8%	4.7	5.521	
	blades	78	13.0%		230.4	6.2%	3.0	2.632	
	art. debris	82	13.6%		593.7	16.0%	7.2	8.717	
	pebbles	14	2.3%		664.7		47.5	24.552	
	cores	18	3.0%		503.3	13.5%	16.9	8.446	
	total with cortex	238	39.6%		2317.8	62.3%	9.7	13.636	
	non-mod. pieces	492	81.9%		3104	83.5%	6.3	10.384	
	burin spalls	2	0.3%		4.3	0.1%	2.2	1.202	
	tools	109	18.1%		615.1	16.5%	5.6	5.191	
flakes & blades	total	487	81.0%		2157.4	58.0%	4.4	5.521	
	complete*	151	31.0%		662.7	30.7%	4.4	6.320	
	dorsal reduction**	92	33.2%		395.1	30.2%	4.3	6.220	
		index	*ratio*		*index*	*ratio*			
	n flakes : n blades	5.2	05:01		6.5	13:02			
operation chain	0 RM procurment	15	2.5%		675.2	18.2%	45.0	25.512	
	1 decortification	44	7.3%		302.4	8.1%	6.9	5.736	
	2 core preparation	24	4.0%		159.8	4.3%	6.7	7.431	
	3 débitage	220	36.6%		669.4	18.0%	3.0	2.764	
	4 repreparation	31	5.2%		159.8	4.3%	5.2	4.655	
	5 tools&use	214	35.6%		1410.1	37.9%	6.6	9.605	
	6 discarding	440	73.2%		2482.0	66.7%	5.7	6.794	

Tab. 229 A6 NEO/MA. Early Neolithic lithic assemblage (weight in gram (g); *referring to total flakes and blades; **referring to flakes and blades with proximal end: 277 pieces/1307.2g).

EARLY NEOLITHIC

POTTERY		number VUs		
		Σ (n)	*%*	*ratio (% VU)*
Σ VU *(reference amount)*		10	100.0%	
Σ sherds		610		
Ø sherds/ VU		2.0		0% 100%
VU	with rim frag.	4	40.0%	
	with definable DM		0.0%	
		cm		
	Ø DM	12		
shape	with definable shape	6	60.0%	
	shape not definable	4	40.0%	
	bottles*	3	50.0%	
	jars*	2	33.3%	
	small globular vessels*	1	16.7%	
decoration	decorated	5	50.0%	
	non-decorated	5	50.0%	
	n decoration techniques	11		
		index	*ratio*	
	n decoration techniques : n decorated VU	2.2	02:01	
	with impressed decoration**	5	45.5%	
	Cardium-impressed***	1	20.0%	
	with incisions**	2	18.2%	
	with sculptured bands**	2	18.2%	

Tab. 230 A6 NEO/MA. Early Neolithic pottery assemblage (*referring to VUs with definable shape; **referring to n decoration techniques; ***referring to VUs with impressed decoration).

SETTING

The cave is situated in Complejo del Humo between the districts of Málaga and Rincón de la Victoria. Various sites are located in the vicinity. A6 is on a cliff in the Málaga Bay and on the river Totalán (RAMOS FERNÁNDEZ ET AL. 2005, 520 Fig. 1).

DESCRIPTION

Despite the denomination as Abrigo, Fig. 2 of RAMOS FERNÁNDEZ (2004b) depicts the site as a cave with narrow entrances and corridors leading to three small chambers "*tramo* A", "B" and "C". The cave is approached by a terrace with two entrances: The northern entrance leads to "*tramo* B" and the S opening of 1984 to "*tramo* A".

RESEARCH

Three sections in *tramo* A, B and the southern entrance were opened in 1982 and 1983 during rescue excavations. An additional excavation took place in 1986 (RAMOS FERNÁNDEZ ET AL. 2005, 519).

Current studies about Neolithic periods (RAMOS FERNÁNDEZ 2004b, RAMOS FERNÁNDEZ ET AL. 2005) briefly reviewed and generally connected the finds to other SE Spanish sites.

Detailed analyses especially of the Epipaleolithic assemblage are lacking.

CHRONOLOGY

14C-ages:	Stratigraphy:	References:
/	Solutrean (level 10) to post-Chalcolithic (level 1): level 9 = Magdalenian level 8 = Epipaleolithic level 7 = Early Neolithic level 6 = Middle Neolithic etc.	RAMOS FERNÁNDEZ 2004b, 52 Fig. 1

Remarks:

Samples (animal bones) for 14C-dating were obtained (cf. **6. New radiocarbon dates**).

ARTIFACTS

Lithic assemblage:

Similar techniques are present in the Epipaleolithic and Early Neolithic inventories, thus the technology did not change. The assemblages consist of: blades and flakes of uni- and multipolar percussion, nodules, carinated cores, end scrapers, burins, very few borers (RAMOS FERNÁNDEZ 2004b, 54-55; RAMOS FERNÁNDEZ ET AL. 2005, 521).

Figures: RAMOS FERNÁNDEZ 2004b, 55 Fig. 03, 12, 31 [= ID 8420], 32 [= ID 8421], 33, 35 [= ID 8510].

Pottery assemblage:

For detailed descriptions and depictions see RAMOS FERNÁNDEZ ET AL. (2005, 521; 521 Fig. 3) and RAMOS FERNÁNDEZ (2004b, 56-58).

Spherical shapes with necks and strap handles of small to medium size dominate. Besides non-decorated pottery, vessels are decorated with impressed (among others Cardium) or incised ornaments, sculptured bands and red slip (RAMOS FERNÁNDEZ 2004b, Fig. on p. 66). The pottery is comparable to Cova de l'Or and Sarsa/Valencia, Cueva de la Carigüela/GR and Cueva de Nerja, Tapada and Higuerón/MA (RAMOS FERNÁNDEZ 2004b, 57 Fig. 08).

Additionally, three ceramic fragments are present in the Epipaleolithic level 8 *tramo* A *corte* 2 "*zona de revuelto*".

Figures: RAMOS FERNÁNDEZ 2004b, 56 Fig. 07, 1 [=VU 996]; 57 Fig. 08; 58 Fig. 06, 1 [= VU 998] and Fig. 07, 3 [= VU 993], 6 and 7 [= VU 995]; RAMOS FERNÁNDEZ ET AL. 2005, 521 Fig. 3.

Ground stone tools:

In the Epipaleolithic level (level 8) the following fragments were found:
- 5 fragments of grinding stones amongst others with pecking pits
- ca. 10 pebbles, partly possibly of mica schist and some with pecking pits and red ocher

In the Early Neolithic level (level 7) no adzes or axes, but other ground stone tools are present:
- ca. 35 pebbles of various raw materials (amongst others "*quarzo massivo*" or milky quartz) with polishing and traces of red ocher and/or pecking marks or possible drillings (ID 8406-8415)

- 8 fragments of grinding stones and grinding plates partly with pecking marks, pecking pits, red ocher, polished sections, two working surfaces and/or flake scars, amongst others grinding stone of RAMOS FERNÁNDEZ 2004b, 54 Fig. 3, 46 (actual dimensions: approximately 20 x 14 x 5 cm; *DIBUJADO lam. 159*)
- ID 8403: irregular, big core of quartzite with a weigh of more than 2kg (*DIBUJADO* lam. 162)
- 34 pieces of coarse raw material (caja 11, n° inventario 12337/1)
- red ocher.

Figures: RAMOS FERNÁNDEZ 2004b, 54 Fig. 03, 46.

Bone industry:

No bone industry in the Early Neolithic level.

Figures: /

Faunal remains/fauna:

Bones of terrestrial and marine fauna: birds, deer, carnivores, lagomorphs (wild game = hunting); bovine, suidae (domestic animals = animal husbandry); fish, malacofauna (RAMOS FERNÁNDEZ 2004b, 58).

Botanic remains:

/

Other:

Human bones; jewelry (RAMOS FERNÁNDEZ 2004b, 55-56): marble arm rings with 70 and 74mm interior diameter and pendants of malacofauna; pebble with figurative engravings (see RAMOS FERNÁNDEZ 2004b, 56).

FEATURES

/

INTERPRETATION

Dwelling, workshop site, (burial place ?).

Abrigo del Monje/Murcia

Jumilla, Murcia

Name short: **AM**
ID site: **5**

Longitude:
1°15'W [2°13'30"E]

Latitude:
38°30'N [38°29'7"N]

cf. Observations

Altitude asl:
860m

Orientation:
to S

Distance to coastline:
today approx. 65km

Type of site:
rock shelter

Publications:
HERNÁNDEZ CARRIÓN/GIL GONZÁLEZ 1998, 98-100; MARTÍNEZ ANDREU 1981, 146-149, 178; MARTÍNEZ ANDREU 1983, 43; MOLINA GRANDE/MOLINA GARCÍA 1991, 85-94; MAM n.d.

Observations:
In many publications the site is classified as Mesolithic, Epipaleolithic Microlaminar or Epigravettian. Thus, generally people do not know much about the site and the inventory is very small (MARTÍNEZ ANDREU 1981, 178). Coordinates of MOLINA GRANDE/MOLINA GARCÍA (1991, 87; given here in []) are wrong.

RECORDING

Relevant stages:
Epipaleolithic, Early Neolithic

Depository:
Jumilla, Museo Arqueológico Municipal "Jerónimo Molina"

Recorded artifacts:
Lithic artifacts

Lithic IDs:
5000-5999

Pottery VUs:
/

Remarks:
The lithic assemblages of AM and CZ were partly mixed in their storage boxes. Several pieces could be sorted according to the figures of MARTÍNEZ ANDREU (1981, 1983) and MOLINA GRANDE/MOLINA GARCÍA (1991). All artifacts without illustration were assigned to one of the sites: I assigned all non-illustrated pieces of a bag to the same site as the illustrated artifacts in the same bags. Artifacts with ID 5278-5299 were assigned to AM (cf. Remarks of **Cueva de los Zagales/Murcia**).

LITHIC ARTIFACTS		*number*			*weight*				
		Σ (n)	*%*	*ratio (% Σn)*	*Σ (g)*	*%*	*Ø (g)*	*SD*	*ratio (% Σg)*
Σ (reference amount)		91	100.0%		223.1	100.0%	2.5	3.786	
chips		19		0% 100%					0% 100%
blanks	flakes	59	64.8%		197.5	88.5%	3.3	4.361	
	blades	28	30.8%		18.8	8.4%	0.7	1.244	
	art. debris	4	4.4%		6.8	3.0%	1.7	1.543	
	pebbles								
	cores								
	total with cortex	19	20.9%		94.0	42.1%	4.9	5.527	
flakes & blades	non-mod. pieces	75	82.4%		167.3	75.0%	2.2	3.687	
	burin spalls								
	tools	16	17.6%		55.8	25.0%	3.5	4.190	
	total	87	95.6%		216.3	97.0%	2.5	3.859	
	complete*	31	35.6%		104.8	48.5%	3.4	4.969	
	dorsal reduction**	42	66.7%		93.4	52.7%	2.2	3.564	
		index	*ratio*		*index*	*ratio*			
	n flakes : n blades	2.1	02:01		10.5	21:01			
operation chain	0 RM procurment								
	1 decortification	1	1.1%		2.7	1.2%	2.7		
	2 core preparation	5	5.5%		40.7	18.2%	8.1	4.762	
	3 débitage	52	57.1%		54.0	24.2%	1.0	1.402	
	4 repreparation	4	4.4%		13.2	5.9%	3.3	2.780	
	5 tools&use	50	54.9%		171.1	76.7%	3.4	4.562	
	6 discarding	17	18.7%		23.8	10.7%	1.4	1.992	

Tab. 231 AM/MU. Lithic assemblage (weight in gram (g); *referring to total flakes and blades; **referring to flakes and blades with proximal end: 63 pieces/177.2g).

SETTING

The rock shelter is situated together with Abrigo del Monje II and III (HERNÁNDEZ CARRIÓN/GIL GONZÁLEZ 1998) in Sierra del Buey/Sierra de la Hermana 12km W of Jumilla on the foothills of Sierra del Molar (MOLINA GRANDE/MOLINA GARCÍA 1991, 87 with map on p. 86 and in MARTÍNEZ ANDREU 1997b, 351 Fig 3, 23). A spring is close by.

DESCRIPTION

AM is uphill on the base of a high rock wall. The rock shelter consisting of three shallow cavities on a narrow terrace (HERNÁNDEZ CARRIÓN/GIL GONZÁLEZ 1998, 98 Plate 1; MOLINA GRANDE/MOLINA GARCÍA 1991, 87 and Fig. 17).

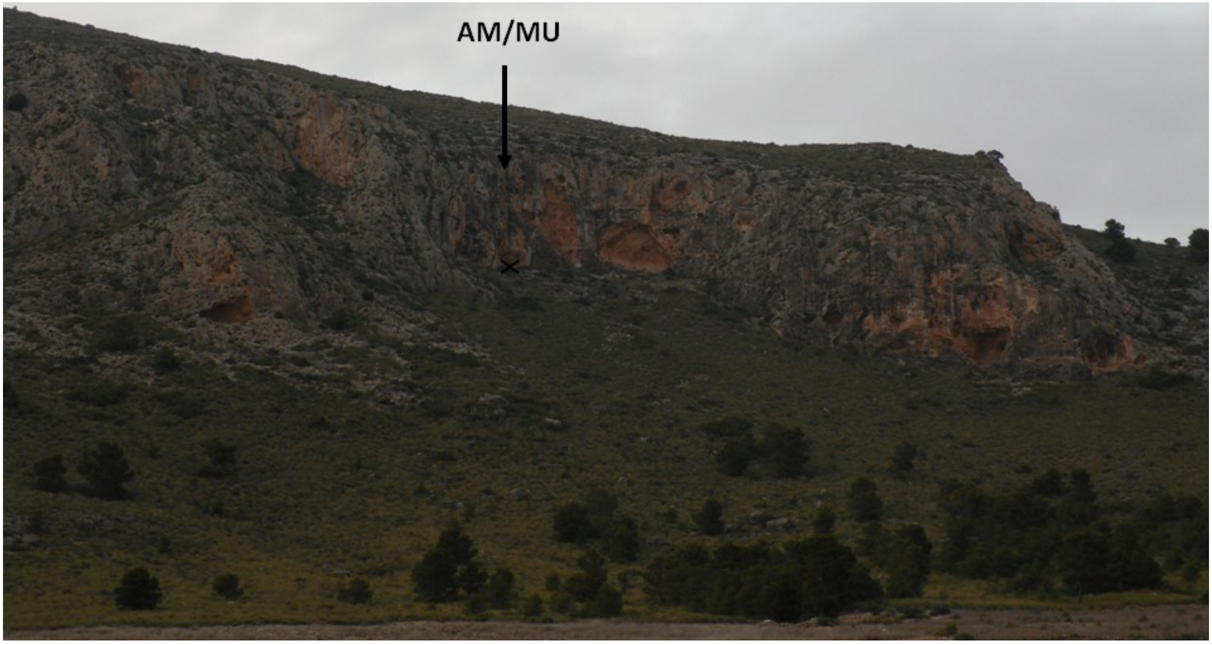


Fig. 72 AM/MU. Situation of the abri.

Fig. 73 AM/MU. View from the abri.

RESEARCH

Since the 1950ies remains of dwellings and a small spring are known from the site. A hermit monk that lived there was eponym ("*monje*"). In 1975 Cayetano Herrero, Francisco Lencina and Antonio Navarro reported lithic finds (MOLINA GRANDE/MOLINA GARCÍA 1991, 85). The former curator of the

Archaeological Museum of Jumilla, Jerónimo Molina García, discovered the rock shelter within a prospection and excavated a small test trench (MARTÍNEZ ANDREU 1983, 43). MARTÍNEZ ANDREU (1983, 1989) analyzed the lithic assemblage.

CHRONOLOGY

14C-ages:	Stratigraphy:	References:
/	5 levels (A-E or I-V) were detected in the test trench near the back wall of the E cavity. However, most finds originate from a mixed context caused by the collapse of the test pit. These correspond to levels A-D or I-IV ("mixed level"). Furthermore, finds from the surface are present.	stratigraphy: MOLINA GRANDE/MOLINA GARCÍA 1991, 90 Fig. 19; typological classification: MARTÍNEZ ANDREU 1981, 147; MARTÍNEZ ANDREU 1983, 43; MOLINA GRANDE/MOLINA GARCÍA 1991, 85; 94.

Remarks:

Epipaleolithic, Eneolithic, Bronze Age and Iberian finds occurred. Due to baked bladelets MARTÍNEZ ANDREU (1983, 43) considered an Epipaleolithic occupation, besides probable Magdalenian, Epigravettian or Azilian origin. A microgravette point and the vicinity to CZ with Epipaleolithic material indicate a similar occupation in AM.

ARTIFACTS

Lithic assemblage:

A small lithic assemblage remains: MARTÍNEZ ANDREU (1981, 148) registered 27 artifacts:
1 microgravette point (mixed level), 1 bipolar baked bladelet (mixed layer), 4 retouched flakes (mixed, surface level and level II), 2 denticulates (mixed and surface level), 1 modified piece (formerly mistaken as burin; level V), 18 frags. of flakes, blades and bladelets (mixed and surface level; levels I, III, IV).
MOLINA GRANDE/MOLINA GARCÍA (1991, 90-94) described 7 pieces from the surface and 57 pieces of the test trench: A: 4, B: 8 (amongst others a core frag., burin), C: 26, D: 14 (2 burins, 3 truncations, 1 laurel-leaf point), E: 5 (1 burin); mixed materials: approximately 35 pieces and 65 chips: 23 frags. flakes and blades, 1 end scraper, 2 truncations, 3 burins + 1 micro burin, 1 borer, 1 notched piece, 1 core, 1 microgravette; rock crystal flakes (MOLINA GRANDE/MOLINA GARCÍA 1991, 88).

Figures: MARTÍNEZ ANDREU 1981, 149 Fig. 32; MOLINA GRANDE/MOLINA GARCÍA, 89 Fig. 18; 91 Fig. 20; 93 Fig. 21.

Pottery assemblage:

/ (5 Prehistoric and Iberian fragments from the surface; MARTÍNEZ ANDREU 1981, 146; MOLINA GRANDE/MOLINA GARCÍA 1991, 88).

Ground stone tools:

Red ocher, gypsum and limestone frags.

Bone industry:

/

Faunal remains/fauna:

Bone and malacofauna frags.

Botanic remains:

Wood and charcoal frags.

Other:

1 glass (MOLINA GRANDE/MOLINA GARCÍA 1991, 88).

FEATURES & INTERPRETATION

/

Abrigos del Pozo/Murcia

Calasparra, Murcia

Name short: **Pozo**
ID site:

Longitude: *NA*

Latitude: *NA*

Altitude asl: 250m

Orientation: to N (?)

Distance to coastline: *NA*

Type of site: rock shelter

Publications:
MARTÍNEZ SÁNCHEZ 1994; 2005; MATEO SAURA 1996; SÁNCHEZ-GÓMEZ ET AL. 2009 (and citations therein).

Observations:
/

RECORDING

The site and finds are currently subject of study and were thus not available for the present analysis.

SETTING

The rock shelter is located on the right of the canyon-valley 3-4m above the Segura River in the carbonate massif Sierra del Molino in the Prebetic Zone of the Betic Cordillera (SÁNCHEZ-GÓMEZ ET AL. 2009, 129; MARTÍNEZ SÁNCHEZ 2005, 240). Due to the canyon-like valley the access to the rock shelters was difficult.

DESCRIPTION

Two rock shelters are next to each other (MARTÍNEZ SÁNCHEZ 1994, 157). The larger one is 30m wide with a maximum deep of 9m and about 2m high (SÁNCHEZ-GÓMEZ ET AL. 2009, 129).

RESEARCH

In the 1980ies and 1990ies San Nicolás and Martínez Sánchez studied the rock art.
Four test trenches of 3m² were excavated in the large rock shelter and MARTÍNEZ SÁNCHEZ (1994) did a preliminary study of the Neolithic finds of the levels V-VI. MATEO SAURA (1996) studied the faunal remains. In 2004 two long excavations (four months in May, June, November and December) took place (MARTÍNEZ SÁNCHEZ 2005, 240; 241 Fig.) and the sedimentary record was studied concerning seismic events (SÁNCHEZ-GÓMEZ ET AL. 2009).

CHRONOLOGY

14C-ages:
level N2 5820 ± 50 BP
level Ch 3710 ± 40 BP
(without further information);
level VI/Neolithic
I-16,783 6260 ± 120 14C-yrs BP (7160 ± 140 calBP).

Stratigraphy:
test trenches 1-4 with levels IX-VII Paleolithic; levels VIa-d *Neolithic*; level III-IV Bronze Age to *Neolithic*; surface and level 1 - Late Roman & Medieval period; excavations in 2004 with 7 levels separated by fluvial deposits:
P - Paleolithic;
N1 and N2 - Neolithic;
Ch - Chalcolithic;
Br - Bronze Age (El Argar);
R1 and R2 Latest Roman period.
An earthquake might have caused large rock falls from the ceiling and walls and thus an abandonment between the levels N2 and Ch.

References:
14-ages: SÁNCHEZ GÓMEZ ET AL. 2009; MARTÍNEZ SÁNCHEZ 1994, 159
stratigraphy: MATEO SAURA 1996; SÁNCHEZ-GÓMEZ ET AL. 2009, 130 with Fig. 3; MARTÍNEZ SÁNCHEZ 2005; SÁNCHEZ-GÓMEZ ET AL. 2009.

Remarks:

Due to the absolute 14C-age and the decorated pottery MARTÍNEZ SÁNCHEZ (1994, 160) assumes amongst others an Early to Middle Neolithic occupation.

ARTIFACTS

Lithic assemblage:

Production remains, flakes partly with use traces or few lateral retouches and a core are present (MARTÍNEZ SÁNCHEZ 2005, 241; 1994, 159).

Figures: /

Pottery assemblage:

Only few (MARTÍNEZ SÁNCHEZ 2005, 241) and highly fragmented pottery remained (MARTÍNEZ SÁNCHEZ 1994, 159): The vessels are by trend globular, open or straight with lugs and strap handles. Monochrome colors dominate and the temper material is fine and medium and in some cases coarse. The surfaces are treated with spatulas. The pottery is predominantly without decoration. Few incised and impressed zigzag, parallel lines and other motifs exist.

Figures: /

Ground stone tools:

Pigments in level VI/Neolithic.

Figures: /

Bone industry:

/

Figures: /

Faunal remains/fauna:

Remains of rabbit, ungulate, boar, ruminant, stag in the Neolithic level (MATEO SAURA 1996).

Botanic remains:

/

Other:

Objects of personal adornment, e.g. arm rings of white limestone (MARTÍNEZ SÁNCHEZ 2005, 241; 1994, 159).

FEATURES

The schematic cave paintings originate from a Neolithic and Chalcolithic to Bronze age occupation (MARTÍNEZ SÁNCHEZ 2005, 241; 1994, 160 and citations therein): panels II-V in the large abri with quadrupeds, anthropomorphic motives, points, lines etc. Ash and burned artifacts imply hearths (MARTÍNEZ SÁNCHEZ 1994, 158-159).

INTERPRETATION

During river floods the abri was occupied as residence and possibly sanctuary with cave art in Neolithic times (MARTÍNEZ SÁNCHEZ 2005, 241; SÁNCHEZ-GÓMEZ ET AL. 2009, 129). Subsequently in the late Roman Age people came here during transhumance and used it as temporary camp (MARTÍNEZ SÁNCHEZ 2005, 241).

Barranco de la Hoz/Murcia

Zúñiga, Lorca, Murcia

Name short: **Hoz**
ID site: **3**

Longitude:
1°42'45"W

Latitude:
37°48'20"N

(coordinates estimated)

Altitude asl:
620m

Orientation:
to W

Distance to coastline:
today approx. 40km

Type of site:
rock shelter

Publications:
ARQUEOMURCIA 2011; LILLO CARPIO/LILLO CARPIO 1982-1983.

Observations:
Probably an unpublished study exists: In the Museum of Lorca I received a schematic stratigraphy - but without reference.

RECORDING

Relevant stages:
Epipaleolithic

Depository:
Lorca, Museo Arqueologico Municipal

Recorded artifacts:
Lithic artifacts

Lithic IDs:
3000-3999

Pottery VUs:
/

Remarks:
I studied the artifacts from levels 1 to 7. Together with the boxes of Hoz two similar boxes are stored in Lorca labeled with "Sima Cueva Peña Rubia - Lorca" and "Yacto-Cola del Pantano - Lorca". I recorded these artifacts as well (ID 37860-37970), but I neither corrected nor analyzed these datasets.

LITHIC ARTIFACTS		*number*			*weight*				
		Σ (n)	*%*	*ratio (% Σn)*	*Σ (g)*	*%*	*Ø (g)*	*SD*	*ratio (% Σg)*
Σ (reference amount)		219	100.0%		1037.0	100.0%	4.7	10.131	
chips				0% 100%					0% 100%
blanks	flakes	78	35.6%		477.5	46.0%	6.1	6.531	
	blades	123	56.2%		176.8	17.0%	1.4	1.651	
	art. debris	10	4.6%		122.5	11.8%	12.3	11.989	
	pebbles								
	cores	8	3.7%		260.2	25.1%	32.5	36.320	
	total with cortex	72	32.9%		603.5	58.2%	8.7	14.929	
	non-mod. pieces	158	72.1%		699.1	67.4%	4.4	11.191	
	burin spalls								
	tools	61	27.9%		337.9	32.6%	5.5	6.654	
flakes & blades	total	201	91.8%		654.3	63.1%	3.3	4.829	
	complete*	96	47.8%		352.3	53.8%	3.7	5.359	
	dorsal reduction**	100	65.8%		367.6	65.1%	3.7	5.961	
		index	*ratio*		*index*	*ratio*			
	n flakes : n blades	0.6	01:02		2.7	03:01			
operation chain	0 RM procurment								
	1 decortification	3	1.4%		13.5	1.3%	4.5	3.205	
	2 core preparation	25	11.4%		117.5	11.3%	4.7	5.080	
	3 débitage	128	58.4%		197.7	19.1%	1.5	1.965	
	4 repreparation	20	9.1%		73.2	7.1%	3.7	4.198	
	5 tools&use	149	68.0%		538.1	51.9%	3.6	5.096	
	6 discarding	51	23.3%		400.6	38.6%	17.6	3.418	

Tab. 232 Hoz/MU. Lithic assemblage (weight in gram (g); *referring to total flakes and blades; **referring to flakes and blades with proximal end: 152 pieces/564.5g).

SETTING

The rock shelter is located S of a cliff 15km N of Lorca and 800m in NW of Caserío de Zúñiga (LILLO CARPIO/LILLO CARPIO 1982-1983, 3; with map on p. 11 and MARTÍNEZ ANDREU 1997b, 351 Fig 3, 18) in the canyon Barranco de la Hoz. Abrigo Grande de Zúñiga/Barranco de la Hoz III is a neighboring site 350m to the N.

DESCRIPTION

Hoz is a small rock shelter.

RESEARCH

Hoz is hardly investigated:
- clandestine excavations by D. Juan Antonio Lorente
- prospection by P.A. and M.J. Lillo Carpio
- since 23.12.1991 (?) inventories are deposited in the Archaeological Museum of Lorca
- study by Lombardi/University of Murcia (unpublished).

CHRONOLOGY

14C-ages:	Stratigraphy:	References:
/	SE wall: 9 levels (I-IX).	ARQUEOMURCIA 2011; LILLO CARPIO/LILLO CARPIO 1982-1983.

Remarks:

The findings prove late Upper Paleolithic (Solutrean IV to Final Magdalenian)/Epipaleolithic, Iron Age/Roman, medieval and modern occupation. Similar finds are present in the neighboring Barranco de la Hoz III/Abrigo Grande de Zuñiga.

ARTIFACTS

Lithic assemblage:

The used flint is of good quality of local or regional (red or olive flint) origin. The latter could be due to exchange and contacts. Artifacts: flakes, blades; tools: abrupt retouched tools, backed points, tanged point, end scrapers, truncations, burins, denticulates, carinated blades (LILLO CARPIO/LILLO CARPIO 1982-1983, 9-10).

Figures: /

Pottery assemblage:

sherds in level 1 and 2.

Figures: /

Ground stone tools:

/

Figures: /

Bone industry:

level 3 and 6: bone points.

Figures: /

Faunal remains/fauna:

Level 3: 2 burned bone frags.; level 4: 1 tooth (chewing surface 27x27mm); level 6: 3 mollusks, tooth.

Botanic remains:

/

Other:

/

FEATURES

/

INTERPRETATION

LILLO CARPIO/LILLO CARPIO (1982-1983, 9-10) interpreted the site as seasonal camp for large game hunting. The settlers exchanged flint with neighboring sites.

Cabecicos Negros-El Pajarraco/Almería

Vera, Almería

Name short: **CNP**
ID site: **10**

Longitude:
1°49'25" to 1°50'40"W

Latitude:
37°12'38"N (30SXG042187 UTM)

Altitude asl:
20-30m

Orientation:
to NE (? cf. **DESCRIPTION**)

Distance to coastline:
at the ancient coastline (today approx. 2 km)

Type of site:
open-air site

Publications:
AFONSO MARRERO 1993, 226-393; CÁMALICH ET AL. 2004; CÁMALICH MASSIEU ET AL. 1999a; CÁMALICH MASSIEU ET AL. 1999b; CÁMALICH MASSIEU ET AL. 2004; CÁMALICH MASSIEU ET AL. 2010; CÁMALICH MASSIEU/MARTÍN SOCAS 1999; CHÁVEZ ÁLVAREZ 2000, 137-138; GOÑI QUINTEIRO 1999; GOÑI QUINTEIRO ET AL. 1999; GOÑI QUINTEIRO ET AL. 2003; MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO 1999a, b; PAZ MARTÍNEZ/MORALES 1999; RODRÍGUEZ RODRÍGUEZ 1999.

Observations:
CNP consists of two sites: Cabecicos Negros/Loma del Rincón and El Pajarraco. The latter is known from Siret as El Pajarraco/Cabezo del Pajarraco. Erosion affected the preservation. Materials stem from the whole site and are representative for all kinds of on-site-activities (MARTÍNEZ FERNÁNDEZ ET AL. 2010, 164).

RECORDING

Relevant stages:
Early Neolithic

Depository:
Museo de Almería

Recorded artifacts:
Lithic artifacts, pottery

Lithic IDs:
10000-10999

Pottery VUs:
317-990

Remarks:
I recorded the pottery of each trench separately (5, 8 to 10, 14; i.e. box 2278, 2296 and 15, I) within the VUs 317-990. Building vessel units was handicapped by a gray dirt-coat on most fractures and sometimes on the interior and exterior surfaces, especially on the pottery of trench 15. Thus, my preliminary mineralogical classifications and descriptions are mostly based on visual particles on the interior and exterior surfaces of the sherds. I took ceramic samples for mineralogical analyses (cf. **5.3.1. Cabecicos Negros/Almería: Mineralogical analyses**).
Due to high fragmentation, a number of small sherds could not be attached to VUs (*corte* 8: 74 frags., *corte* 9: approximately 20, *corte* 10: approximately 65, *corte* 15: approximately 200). Very hard-fired and fine, thin sherds, which I so far did not observe in Early Neolithic inventories, were not recorded either. Furthermore, two ceramic frags. (*caja de selección 15;* inventory numbers 52370, 52431) do probably not belong to CNP and were not recorded. The fragments of the pointed based vessel (inventory number 82881 cf. CÁMALICH MASSIEU ET AL. 1999a, 115 Fig. 54, 4) were not available. I studied this one based on literature (cf. VU 990).
The pottery displayed in the exhibition is summed up within a standard form on the webpage of the Museum (via http://www.juntadeandalucia.es/culturaydeporte/museos/ *Museo de Almería/Acceso a fondos: buscador domus*; except inventory no./ID no. 8350/10473, 82892/10465, 8352/10479 and additionally inventory no. 82883, 82889 to 82891).
Lithic artifacts of Early Neolithic trenches 5, 8, 9, 10, 13 were available for recording. In the current exhibition lithic artifacts of CNP and another site are shown together. I recorded the finds of the latter one mistakenly with the IDs 100.000 to 199.999. These datasets are not corrected nor evaluated.
Example for labeling: CNP 2000; Corte 15, 1; Sector B; N 1 UME 46.

LITHIC ARTIFACTS		number			weight				
		Σ (n)	*%*	*ratio (% Σn)*	*Σ (g)*	*%*	*Ø (g)*	*SD*	*ratio (% Σg)*
Σ (reference amount)		246	100.0%		508.8	100.0%	2.1	4.182	
chips		9		0% 100%					0% 100%
blanks	flakes	103	41.9%		252.9	49.7%	2.5	2.851	
	blades	126	51.2%		79.0	15.5%	0.6	0.547	
	art. debris	8	3.3%		37.5	7.4%	4.7	3.688	
	pebbles								
	cores	9	3.7%		139.4	27.4%	15.5	13.039	
	total with cortex	34	13.8%		137.5	27.0%	4.0	4.610	
	non-mod. pieces	179	72.8%		365.7	71.9%	2.0	4.477	
	burin spalls	2	0.8%		0.7	0.1%	0.4	0.071	
	tools	65	26.4%		142.4	28.0%	2.2	3.332	
flakes & blades	total	229	93.1%		331.9	65.2%	1.4	2.152	
	complete*	47	20.5%		109.3	32.9%	2.3	2.763	
	dorsal reduction**	45	36.9%		77.3	36.3%	3.2	3.261	
		index	*ratio*		*index*	*ratio*			
	n flakes : n blades	0.8	01:02		3.2	03:01			
operation chain	0 RM procurment								
	1 decortification	3	1.2%		6.7	1.3%	2.3	3.092	
	2 core preparation	14	5.7%		32.4	6.4%	2.3	2.313	
	3 débitage	171	69.5%		154.5	30.4%	0.9	1.165	
	4 repreparation	8	3.3%		13	2.6%	1.6	1.296	
	5 tools&use	148	60.2%		248.8	48.9%	1.7	2.945	
	6 discarding	128	52.0%		334.7	65.8%	2.6	5.218	

Tab. 233 CNP/AL. Lithic assemblage (weight in gram (g); *referring to total flakes and blades; **referring to flakes and blades with proximal end: 122 pieces/212.9g).

POTTERY		number VUs		
		Σ (n)	*%*	*ratio (% VU)*
Σ VU *(reference amount)*		674	100.0%	
Σ sherds		1605		
Ø sherds/ VU		2.4		0% 100%
VU	with rim frag.	139	20.6%	
	with definable DM	99	14.7%	
		cm		
	Ø DM	18.2		
shape	with definable shape	89	13.2%	
	shape not definable	585	86.8%	
	pots*	19	21.3%	
	small bowls*	18	20.2%	
	small globular vessels*	12	13.5%	
decoration	decorated	112	16.6%	
	non-decorated	562	83.4%	
	n decoration techniques	164		
		index	*ratio*	
	n decoration techniques : n decorated VU	1.5	03:02	
	with impressed decoration**	84	51.2%	
	Cardium-impressed***	13	15.5%	
	with incisions**	49	29.9%	
	with sculptured bands**	15	9.1%	

Tab. 234 CNP/AL. Pottery assemblage (*referring to VUs with definable shape; **referring to n decoration techniques; ***referring to VUs with impressed decoration).

SETTING

The site was located at the ancient coast line in a wide bay directly at the Antas river mouth (CÁMALICH MASSIEU/MARTÍN SOCAS 1999, 392 Fig. 83 no. 155). Currently it is approximately 2km inland on the left bank of river Antas (km 5.5 of road from Vera to Garrucha).

DESCRIPTION

CNP is an open-air site and consists of two main find concentrations on hills to the W and to the E of the Vera-Garrucha road: Cabecicos Negros and Cerro del Pajarraco (CÁMALICH MASSIEU ET AL. 1999a, 107; 108 Fig. VI). The site is a generally oriented to NE.

RESEARCH

1991 Cámalich Massieu and Martín Socas initiated the studies with a prospection and a stratigraphic sondage in the frame of the project "*Los inicios de la metalurgia en la Cuenca del río Almanzora*" (CÁMALICH MASSIEU/MARTÍN SOCAS 1999). Rescue excavations took place in 1991 (evaluated by CÁMALICH MASSIEU/MARTÍN SOCAS 1999 and studies therein) and 2000 (GOÑI QUINTEIRO ET AL. 2003). In 1991 trenches 5, 8-10, 13 (CÁMALICH MASSIEU ET AL. 1999a, 110 Fig. 48; El Pajaraco: 1, 2, 4, 5, 7, 11, 12) and in 2000 trench 14 (82m²), 15 and 18 (El Pajaraco: 19?) were excavated. Trench 18 did not provide any archaeological finds, but mixed material and sediments.

CHRONOLOGY

14C-ages:	Stratigraphy:	References:
Due to insufficient amounts of organic remains 14C-datings are not possible (pers. comm. D. Martín Socas).	CNP is an open-air site without stratigraphy and CÁMALICH ET AL. (2004, 186) characterized it as "a single occupation layer site".	CÁMALICH ET AL. 2004 (cf. previous publications); GOÑI QUINTEIRO ET AL. 2003.

Remarks:

CNP was occupied during several Neolithic stages starting in the Early Neolithic. Representative Neolithic materials are classified as "*Neolítico Pleno o Cultura de las Cuevas con cerámica decorada*" from the mid-6th Mil. calBC onwards (CÁMALICH MASSIEU ET AL. 2004, 169; season 1991 trenches 5, 8, 9, 10, 13; 2000 trench 14 and 15, stage I) and correspond to the finds in Cueva de la Carigüela, Las Majolicas, Cueva del Malalmuerzo, stage I of Los Castillejos/all in GR, Cueva Nerja, El Toro/both in MA, Los Murciélagos/Córdoba and Cova Fosca/Castellón (CÁMALICH ET AL. 2004, 190; 192; GOÑI QUINTEIRO ET AL. 2003, 76). On the base of impressed pottery and the settlement type CÁMALICH ET AL. (2004, 188) assumed an Early Neolithic occupation. The inventory of 2000 trench 14, and perhaps 15, phase I is attributed to the Early Neolithic, too.

Also findings originating from the Bronze Age (excavation 2000, trench 15, stage II) the Phoenician (2000, 15, III) and Roman period are present (GOÑI QUINTEIRO ET AL. 2003, 76).

El Pajarraco is characterized as a Phoenician settlement.

ARTIFACTS

Lithic assemblage:

AFONSO MARRERO (1993, 226-393), MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO (1999a: 1066 pieces concerning technology) and RODRÍGUEZ RODRÍGUEZ (1999: 50 pieces with use wear) evaluated the lithic assemblage (cf. **Tab. 235**):

Approximately 1300 pieces occur highly fragmented (86%) and are of a homogenous, standardized micro-"laminar manufacturing type" (ratios approximately): 55% flakes and 43% (small microlaminar) blades each with more than 60% plain platforms, 2% cores (MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO 1999a; CÁMALICH ET AL. 2004, 188; GOÑI QUINTEIRO ET AL. 2003, 76). Blade- and flake-cores and all kinds of debitage demonstrate a (partial) knapping in situ by (in-) direct pressure technique (CÁMALICH MASSIEU/MARTÍN SOCAS 1999, 332). Heat treatment (66% burned artifacts) was applied on cores previous to the blank removal or subsequent to the preparation (MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO 1999b, 245).

The tool assemblage is not very variable: 80% pieces with continuous and/or discontinuous retouch and additionally borers on blades, microliths, denticulates and scrapers occur.

Thus, techno- and typologically CNP is similar to contemporaneous assemblages in Upper Andalusia (MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO 1999b, 244).

The raw material of immediate local origin and from the Vélez region ("*sílex de radiolarios*") is

dominating (CÁMALICH ET AL. 2004, 188; CÁMALICH MASSIEU/MARTÍN SOCAS 1999, 332). Special products were manufactured of foreign raw material (MARTÍNEZ FERNANDEZ/AFONSO MARRERO 1999b, 245: prismatic blades; compare GOÑI QUINTEIRO ET AL. 1999, 169 and RODRÍGUEZ RODRÍGUEZ 1999, 235). Additionally, an exhaustive exploitation with recycled pieces demonstrates a certain scarcity (CÁMALICH ET AL. 2004, 188; GOÑI QUINTEIRO ET AL. 1999, 169). A system for the procurement can be assumed (MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO 1999b, 245), but whether this is based on direct access to the sources or exchange networks remains open.
Use ware analysis indicate a variety of activities on-site: Only one sickle indicates harvesting, whereas indications for work with mineral materials and shells - amongst others jewelry is most frequent (perforating, sawing, grooving, scraping, cracking; CÁMALICH ET AL. 2004, 188; GOÑI QUINTEIRO ET AL. 1999). Skins, bone, plants, wood and meat were also treated. Traces on microliths and segments confirm their use as projectiles and hunting (CÁMALICH ET AL. 2004, 188; GOÑI QUINTEIRO ET AL. 1999, 164; in summary see RODRÍGUEZ RODRÍGUEZ 1999 especially p. 233 Fig. 31). Trenches 5 and 10 of 1991 present a high density of artifacts with use wears and trench 10 a dominance of skin treatment (RODRÍGUEZ RODRÍGUEZ 1999, 234).
Epipaleolithic traditions were maintained (CÁMALICH MASSIEU/MARTÍN SOCAS 1999, 333).

Figures: GOÑI QUINTEIRO ET AL. 1999, 168 Fig. 3; AFONSO MARRERO 1993, 227-233 Fig. 70-78; 378 Fig. 197; 402-462 Fig. 200-213.

Pottery assemblage:

In addition to undecorated pottery, vessels with various ornamental techniques and single or combined motives exist. Impressed and incised decoration (Cardial and other tools), sculptured bands and *almagra* occur (CÁMALICH ET AL. 2004; CÁMALICH MASSIEU ET AL. 1999a; GOÑI QUINTEIRO ET AL. 2003). Closed profiles are dominating, amongst others one vessel has a conic base and approximately 18l holding capacity (CÁMALICH MASSIEU ET AL. 1999b, 480). The handles are variable: Lugs, horizontal or vertical strap handles and a nozzle-spout exist (VU 692; CÁMALICH MASSIEU ET AL. 1999a, 113 Fig. 52, 7).

Figures: CÁMALICH ET AL. 2004, 187 Fig. 2; 189 Fig. 3; CÁMALICH MASSIEU ET AL. 1999a, 111-115 Fig. 50-54; GOÑI QUINTEIRO ET AL. 2003, 77-78 Fig. 2-3; CÁMALICH MASSIEU ET AL. 1999a, 113 Fig. 52,7.

Ground stone tools:

Few: axes, adzes, chisels and a grinding stone fragment (CÁMALICH ET AL. 2004, 188).

Figures: CÁMALICH MASSIEU ET AL. 1999a, 118 Fig. 57.

Bone industry:

Few: perforation implements, punches (CÁMALICH ET AL. 2004, 188).

Figures: CÁMALICH MASSIEU ET AL. 1999a, 119 Fig. 58, 15-16.

Faunal remains/fauna:

Few: rabbit, pig and stag (PAZ MARTÍNEZ/MORALES 1999, 319).

Botanic remains:

(Only in El Pajarraco/Phoenician period; RODRÍGUEZ ARIZA 1999, 286-287).

Other:

Jewelry (GOÑI QUINTEIRO 1999, 252-260, 263-265; GOÑI QUINTEIRO ET AL. 1999, 164; 165 Fig. 1; 166 Fig. 2): 132 arm ring fragments of schist and marble, 16 perforated shells, 11 discoid beads and four ellipsoid pendants of season 1999. These ornaments present a variety of types and standardization (GOÑI QUINTEIRO 1999, 265). The raw material spectrum is also divers. GOÑI QUINTEIRO (1999, 263; 265) assumes a local schist source in max. 4km distance and direct access.
The jewelry is characteristic for the "*Neolítico Pleno de la Cultura de las Cuevas*" in Upper Andalusia and is similar to the finds of Raja Ortega, las Lomas del Campo, Cuartillas, Cortijo de Gatas, Cerro Virtud, El Peñascal, La Isleta, Rambla del Gitano and Cabezo Guevara (GOÑI QUINTEIRO 1999, 265; GOÑI QUINTEIRO ET AL. 1999, 169). Fig. 4 of CÁMALICH ET AL. (2004, 191)/Fig. 1 of GOÑI QUINTEIRO ET AL. (2003, 75) display similar pieces of the excavation season 2000.

BLANKS: CNP/AL	*n*	*%*	*n*	*We (g)*
flakes	493	54.83%	*NA*	
irregular blades	53	5.89%	196.5	53.66%
prismatic blades	344	37.17%		
cores	19	2.11%	169.69	46.34%
Σ blanks*	909	85.27%	366.19	100%
n.s.*	157	14.73%		

PRESERVATION: preservation	*n*		*%*
complete flakes		111	76.55%
dimensions (Ø ± σ in cm)	L 1.98±0.91	Wi 1.81±0.89	Th *NA*
complete blades		23	15.86%
dimensions (Ø ± σ in cm)	L 2.82±0.96	Wi 0.89±0.22	Th 0.34±0.21
other (complete, n.s.)		10	6.90%
complete artifacts*		145	13.60%
incomplete artifacts*		921	86.40%
heat treatment		406	65.91%
intentional heat treatment		15	2.43%
chemical alteration		167	27.11%
mechanical alteration		11	1.79%
gloss n.s.		16	2.60%
sickle gloss		1	0.16%
Σ alteration*		616	57.79%

PLATTFORM REMNANT	flakes		irreg. blades		pris. blades		Σ	
with platform remant				378				42.47%
w/o platform remnant				512				57.53%
removed by retouch**				13				2.54%
w/o due to fracture**				4				0.78%
flakes and blades				890				97.91%
types of plattform remnants	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
plain	166	69.75%	18	64.28%	74	57.36%	258	65.32%
point	28	11.76%	4	14.29%	2	1.55%	34	8.61%
diedric	23	9.66%	3	10.71%	14	10.85%	40	10.13%
facetted	11	4.62%	2	7.14%	33	25.58%	46	11.64%
removed by retouch	10	4.20%	1	3.57%	2	1.55%	13	3.29%
w/o due to fracture					4	3.10%	4	1.01%
Σ (refering to 395)	238	60.25%	28	7.09%	129	32.66%	395	100%

USE WEARS & TOOLS: tool types	*n*	*%*
1A flakes with use traces	8	5.06%
1B flakes with lateral retouch	60	37.97%
2A blades with use traces	19	12.02%
2B blades with lateral retouch	42	26.58%
3 notched pieces	1	0.63%
4 denticulates	5	3.16%
7 microliths	6	3.80%
9 borers	3	1.89%
10 end scrapers	3	1.90%
n.s.	11	6.96%
Σ tools	158	14.82%
use wear analysis (n pieces)	89	
thereof pieces with use traces	50	56.20%

Σ total assemblage	1066	100%

Tab. 235 CNP/AL. Summary table of studies by Afonso Marrero (1993, 226-380; 400-467), Martínez Fernández/Afonso Marrero (1999a, b) and Rodríguez Rodríguez (1999).

FEATURES

"Remains of a structure" were severely affected by erosion (CÁMALICH MASSIEU ET AL. 1999a, 108; GOÑI QUINTEIRO ET AL. 2003, 73; CÁMALICH MASSIEU/MARTÍN SOCAS 1999, 412-413 Fig. 49), modern agriculture, road construction and illegal excavations (AFONSO MARRERO 1993, 226). Several sinks, stones and loam in the area of trench 18 were interpreted as floors of cabins. Natural stairs in trench 14 could have once supported housing structures (GOÑI QUINTEIRO ET AL. 2003, 74).

INTERPRETATION

CNP was one of several temporally, periodically visited camps to exploit and process uneven dispersed resources in the habitat (CÁMALICH ET AL. 2004, 192). A semi-nomadic farming group stayed at the "small hill settlement" (as Almizaraque, La Isleta, Lama del Campo; CÁMALICH ET AL. 2004, 190) to acquire regional and above all costal resources. Due to high mobility they exploited different resources and exchanged goods on (inter-)regional scale. Knapping, handcrafts and agriculture was practiced on-site and in the immediate surroundings. Hardly any traces for harvesting are present in CNP. This can be assigned to the shortened occupation or the marginal or so far non-committed role of agriculture and variable execution (CÁMALICH ET AL. 2004, 192-193; MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO 1999b, 246). However, subsistence was based on livestock breading complemented by divers harvesting, hunting and gathering (CÁMALICH MASSIEU/MARTÍN SOCAS 1999, 335). The handcrafts were not of existential importance, but still it played an important role in CNP and the inhabitants produced beyond their own needs. A distinct processing area for each handcraft is probable (RODRÍGUEZ RODRÍGUEZ 1999, 234) and a certain division of labor and specialization was required (GOÑI QUINTEIRO ET AL. 1999, 169).

Cueva (de) Ambrosio/Almería

Las Cuevas de Ambrosio, Vélez Blanco, Almería

Name short: **CA**
ID site: **9**

Longitude:	Latitude:	
02°05'24"W (-2.00)	37°41'24"N (+37.69)	(coordinates converted)
Altitude asl:	Orientation:	Distance to coastline:
1060m	to S/SW	today approx. 55km

Type of site:
rock shelter

Publications:
Epipaleolithic: SUÁREZ MARQUEZ 1980; SUÁREZ MARQUEZ 1981;
Neolithic: NAVARRETE 1976, 397-398; lam. CCCXCIX-CDIII; JIMÉNEZ NAVARRO 1956-1961;
Paleolithic (selection with further citations therein): FULLOLA PERICOT 1979, 235-237; JORDÁ PARDO/PILAR CARRAL 1988; MARTÍNEZ GARCÍA 1994; PANIAGUA PÉREZ 1997; RIPOLL LÓPEZ 1988; RIPOLL LÓPEZ 1988a-i; RIPOLL LÓPEZ/MORALÁ 1988; RIPOLL LÓPEZ 1994; RIPOLL PERELLÓ 1960-61; www.uned.es/dpto-pha/ambrosio/biblio.html.

Observations:
The cave is also known as Cueva del Tesoro (SUÁREZ MARQUEZ 1980, 78; cf. JIMENEZ NAVARRO 1962, 13-14, footnote 3). For this reason Siret, Cacho and FORTEA (1973, 229-230 cf. 274-275) probably counted two different sites or confused CA/Almería with a same-named site in MU (PANIAGUA PÉREZ 1997, 101).
Additional collections from the cave are stored in the Museo Arqueológico de Madrid, the Servicio de Investigación Prehistórica de Valencia and the Museo Arqueologico Municipal de Lorca.

RECORDING

Relevant stages:	Depositories:	
Epipaleolithic	Museo de Almería	Museo Arqueologico Municipal Lorca
Recorded artifacts:	Lithic IDs:	Pottery VUs:
Lithic artifacts	9000-9999 and 90000-99999	/

Remarks:
In Almería all finds of CA are stored in approximately 150 cardboard boxes without obvious reference of precise origin (i.e. season, excavator, trench): boxes n° 155-187, 191-193 (trench 4, Botella 1975), 194-219, 765-801 (excavations 1963, 1982, 1983), 905, 1818-1825 (Solutrean levels), 2369-2384 (excavation 1994), 3569-3577, 5872-5880 (excavations 1992, 1994), 6641-6646 (excavations 1990, 1991) and "*cajas de la selección*" 2, 12, 95, 265 (inventory numbers around 52093 and 52555; ambiguous origin), 267.
Epipaleolithic: Only material with clear stratigraphic origin was recorded: **Box 188**: Trench 2/Botella 1975, level 1 (3 bags with excavation n° 20003, 20004 and 20007), level 2 (2 bags 20009 and 20010), level 3 (2 bags 20011 and 20012; not recorded: 2 bags *"nivel superficial"*, 2 bags *"limpieza perfiles"*); **box 189**: Trench 2/Botella 1975, level 4 (4 bags 20013 to 20016), level 5 (3 bags 20019, 20021 and 20028; not recorded: 4 bags *"limpieza perfiles"*, 1 bag *"sin referencia de nivel"*); **box 190**: Trench 2/Botella 1975, level 5 (1 bag 20041), level 6 (1 bag 20043), level 7 (2 bags 20045, 20047; not recorded: 1 bag *"seleccion exposicion"*, 3 bags *"sin referencia nivel"*, 3 bags *"limpieza de perfiles"*) "*caja de selección*" 12 (display case n° 4 of the former exhibition; exhibited with materials from El Serron Antas; thereof not recorded: pieces of *"limpieza de perfiles"* 20005, 20006 and 30201).
In contrast PANIAGUA PÉREZ (1997, 100) found the materials from the excavation of Botella in 1975 in boxes n° 252 to 269. These changes are due to modifications in the storage and numbering systems in the Museum of Almería.
Regarding the study of SÚAREZ MÁRQUEZ (1980; 1981) and the present study, differences in the designation of tools and their frequencies appear, probably due to various applied typological concepts. Additionally, a few pieces are missing: Suárez Marquez recorded 2152 pieces of level 1

to 7, whereas I found 2053 pieces (including 452 chips). Bags with excavation no. 20017, 20018, 20019 and 20041 and the following tools are missing: Súarez Márquez 1980, plate II, 22, III, IV and IV. Parniagua Pérez (1997, 100) also complained divergences between the published and the stored artifact numbers.

In contrast I recorded additionally artifacts with excavation no. 20021 (trench 2, level 5).

I did not find <u>Early Neolithic</u> material from the excavations of Jiménez Navarro 1944/45 or Ripoll 1960. The former could be stored in Valencia (Ripoll López 1988b, 51) and in the MAN, Madrid (collection of Julio Martínez Santa Olalla; pers. comm. C. Cacho Quesada). Material from the excavations of Ripoll are stored in the Archaeological Museum of Barcelona (pers. comm. C. Cacho Quesada).

LITHIC ARTIFACTS		*number*			*weight*				
		Σ (n)	*%*	*ratio (% Σn)*	*Σ (g)*	*%*	*Ø (g)*	*SD*	*ratio (% Σg)*
Σ (reference amount)		1613	100.0%		4859.3	100.0%	3.0	7.135	
chips		452		0% 100%					0% 100%
blanks	flakes	985	61.1%		2244.3	46.2%	2.3	3.826	
	blades	442	27.4%		471.9	9.7%	1.1	1.896	
	art. debris	121	7.5%		757.1	15.6%	6.3	12.729	
	pebbles								
	cores	65	4.0%		1386.0	28.5%	21.3	18.269	
	total with cortex	418	25.9%		2568.8	52.9%	6.1	11.497	
	non-mod. pieces	1459	90.5%		4155.2	85.5%	2.8	6.966	
	burin spalls	8	0.5%		5.3	0.1%	0.7	0.515	
	tools	146	9.1%		698.8	14.4%	4.8	8.621	
flakes & blades	total	1427	88.5%		2716.2	55.9%	1.9	3.395	
	complete*	480	33.6%		1106.3	40.7%	2.3	3.920	
	dorsal reduction**	360	42.4%		699.5	37.1%	1.9	3.390	
		index	*ratio*		*index*	*ratio*			
	n flakes : n blades	2.2	02:01		4.8	05:01			
operation chain	0 RM procurment								
	1 decortification	51	3.2%		242.3	5.0%	4.8	6.979	
	2 core preparation	77	4.8%		343.2	7.1%	4.5	5.149	
	3 débitage	942	58.4%		1203.3	24.8%	1.3	2.513	
	4 repreparation	47	2.9%		114.8	2.4%	2.4	2.564	
	5 tools&use	284	17.6%		978.6	20.1%	3.4	6.544	
	6 discarding	704	43.6%		2746.1	56.5%	3.9	8.919	

Tab. 236 CA/AL. Lithic assemblage (weight in gram (g); *referring to total flakes and blades; **referring to flakes and blades with proximal end: 849 pieces/1885.4g).

SETTING

CA is situated with several other caves (Ripoll López 1988a, 10) in N Almería near Las Cuevas de Ambrosio 25-29km N of Vélez Blanco. The location in a valley approximately 15m above the rivulet El Moral (Jordá Pardo/Pilar Carral 1988, 21) on a cliff provides an important geographical position at a natural passage-way and communication channel from the Mediterranean Levant to Inner Andalusia (Suárez Marquez 1981, 51/Ripoll López 1988, 585). It is separated from the coast by mountains (Almagrera, Almenara and Cartagena; Jimenez Navarro 1962, 13; for a topographical map see Ripoll López 1988a, 8 Fig. 1).

DESCRIPTION

CA is rather a rock shelter at the bottom of a 100m-high cliff with a width between 39 and 31m and a 13 to 18m-high entrance. The maximum depth is 17m. The ceiling of the former cave collapsed partly (Jiménez Navarro 1956-1961, 14; Ripoll Perelló 1960-61 with a photo on p. 47 Plate I, 2 or Martínez García 1994, 39 Fig. 9 or Ripoll López 1988a, 11 Plate II).

RESEARCH

Since the beginning of the 20th century the Paleolithic occupation and art was investigated (shouldered point; Motos, Breuil, Cabré, Obermaier, Siret, Jiménez Navarro, Pericot; in summary Ripoll López 1988b, 42-49; Ripoll López 1994, 56-65; Suárez Marquez 1980; 1981, 64).

1944 first excavations by JIMÉNEZ NAVARRO (1956-61) in the W area of CA: Neolithic and Epipaleolithic;
1958, 1960, and 1962 to 1964 further excavation seasons by E. Ripoll Perelló (partly published by FULLOLA PERICOT 1979, 235-237; RIPOLL PERELLÓ 1960-61; location of trenches see RIPOLL LÓPEZ 1988b, 53-55 Fig. 10-12; 60 Fig. 13; 64-65 Fig. 14-15): Neolithic to Paleolithic;
1975 test trenches and excavation by Botella López: trenches 1 and 3 w/o archaeological finds; trench 2: Epipaleolithic and trench 4: Solutrean (unpublished MA thesis of SUÁREZ MARQUEZ 1980; SUÁREZ MARQUEZ 1981; PANIAGUA PÉREZ 1997, 97-102; location of trenches see RIPOLL LÓPEZ 1988b, 69 Fig. 18);
1982, 1983, 1986, 1990, and 1993 excavations of Upper Paleolithic levels/Solutrean (compiled studies edited by RIPOLL LÓPEZ 1988 with location of trenches in RIPOLL LÓPEZ 1988c, 105 Fig. 39 and study of the Solutrean lithic industry by RIPOLL LÓPEZ 1988e-h).
Besides, clandestine excavations took place until 1980, when the cave was closed.

CHRONOLOGY

14C-ages:

Ages for Solutrean present.

References:

Stratigraphy: SUÁREZ MARQUEZ 1980; JIMÉNEZ NAVARRO 1956-1961; RIPOLL PERELLÓ 1960-1961, 33-34; RIPOLL LÓPEZ 1988b, 57 Plate X; RIPOLL LÓPEZ 1988c, 101 Fig. 36; LÓPEZ RIPOLL 1988d, 211; 1988e, 227; RIPOLL LÓPEZ 1988i, 500; controversy about Aurignacian: RIPOLL LÓPEZ 1988, 587; PANIAGUA PÉREZ 1997;
Solutrean 14C-ages: RIPOLL LÓPEZ 1988d, 209; RIPOLL LÓPEZ 1994, 68; 72-73).

Stratigraphy:

CA was occupied from the Solutrean to the Bronze Age:
Excavation Jiménez Navarro 1944: upper level with (Early and) Middle Neolithic (*Neolítico hispano-mauritano/Cultura de las Cuevas/Neolítico puro*) and subsequent level with mixed Neolithic/Paleolitic/Epipaleolithic;
Ripoll Perelló 1960: I/A Eneolithic/Bell Beaker; I/B Neolithic (incised pottery, PPN); II/C Epipaleolithic/Epigravettian; III/D: rocks intermixed with material from level II/C; IV-V/E-F: Upper Solutrean;
Botella 1975, trench 2: natural levels from 1 to 7 with Epipaleolithic remains: All this material equals Epipaleolithic occupation(s) and thus can be compared as total to other sites (pers. comm. Súarez Marquez). PANIAGUA PÉREZ (1997, 102) doubts this sequence.
Botella 1975, trench 4: Solutrean; (w/o Aurignacian);
Ripoll López 80s, Solutrean deposits of 6.50 to 7m: levels (and corresponding lithostratigraphical units): II (5) Evolved Upper Solutrean; IV (3) Upper Solutrean/Lascaux interstadial and VI (2.2) Middle Solutrean. Levels 0 (7); I (6); III (4); V and VII (2) are practically sterile. Radiocarbon dates from levels II, IV and VI support the relative chronology.

Remarks:

From the Epipaleolithic/trench 2/Botella 1975 radiocarbon ages are not available: Fragile bones from small fauna are present, but they are stored apart with a different numbering system than the lithic artifacts. Thus, I did neither know from which trench nor from which level the bones originated.

ARTIFACTS

Lithic assemblage:

SUÁREZ MARQUEZ (1980; 1981) analyzed the Epipaleolithic artifacts of trench 2/Botella 1975. She described the tools (after the typology of FORTEA 1973; SUÁREZ MARQUEZ 1980, 106-175) and compared their frequencies (cf. **Tab. 237** and **Tab. 238**; PANIAGUA PÉREZ 1997, 98 Tab. 1, 2) to corresponding levels of Mallaetes (6-8), Barranc Blanc (I-III), St. Gregori (1-3), Cueva Grande de la Huesca Tacaña and Pinar de Tarruella in Valencia (SUÁREZ MARQUEZ 1980, 217-225). Due to similarities with Mallaetes, SUÁREZ MARQUEZ (1980, 248) classified the remains of trench 2 (all levels) to a Microlaminar Epipaleolithic with a medium frequency of end scrapers (compared to St. Gregori) and backed pieces and a relative high frequency of burins in Magdalenian tradition.

NAVARRETE (1976, 398) shortly listed the few lithics originating from the Neolithic of the excavation Jiménez Navarro 1944: flakes, blades, end scrapers and microliths.
For the Solutrean horizons RIPOLL LÓPEZ and MORALA (1988, 111-125) described a broad variety of used raw material.

Figures: SUÁREZ MARQUEZ 1980, plates I-XII; PANIAGUA PÉREZ 1997, 98 Tab. 1, 2; look for CA on http://ceres.mcu.es/pages/SimpleSearch?index=true.

TOOLS	total *corte 2*	
	n	*%*
end scrapers	58	26.13%
borers	2	0.90%
burins	24	10.81%
backed pieces	40	18.02%
notched pieces/denticulates	58	26.13%
retouched fractures	9	4.05%
lateral retouches	21	9.46%
crested pieces	9	4.05%
others	1	0.45%
tools	222	100.0%

Tab. 237 CA/AL. Tools of trench 2 (including surface findings and mixed filling) compiled according to SUÁREZ MARQUEZ (1980, 128-140; 238-245; 227 cf. PANIAGUA PÉREZ 1997, 98 Tab. 1).

Pottery assemblage:
Sherds from the excavations of Jiménez Navarro 1944: In the lower level occur non-decorated, burnished, coarse and rather small pottery and hemispheric bowls. In the upper level also decorated ceramic was present, e.g. with sculptured bands, impressions, incisions and red incrustation, but without Cardium. Non-decorated pottery has ovoid and globular forms with cylindrical neck, handles (typology of handles) and red pigments (NAVARRETE 1976, 397).

Figures: MARTÍNEZ GARCÍA 1994, 44 Fig. 12; NAVARRETE 1976, Plates CCCXCIX-CDIII; JIMÉNEZ NAVARRO 1956-1961, 25-37 Fig. 6-18)

Ground stone tools:
Botella 1975, trench 2: 2 ground stone tools of level 5 (20028), including 1 with red ocher; 1 grinding plate of level 2 (61980 20009) with two pecking pits and a fractured or chipped fringe; 1 frag. red ocher, 2 grinding plates, 3 pebbles with pecking marks, traces of red ocher and polishing, 1 frag. limestone with trace of red ocher of level 5 (20028; *caja selección* 12, display case 4);
Jiménez Navarro 1944: Neolithic: frags. axes, burnisher, marble arm ring (NAVARRETE 1976, 398).

Figures: RAMOS FERNÁNDEZ 2004b, 54 Fig. 03 n° 46.

Bone industry:
Few; points.

Figures: /

Faunal remains/fauna:
Animal bones present.

Botanic remains:
1 large piece of carbon.

Other:
Jewelry, human bones.

FEATURES

Fireplaces; Paleolithic rock art.

INTERPRETATION

Solutrean groups occupied CA shortly and seasonally from spring to fall in the manner of an ephemeral camp. The rock shelter was used as workshop representing various raw material sources within a surrounding radius of 30km (RIPOLL LÓPEZ 1988i, 501; 502; Ripoll López 1988, 590; 594; 595). Neolithic people used the cave as residence and burial place (NAVARRETE 1976, 398).

	LITHIC ARTIFACTS	level 1		level 2		level 3		level 4		level 5		level 6		level 7		Σ (all levels)	
		n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
	Σ *(reference amount)*	351	100.0%	211	108.3%	221*	100.0%	399*	100.0%	799	100.0%	113	100.0%	39	100.0%	2152*	100.0%
	flakes	102	29.06%	78	36.97%	48	21.72%	107	26.82%	234	29.29%	30	26.55%	15	38.46%	614	28.53%
	blades	36	10.26%	27	12.80%	32	14.48%	67	16.79%	124	15.52%	24	21.24%	7	17.95%	317	14.73%
	art. debris	179	51.00%	101	47.87%	118	53.39%	193	48.37%	368	46.06%	54	47.79%	3	7.69%	1016	47.21%
	cores	19	5.41%	5	2.37%	5	2.26%	8	2.01%	26	3.25%			11	28.21%	74	3.44%
	tools	15	4.27%	19*	8.26%	18	8.14%	24	6.02%	47	5.88%	5	4.42%	3	7.69%	131	6.09%
tools**	end scrapers	6	40.00%	4	21.05%	7	38.89%	3	12.50%	9	19.15%			2	66.67%	31	23.66%
	borers									1	2.13%	1	20.00%			2	1.53%
	burins	3	20.00%			3	16.67%	4	16.67%	10	21.28%					20	15.27%
	backed pieces	3	20.00%	6	31.58%	4	22.22%	4	16.67%	9	19.15%	3	60.00%	1	33.33%	30	22.90%
	notched pieces/denticulates	2	13.33%	3	15.79%	4	22.22%	4	16.67%	14	29.79%	1	20.00%			28	21.37%
	retouched fractures	1	6.67%	1	5.26%			3	12.50%	2	4.26%					7	5.34%
	lateral retouches			4	21.05%			5	20.83%	1	2.13%					10	7.63%
	crested pieces			1	5.26%			1	4.17%	1	2.13%					3	2.29%

Tab. 238 CA/AL. Blanks and tools according to Suárez Marquez (1980, 126-128; *amounts adjusted instead of 228 in level 3; 401 in level 4 and 20 in level 2 cf. Suárez Marquez 1980, 116; 119; 209; Paniagua Pérez 1997, 98 Tab. 1; **refers to the total number of tools in each or all levels, respectively).

Cueva del Algarrobo/Murcia

Mazarrón, Murcia

Name short: **AL**
ID site: **0**

Longitude:
1°17'35"W

Latitude:
37°38'15"N

Altitude asl:
200m

Orientation:
to NE

Distance to coastline:
today approx. 8-10km

Type of site:
cave

Publications:
MARTÍNEZ ANDREU 1989, 62-94; MARTÍNEZ ANDREU 1991a, b, 91-92; MARTÍNEZ ANDREU 1993; MARTÍNEZ ANDREU 1995, 81-83; MARTÍNEZ ANDREU 1997a, b, 349 Fig. 2; 351-352; MARTÍNEZ ANDREU 2002; MUNUERA/CARRION 1991; MAM n.d.

Observations:
/

RECORDING

Relevant stages:
Epipaleolithic

Depository:
MAM Murcia

Recorded artifacts:
Lithic artifacts

Lithic IDs:
0-999

Pottery VUs:
/

Remarks:
Labeling (bags, artifacts): AL = abbreviation of the site, 11N = square, 2 = level, 345 = numbering in each square (ID; cf. MARTÍNEZ ANDREU 2002, 50).

	LITHIC ARTIFACTS	number			weight				
		Σ (n)	*%*	*ratio (% Σn)*	*Σ (g)*	*%*	*Ø (g)*	*SD*	*ratio (% Σg)*
	Σ (reference amount)	513	100.0%		646.7	100.0%	1.3	3.031	
	chips	250		0% 100%					0% 100%
blanks	flakes	271	52.8%		372.2	57.6%	1.4	2.826	
blanks	blades	191	37.2%		108.8	16.8%	0.6	0.977	
blanks	art. debris	36	7.0%		55.8	8.6%	1.6	1.853	
blanks	pebbles								
blanks	cores	15	2.9%		109.9	17.0%	7.3	10.674	
	total with cortex	136	26.5%		249.2	38.5%	1.8	4.043	
	non-mod. pieces	405	78.9%		459.1	71.0%	1.1	3.135	
	burin spalls								
	tools	108	21.1%		187.6	29.0%	1.7	2.557	
flakes & blades	total	462	90.1%		481.0	74.4%	1.0	2.286	
flakes & blades	complete*	224	48.5%		270.6	56.3%	1.2	2.835	
flakes & blades	dorsal reduction**	128	35.3%		122.2	30.2%	1.0	1.304	
flakes & blades		*index*	*ratio*		*index*	*ratio*			
flakes & blades	n flakes : n blades	1.4	03:02		3.4	04:01			
operation chain	0 RM procurment								
operation chain	1 decortification	20	3.9%		34.7	5.4%	1.7	1.789	
operation chain	2 core preparation	29	5.7%		46.7	7.2%	1.6	1.990	
operation chain	3 débitage	282	55.0%		212.6	32.9%	0.8	2.375	
operation chain	4 repreparation	20	3.9%		29	4.5%	1.5	0.943	
operation chain	5 tools&use	182	35.5%		273.5	42.3%	1.5	2.244	
operation chain	6 discarding	126	24.6%		144.5	22.3%	1.2	1.600	

Tab. 239 AL/MU. Lithic assemblage (weight in gram (g); *referring to total flakes and blades; **referring to flakes and blades with proximal end: 363 pieces/404.9g).

SETTING

AL is located in the foothills of Sierra del Algarrobo (Pico del Algarrobo: 713m asl; MARTÍNEZ ANDREU 1993, 36) 7 to 10km N of Mazarrón on the left hand site of rambla Los Algarrobos (MARTÍNEZ ANDREU 1989, 64 with map on p. 62 Fig. 29 and p. 156 Fig. 82; MARTÍNEZ ANDREU 1991a, 61 Fig. 1). Other cave sites and a former spring are in the vicinity.

DESCRIPTION

AL is rather a small rock shelter of 3 to 4m width (entrance approximately 3m and interior slightly wider) and 5m depth (thereof only 3m accessible) with a narrow terrace (photo: MARTÍNEZ ANDREU 2002, 48 Plate 1-2). From approximately 20m² about 12m² are accessible (MARTÍNEZ ANDREU 1989, 68 Fig. 31; MUNUERA/CARRIÓN 1981, 110 Fig. 2).

RESEARCH

The discovery is due to the drinking water supply of Mazarrón from cavern Hoyo de los Izquierdos during a survey project in the 1980s. The excavations in between 1986 to 1996 were carried out in 1m²-squares according to natural layers. The sediment became screened. Finally approximately 70% of the estimated elongation of the site were investigated - corresponding to 8m³ soil (MARTÍNEZ ANDREU 2002, 49; MARTÍNEZ ANDREU 1989, 66-67 with a map/plan of the excavation in Fig. 30):
In 1986 the stratigraphy was investigated in two squares (CS/Corte Sondeo 1 and 2). Till 1993 the excavations concentrated on the entrance (in 1987-1988: squares 10, 11M, 10N and 10O). Afterwards up to 1996 the excavation area shifted to the interior of the cave (8O, P, Q, 7P and 9O).
The land snails were evaluated at the *Departamento de Ingeniería Geológica de la Universidad Politécnica de Madrid* (MARTÍNEZ ANDREU 1971, 16-17) and pollen analysis were done by MUNUERA and CARRIÓN (1981: palynology primarily for the layers of the Upper Paleolithic; 1992: 15 samples from 10M). Lorenzo Alcolea analyzed the marine malacofauna in 1992 (MARTÍNEZ ANDREU 2002, 54-55). MARTÍNEZ ANDREU (1989, 2002) analyzed and compared the lithic assemblage.

CHRONOLOGY

14C-ages:	Stratigraphy:	References:
Contaminated or false 14C-age: 960±80 BP (level II).	5 levels: I Initial/Microlaminar Epipaleolithic "*finipaleolítica*" (with few modern remains) II-V Upper Magdalenian: II: Late Magdalenian and transition to the Holocene.	MARTÍNEZ ANDREU 1989, 67-70; 150-152; 160; MARTÍNEZ ANDREU 1993, 39; MARTÍNEZ ANDREU 2002, 52-53, 63-64.

Remarks:

MARTÍNEZ ANDREU (1989, 91-92; 93) classifies the assemblage of level 1 as an initial stage of the Microlaminar Epipaleolithic rooting in the Magdalenian.

ARTIFACTS

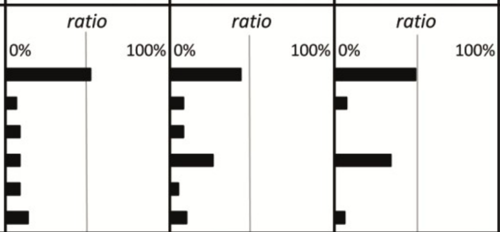
Lithic assemblage:

MARTÍNEZ ANDREU (1989, 2002) recorded and evaluated the lithic assemblage concerning portions of raw materials, forms of platform remnants and tools (cf. **Tab. 240**).
Primarily high variable flints were used for knapping. The settlers procured most flint from the Guadalentín valley (30% of total assemblage; MARTÍNEZ ANDREU 1989, 73; 147). The local, bluish flint of rough, medium-quality from the Viña Roja/Viña de Raja region, in 2km distance of AL, was hardly present (MARTÍNEZ ANDREU 1993, 38; 1997b, 351 Fig 3, 5). The so-called "*jaspe limonitico*" was abundant at the coast and an exposure was available in 3km distance (MARTÍNEZ ANDREU 1991b, 92). Additionally, they used the following raw materials: limonite (jaspoid; 5%), red ocher, quartz (20-30% amongst others rock crystal; from local sources in the coastal mountain range; MARTÍNEZ ANDREU 1989, 148), diaspore (concentration around 10/11N), chalcedony, jasper, quartzite (specifically used e.g. for borers, MARTÍNEZ ANDREU 1989, 148), phyllite (MARTÍNEZ ANDREU 2002, 57-58). The raw materials were exploited and used according to their quality and designated use (MARTÍNEZ ANDREU 2002, 56). MARTÍNEZ ANDREU (2002, 59) assumes flint exchange in between groups. Generally the reduction sequences differed between the raw materials.
Débitage dominate the assemblage (max. L of blades/flakes: 2 to 3 cm; MARTÍNEZ ANDREU 2002, 58; MARTÍNEZ ANDREU 1989, 72/MARTÍNEZ ANDREU 1991a, 63). The majority of platform remnants is plain. The few, small cores are mostly of irregular or globular shape and terminally exhausted (58% vs.

36% cores in preparation and 5% initiation max. length 5 cm; MARTÍNEZ ANDREU 1997b, 351; MARTÍNEZ ANDREU 2002, 59) and indicate an economic handling and possibly a raw material scarcity.
MARTÍNEZ ANDREU (2002, 59-60) interpreted the "miniaturization" as an experiment aiming to support and increase the mobile lifeway.
End scrapers and backed bladelets dominate the Epipaleolithic assemblage of level 1. MARTÍNEZ ANDREU (1989-1990, 54) noticed a change in the industry to level 1 with an increasing of scrapers and pieces with truncation, the presence of one isosceles triangle, a decrease of abrupt, marginal retouched bladelets and of burins. Furthermore, elongated scalene triangles are absent. Tools were also effectively used to their complete exhaustion (e.g. end scrapers; MARTÍNEZ ANDREU 2002, 61).
Use wear analyses indicate distinct activities on-site (i.e. skin treatment; MARTÍNEZ ANDREU 2002, 60-62).

Figures: MARTÍNEZ ANDREU 1989, 72-90 Fig. 35-47; 153 Fig. 74; MARTÍNEZ ANDREU 1991a, 64 Fig. 5; 65 Fig. 7;69 Fig. 9; 72-75 Fig. 12-15.

	AL/MU: LITHIC ASSEMBLAGE	level 1		level 2		level 3		level 4/5		total	
		n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
RAW MATERIAL	flint	319	71.04%	1266	79.87%	1019	82.31%	331	66.06%	2935	77.78%
	quartz	103	22.93%	202	12.72%	85	6.86%	98	19.56%	488	12.93%
	rock crystal	26	5.79%	109	6.87%	132	10.66%	64	12.77%	331	8.77%
	jaspe limonitico	1	0.22%	5	0.32%	2	0.16%	8	1.59%	16	0.42%
	quartzite			3	0.19%					3	0.08%
	total	449	100.0%	1585	100.0%	1238	100.0%	501	100.0%	3773	100.0%
PLATFORM REMNANTS		*ratio* 0%	100%	*ratio* 0%	100%	*ratio* 0%	100%				
	plain										
	diedric										
	facetted							NA		NA	
	point										
	with cortex										
	fracture										
TOOLS	end scrapers	13	32.50%	14	15.73%	8	12.70%	4	11.76%	39	17.26%
	borers	2	5.00%	1	1.12%	1	1.59%			4	1.77%
	burins	5	12.50%	18	20.22%	15	23.81%	13	38.24%	51	22.57%
	truncations	5	12.50%	6	6.74%	4	6.35%			15	6.64%
	backed pieces	2	5.00%	9	10.11%	5	7.94%	6	17.65%	22	9.73%
	notched pieces and denticulates	2	5.00%	7	7.87%	7	11.11%	4	11.76%	20	8.85%
	splintered pieces			2	2.25%	1	1.59%			3	1.33%
	side scraper	1	2.50%							1	0.44%
	backed bladelets	8	20.00%	31	34.83%	22	34.92%	7	20.59%	68	30.09%
	microliths	1	2.50%							1	0.44%
	others	1	2.50%	1	1.12%					2	0.88%
	total	40	100.0%	89	100.0%	63	100.0%	34	100.0%	226	100.0%



Tab. 240 AL/MU. Summary table of studies by MARTÍNEZ ANDREU (1989, 72-77; 1991a, 63-67).

Pottery assemblage:

Several modern ceramic fragments as well as iron fragments (from layer 1) indicate occasional occupations by herdsmen.

Figures: /

Ground stone tools:

Grinding and hammer stones of mica schist (MARTÍNEZ ANDREU 2002, 57-58).

Figures: /

Bone industry:

/ (4 frags. from level II).

Figures: (MARTÍNEZ ANDREU 1989, 93; 94 Fig. 48).

Faunal remains/fauna:

Horse, deer, ibex, rabbit (Martínez Andreu 1997, 352 Fig. 4); small amount of malacofauna with few species: The present remains could be due to an import from a costal camp with intensive exploitation of marine resources. The amount increased in the lower levels (Younger Dryas; Martínez Andreu 2002, 55).

Botanic remains:

12185 pollen grains and spores of 63 pollen types: Amongst others *Cichorioideae, Asteroideae, Chenopodiaceae* and *Artemisia, Quercus, Olea, Pistacia, Cistus*. These indicate a semiarid thermomediterranean bioclimate, which differs not particularly from the contemporary vegetation. During the studied period no fundamental changes took place, but the large amount of nitrofil plants as grasses and scrubs indicate anthropogenic changes in the surrounding of AL (Martínez Andreu 2002, 54; 65; Munuera/Carrion 1991).

Other:

Iron frag., perforated shells.

FEATURES

/

INTERPRETATION

Since the Magdalenian AL was an important camp connecting coast and interior (Martínez Andreu 1993, 37). Environmental changes indicate repetitive frequentation or seasonal permanent settlements with a spectrum of diverse activities on-site (Martínez Andreu 2002, 60; 65).

The presence of various products reflects a perfect common knowledge of the available resources. By vast concepts the territory was exploited efficiently and to its full extends (Martínez Andreu 2002, 60). Settlers exploited the lithic raw materials due to their quality or their intended purpose (Martínez Andreu 2002, 56). The exploitation was carried out direct and indirect via trade-off (Martínez Andreu 2002, 57) by – amongst others – possibly mining (Martínez Andreu 2002, 59). Additionally, the mobile lifeway was improved: Due to the overall small-sized stone industry, hunter-gatherers were not primarily addicted to raw material sources and could thus pass and stay also in regions of lithic raw material-shortage (Martínez Andreu 2002, 61, 65).

Cueva Bajondillo/Málaga

Torremolinos, Málaga

Name short: **Bj**
ID site:

Longitude:	Latitude:	
-4.49994 (Y=4.054.30)	36.621982 (X=366.10)	WGS84 (UTM)
Altitude asl:	Orientation:	Distance to coastline:
56m	/	today approx. 370m

Type of site:
cave

Publications:
BALDOMERO NAVARRO/MARQUÉS MERELO/FERRER PALMA 1989; CORTÉS SÁNCHEZ 2007; CORTÉS SÁNCHEZ ET AL. 2007a, b (with references therein).

Observations:

The Holocene archaeological assemblages are generally very small (CORTÉS SÁNCHEZ ET AL. 2007b, 454).

RECORDING

The site and finds are currently subject of study and were thus not available for the present analysis (pers. comm. M. Cortés Sánchez).

SETTING

The cave was situated in Torremolinos between Calle de las Mercedes, Calle de la Cuesta del Tajo and Calle Bajondillo (BALDOMERO NAVARRO/MARQUÉS MERELO/FERRER PALMA 1989, 13 Fig. 1; 15 Plate I).

DESCRIPTION

/

RESEARCH

Bj was discovered in 1989 during multi-storey dwellings-constructions and rescue-excavations started (in zone A and B till level Bj/17).
From 1989 to 1999 no archaeological investigations of the site took place, but the site was exposed to environmental influences (cf. BALDOMERO NAVARRO/FERRER PALMA/MARQUÉS MERELO 2001).
From 2000 to 2002 excavations and several analyses (sediments, microstratigraphy, palinology) started again. Three further levels were discovered (Bj/18 to Bj/20).

CHRONOLOGY

14C-ages:	Stratigraphy:	References:
Bj/4 7325±65 14Cyrs BP = 8138±79 calBP, 8059-8217 calBP; Bj/3 7475±80 14Cyrs BP = 8288±75 calBP, 8213-8363 (without laboratory numbers).	Cueva Bajondillo was occupied since the Middle Pleistocene (OIS 6) to the Neolithic/Chalcolithic period: Level Bj/1: Neolithic/ Chalcolithic; Bj/2: Middle/Late Neolithic; Bj/3 and Bj/4: Epipaleolithic.	14C-ages: CORTÉS SÁNCHEZ ET AL. 2007b, 463; 465 Tab. 2; Stratigraphy: CORTÉS SÁNCHEZ ET AL. 2007a, 495 Tab. 1; 496 Fig. 1; 459.

Remarks:
/

ARTIFACTS

Lithic assemblage:

Small Epipaleolithic and Neolithic assemblages; two trapezes of Epipaleolithic origin (concave and in micro-burin-technique; CORTÉS SÁNCHEZ ET AL. 2007b, 454).

Figures: CORTÉS SÁNCHEZ 2007b, 455 Fig. 1, 1-2.

Pottery assemblage:

The pottery is predominantly non-decorated and consists of closed vessels with rounded rims and flat bases. A few sherds with sculptured, impressed or incised decorations or graphitic ceramic occur. The pottery points to a Middle or Late Neolithic origin and is similar to occurrences in Hostal Guadalupe, Zorreras, Botijos, Nerja, Toro, Grand Duque, Gato and La Pileta/all in MA, Carigüela/GR and Murciélagos/Córdoba (CORTÉS SÁNCHEZ ET AL. 2007a, 456; 459 cf. BALDOMERO NAVARRO/MARQUÉS MERELO, FERRER PALMA 1989, 17 Plate II).

Figures: CORTÉS SÁNCHEZ 2007b, 457-458 Fig. 2-3; 461-462 Fig. 4-5

Ground stone tools:

Pigments (CORTÉS SÁNCHEZ ET AL. 2007b, 460).

Figures: /

Bone industry:

/

Figures: /

Faunal remains/fauna:

Few malacofauna that include objects of personal adornment (CORTÉS SÁNCHEZ ET AL. 2007b, 459; 455 Fig. 1, 3-7; 460 Tab. 1).

Botanic remains:

Few organic remains and carbon; palynological analyses (CORTÉS SÁNCHEZ ET AL. 2007b, 463).

Other:

Human bones (CORTÉS SÁNCHEZ ET AL. 2007b, 463; 464 Fig. 6).

FEATURES

/

INTERPRETATION

/

Cueva de la Carigüela/Granada

Piñar, Granada

Name short: **GR**
ID site: **7**

Longitude:
-3.439329/3°25'47"W

Latitude:
37.443381/37°26'56"N

WGS84

Altitude asl:
1020m

Orientation:
to NE

Distance to coastline:
today approx. 80km

Type of site:
cave

Publications:
ALMAGRO/FRYSELL/IRWIN 1970; ATOCHE PEÑA 1985-1987; FERNÁNDEZ ET AL. 2007; MARTÍNEZ FERNÁNDEZ 1985; NAVARRETE 1976, 85-258; NAVARRETE ET AL. 1991, 39-66; PELLICER 1964; SALVATIERRA CUENCA 1980; VEGA TOSCANO ET AL. 1988; VEGA TOSCANO ET AL. 1997; WIGAND 1978.

Observations:
Multiple seasons of excavation have provided more than 550 boxes with large amounts of material. Activities remain unpublished (Spahni; thesis of G. Martínez Fernández; P.E. Wigand) or partially evaluated (excavations of Washington State University/WSU; VEGA TOSCANO ET AL. 1988; 1997).

RECORDING

Relevant stages:
Early Neolithic

Depository:
Granada, Museo Arqueológico y Etnológico

Recorded artifacts:
Lithic artifacts, pottery

Lithic IDs:
7000-7999

Pottery VUs:
9-316, 1145

Remarks:
Materials are stored in boxes 1974 to 2535 in the Museum of Granada: Approximately two thirds of the boxes originate from excavations by members of the WSU and L.G. Vega. Pieces from the former exhibition are stored apart. VU 81 probably originates from a younger Neolithic period and is therefore not included in this study. The famous globular vessel with narrow neck (VU 1145; see NAVARRETE 1976, Plates CLXXIV-CLXXIX or NAVARRETE ET AL. 1991, 49 Fig. 6) was not present in Granada and was thus recorded from literature. The ceramic is stored in boxes N° 1990, 2076 (decorated, layer XIV), 2026 (decorated, XV), 2016 (decorated, rims, XVI + VU 81), 2076 (not recorded), 1986 (undecorated, XVI: VUs 9-205), 2080 (undecorated, XVI: VUs 206-251), 1987, 2034 and 2086. Lithic artifacts were sorted by G. Martínez according to the blank or tool type. It can be assumed that some pieces with thermal fractures were interpreted as splintered pieces.

SETTING

Car is situated nearby several neighboring caves (Cueva de la Campana and Cueva de la Ventana) near Piñar in NE of Granada on the N slope of the Sierra Arana Mountain/Monte del Castillo, approximately 90m above the Piñar river (FERNÁNDEZ ET AL. 2007, 76; 77 Fig. 1; CARRÍON/MUNUERA/NAVARRO 1998, 318).

DESCRIPTION

A small area (exterior area/AE) in the N entry zone gives rise to several galleries in SE direction: Three entrances open firstly to the interconnected chambers Carigüela I (CI), CII and CIII (13 x 4-6m) with sedimentary deposits. A corridor (2-3m wide) leads further into the cavern to CIV (7 x 7m) and afterwards to CV and CVI. CI and CII are remains of two parallel galleries. CIII and CIV are the main interior chambers. CV is the biggest chamber in the cave illuminated by daylight through the chimney in the S corner, but also affected by erosion. A conic talus extends from the chimney (FERNÁNDEZ ET AL. 2007, 76; 78 Fig. 2; VEGA TOSCANO ET AL. 1997, 64). In total the cave extends over approximately 50m (MARTÍNEZ FERNÁNDEZ 1985, 169).

LITHIC ARTIFACTS		number			weight				
		Σ (n)	%	ratio (% Σn)	Σ (g)	%	Ø (g)	SD	ratio (% Σg)
Σ (reference amount)		483	100.0%		7315.3	100.0%	15.1	22.515	
chips		0		0% 100%					0% 100%
blanks	flakes	325	67.3%		4230	57.8%	13.0	16.218	
	blades	90	18.6%		651.1	8.9%	7.2	7.390	
	art. debris	38	7.9%		590.5	8.1%	15.5	20.947	
	pebbles								
	cores	30	6.2%		1843.7	25.2%	61.5	47.907	
	total with cortex	129	26.7%		2892.4	39.5%	22.4	34.055	
	non-mod. pieces	348	72.0%		4561.2	62.4%	13.1	19.360	
	bruin spalls								
	tools	135	28.0%		2754.1	37.6%	20.4	28.534	
flakes & blades	total	415	85.9%		4881.1	66.7%	11.8	14.943	
	complete*	182	43.9%		2393.8	49.0%	13.2	18.280	
	dorsal reduction**	143	48.0%		1737.3	46.2%	12.1	14.121	
		index	*ratio*		*index*	*ratio*			
	n flakes : n blades	3.6	07:02		6.5	13:02			
operation chain	0 RM procurment								
	1 decortification	7	1.4%		133.9	1.8%	19.1	28.333	
	2 core preparation	36	7.5%		600.9	8.2%	16.7	17.051	
	3 débitage	219	45.3%		2129.0	29.1%	9.7	11.1545	
	4 repreparation	12	2.5%		104	1.4%	8.7	4.803	
	5 tools&use	235	48.7%		3817.3	52.2%	16.2	24.314	
	6 discarding	285	59.0%		4206.3	57.5%	14.8	22.121	

Tab. 241 Car/GR. Lithic assemblage (weight in gram (g); *referring to total flakes and blades; **referring to flakes and blades with proximal end: 298 pieces/3759.5g).

POTTERY		number VUs		
		Σ (n)	%	ratio (% VU)
Σ VU *(reference amount)*		307	100.0%	
Σ sherds		610		
Ø sherds/ VU		2.0		0% 100%
VU	with rim frag.	74	24.1%	
	with definable DM	64	20.8%	
		cm		
	Ø DM	16.9		
shape	with definable shape	61	19.9%	
	shape not definable	246	80.1%	
	jars*	16	26.2%	
	pots*	13	21.3%	
	small globular vessels*	11	18.0%	
decoration	decorated	106	34.5%	
	non-decorated	201	65.5%	
	n decoration techniques	147		
		index	*ratio*	
	n decoration techniques : n decorated VU	1.4	03:01	
	with impressed decoration**	60	40.8%	
	Cardium-impressed***	14	23.3%	
	with incisions**	24	16.3%	
	with sculptured bands**	43	29.3%	

Tab. 242 Car/GR. Pottery assemblage (*referring to VUs with definable shape; **referring to n decoration techniques; ***referring to VUs with impressed decoration).

RESEARCH

Investigations are long-lasting since 1954/55 and manifold with several seasons by varying teams (for details see VEGA TOSCANO ET AL. 1997, 64-66):

1954 and 1955 prospections and excavations of Spahni in the entrance of CIII and test trenches in CIV (Paleolithic research);

1959 and 1960 excavations of Pellicer in corridor D (connects CIII and CIV) and area G (study of Neolithic remains: MARTÍNEZ FERNÁNDEZ 1985, 169-238; NAVARRETE 1976; PELLICER 1964; SALVATIERRA

CUENCA 1980);
1969 to 1971 three seasons of Irwing and Fryxell of the Washington State University (WSU) and Almagro of the Complutense University of Madrid in AE, CI, CIII, corridor D and CIV, area G (ALMAGRO/FRYSELL/IRWIN 1970: Paleolithic studies) or rather the connecting corridors (WIGAND 1978, 110-116: Neolithic studies);
1982 to 1987 (?) excavations of Vega Toscano (VEGA TOSCANO ET AL. 1997).
Whereas the first excavations are due to research interest, the seasons from the 70ies onwards focused on clearance and the development of an infrastructure for visitors. Car was in bad conditions due to open trenches of the early excavations and continuous erosion through the chimney. A clarification of the archaeological record failed (VEGA TOSCANO ET AL. 1997, 73).
NAVARRETE (1976, 93-249; Plates I-CCXV) described particularly the pottery of Spahni's and Pellicer's excavations and a collection from the spoil heaps. ATOCHE PEÑA (1985-1987) focused on the Almagra ceramic and MARTÍNEZ FERNÁNDEZ (1985) on the lithic artifacts of these seasons. WIGAND (1978) evaluated the Neolithic to Bronze age finds from the WSU excavations.

CHRONOLOGY

14C-ages:

No radiocarbon ages of unambiguous Epipaleolithic or Early Neolithic context are available.
Neolithic ages (CIV 5):
6250±110 calBP (Beta-141049 5470±90 14C-yrs BP, organic)
6470±40 calBP (Pta-9162 5690±30 14C-yrs BP, organic)
7210±30 calBP (Pta-9163 6260±20 14C-yrs, organic)
Early Holocene ages without cultural context:
7760±70 calBP (Beta-141050 6910±70 14C-yrs BP, organic)
8500±80 calBP (Pta-9166 7700±90 14C-yrs BP, organic)
9070±170 calBP (Pta-9165 8130±100 14C-yrs BP, organic)
There are Middle Paleolithic thermoluminescence dates, Paleolithic and further Holocene radiocarbon and Th/U dates.

Stratigraphy:

The different excavations exposed the Middle Paleolithic to Bronze Age occupation in different areas of the cave: Spahni 1954/55 in CIII: I Neolithic; II-IV Musterian stages; V sterile; VI bed rock; Pellicer excavation 1959 (CI): I El Argar; II/III Bronze I; IV Bell Beaker; V Late Neolithic; VI/VII Middle Neolithic; **VIII/IX Early Neolithic**; X Quaternary; Pellicer excavation 1960 (CIII, corridor D, area G): I/II Bronze II; III Bronze I-II; IV-IX Bronze I; X/XI Late Neolithic; XII-XIII Middle Neolithic, **XIV-XVI Early Neolithic**; the following level XVII could also be Neolithic; WSU excavation Irwing/Fryxell 1969 in CIV: *trinchera* 700, test trench P and several squares with mixed levels; 1970 in CIV: *área* 700: Neolithic, test trench P1: Epipaleolithic, predominantly Musterian; 1971 in CIV: *trinchera* 71, test trench 71; Vega Toscano et al. since 1980: 12 lithostratigraphical units: I/II: Holocene: Neolithic - Chalcolithic - Iron and Bronze Age up to 1174 calBP - A: A1 (Iron Age) - A2 - A3 - B: B1 - B2 - B3; III/IV: hiatus; IV-XII: 42 Mousterian levels and five pre-würmian Middle Paleolithic layers between 82500 up to 11200 calendar years BP.

References:

14C-ages: FERNÁNDEZ ET AL. 2007, 81-82 Tab. 3 and 4; TL-dates: FERNÁNDEZ ET AL. 2007, 79; 81 Tab. 1-2; stratigraphy: PELLICER 1964, 17-54; 23 Fig. 3 NAVARRETE 1976, 247: no stratigraphical context; MARTÍNEZ FERNÁNDEZ 1985, 174; VEGA-TOSCANO ET AL. 1988; 1997; FERNÁNDEZ ET AL. 2007.

Remarks:

A correlation of the stratigraphical approaches of the various excavation seasons is not possible (cf. FERNÁNDEZ ET AL. 2007, 84; VEGA TOSCANO ET AL. 1997, 72-73). Generally, lentiform levels aggravated the discrimination of cultural layers (VEGA TOSCANO ET AL. 1997, 73). Furthermore, it is likely that the subdivision of Pellicer in the excavations 1959 and 1960 does not correspond to actual stratigraphic levels (VEGA TOSCANO ET AL. 1997, 72-73). But probably level I of the excavation Pellicer 1960 correlates with level A1 of VEGA TOSCANO ET AL. and levels XI-XVI of Pellicer 1960 with Unit II.
The radiocarbon ages are not associated with a specific Neolithic occupation. Additional samples (animal bones) for new 14C-dating are taken (cf. **6. New radiocarbon dates**).

ARTIFACTS

Lithic assemblage:

MARTÍNEZ FERNÁNDEZ (1985, 184-199) analyzed the lithics originating from zone G, excavation Pellicer 1960 (summarized in **Tab. 244**). Generally striking is the large amount of Mousterian artifacts in Neolithic and following levels: In the Early Neolithic assemblage MARTÍNEZ FERNÁNDEZ (1985, 181-183) excluded 173 artifacts due to patina and typology (cf. **Tab. 243**). Weather they were reutilized by the Neolithic groups or if they get artificially intermixed during the excavation is uncertain. The dimensions of the prismatic blades indicate uniformity. But generally the reduction process is less standardized compared to the following periods. 25.5% of the assemblage are tools. Amongst those abrupt or simple retouches dominate. Sickle gloss was visible on 4 retouched blades. Apparently there is no Epipaleolithic input in the lithic industry (no microliths; MARTÍNEZ FERNÁNDEZ 1985, 193).
Previously NAVARRETE (1976) had described the lithic artifacts briefly: Levels VII, IX/excavation of Pellicer 1959: mostly blades with retouch, partly of Paleolithic origin (amongst others a Mousterian point; NAVARRETE 1976, 231-238); levels XV and XVI/excavation of Pellicer 1960: blades and flakes with plain or facetted platform remnants (also Levallois blades and flakes), chips, scrapers and cores (NAVARRETE 1976, 169-180).
Blades and flint sickle blades were also found in CIV, V/unit I, II (FERNÁNDEZ ET AL. 2007, 79) and similar examples in the WSU-excavation I CIV (VEGA TOSCANO ET AL. 1997, 72).

Figures: MARTÍNEZ FERNÁNDEZ 1985, 181; 186-198 Graf. 1-15; 200 Fig. 11; PELLICER 1964, 49 Fig. 21; 51 Fig. 22; 53 Fig. 24.

level	lithic assemblage			Mousterian				Early Neolithic			
	total	with patina*		total		with patina*		total		with patina*	
	n	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
XVI	240	107	44.6%	80	33.3%	71	88.8%	160	66.7%	36	22.5%
XV	226	108	47.8%	72	31.9%	70	97.2%	154	68.1%	38	24.7%
XIV	71	29	40.8%	21	29.6%	21	100.0%	50	70.4%	8	36.0%
total	537	244	45.4%	173	32.2%	162	93.6%	364	67.8%	82	22.5%

Tab. 243 Car/GR. Mousterian and Early Neolithic artifacts in levels XIV to XVI of the excavation of Pellicer 1960 according to MARTÍNEZ FERNÁNDEZ (1985, 181; reference amounts: line totals; *refer to total, Σ of Mousterian or Early Neolithic artifacts, respectively): Mousterian artifacts are more frequently patinated and can thus be separated from the Early Neolithic assemblage.

Pottery assemblage:

From the excavations of Spahni and Pellicer lots of pottery remains. But the material of Sphani does not provide an exact context (NAVARRETE 1976, 247-248). Pottery originates from CIV, V/unit I, II (FERNÁNDEZ ET AL. 2007, 79) and of WSU-excavation in CIV (VEGA TOSCANO ET AL. 1997, 70-71; WIGAND 1978).
PELLICER (1964, 56-64) described the pottery in general, while NAVARRETE (1976; with graphs concerning portions of clay, texture, firing, boiling, surface and decoration) and ATOCHE PEÑA (1985-1987) did detailed analyses. NAVARRETE ET AL. (1991) studied the mineralogical components (pages 141-164; 168-178), the processing of the vessels (pages 195-217), components of the almagra decoration (pages 228-244) and of graphite pottery (pages 225-227) of 11 Early Neolithic samples (pages 39-66; 42-49 Fig. 2-6; see below and summarized in **Tab. 245**).
Generally the Early Neolithic pottery of Carigüela is characterized by fine clay with floury texture and mainly burnished surface. It is of a good quality.
The vessels are more or less open, round formed as bowls or globular vessels with collar. Vertical strap handles and lugs appear.
The majority of the ceramic is impressed decorated, above all with the Cardium shell, but also with other shells or denticulated tools. They are often opulently all over decorated with metopes, horizontal and vertical bands, zigzag, peg tooth (hanging triangles), herringbone pattern and meander. Impressed decoration is often combined with *almagra*. Sculptured bands and incisions with red incrustation appear (NAVARRETE 1976, 250-251; PELLICER 1964, 56-64).

Levels VIII and IX/excavation Pellicer 1959 (NAVARRETE 1976, 231-238)

In both levels VIII and IX the ceramic was burned oxidizing and closed bowls dominate.

VIII: Mainly decorated ceramics with scaly texture, but fine and burnished surface occur. The decoration consists mostly of simple horizontal lines and bands of Cardium-impressions (twice), graphitized (once), sculptured bands (once) and *almagra* (twice).

IX: In this level, the texture is rather floury, but fine, with burnished and polished surfaces. Many handles as lugs and horizontal strap handles appear. Once incised, twice sculptured bands and once Cardium-impression with *almagra* is present.

Levels XIV to XVI/excavation Pellicer 1960 (NAVARRETE 1976, 169-180)

The clay has a floury and fine texture and firing was predominantly oxidizing. The surfaces were burnished, sometimes even polished and display a good quality. The mostly middle-sized vessels are in a globular or hemispheric shape. Bowls, open vessels or vessels with a partly high, well defined collar are characteristic. Different handles like strap handles, vertical or horizontal with horizontal or rather vertical perforations appear. Lugs are rare. The majority of ceramics is decorated, mostly with shell impressions (amongst others Cardium) or impressions done by other tools (comb, finger). Sculptured bands occurs and twice *almagra*. The decorations are ordered in vertical or horizontal bands, in peg tooth, in metopes or in zigzag. Well known is the big globular vessel with short collar, small handles and all-over Cardium-impressed decoration in various arrangements (VU 1145).

Almagra pottery of the excavations Pellicer 1959 and 1960 (ATOCHE PEÑA 1985-1987)

Almagra (i.e. red slip or incrustation) was applied for decorative reasons. *Almagra* pottery developed progressively: Since the Early Neolithic the frequency and quality of *almagra* ceramic increases continuously and decreases again in the Late Neolithic. The Early Neolithic is characterized by additional impressed or incised decorations. The vessels are of various forms, good quality, medium-sized, homogenous temper, various surface treatments.

Raw material studies (NAVARRETE ET AL. 1991; cf. **Tab. 245**)

Samples: cf. **Tab. 245**;

Parameters: Mineralogical components with x-ray diffraction analyses (philosilicates, mica, quarts, carbonates, feldspaths, marker for temperature, hematite, amphibole; NAVARRETE ET AL. 1991, 143 Tab. 1, samples 1-11; 150 Tab. 2), determination of iron by chemical analyses, optical description of clay matrix, temper;

Evaluation: ANOVA, factor analysis; processing techniques (densities, degree of porosity; NAVARRETE ET AL. 1991, 200 Tab. 7; firing temperature p. 206 Tab. 8). Primarily, farming communities processed their pottery from clay of a metamorphic origin due to the regional lithology. The raw material was specifically selected: They used clay with large amounts of philosilicates and medium to small amount of calcite for jars (for cooking). Bowls were processed out of clay with higher amounts of calcite. The clay was tempered with quartzite, feldspaths, calcites mica, schist and small flint chips. The mineral components are rounded and thus originate from a fluvial deposit (NAVARRETE ET AL. 1991, 217). The graphite pottery was tempered with extraordinary amounts of mica. The Early Neolithic ceramic was fired between 710 to 780°C, thus implying similar firing techniques throughout the whole Neolithic with similar temperatures.

Figures: ATOCHE PEÑA 1985-1987, 112-128 Fig. 1-17; NAVARRETE 1976, 165-179 Fig. 69-79; 231-238 Fig. 112-117; 254 Fig. 123; Plates LXII-LXVI; Plates CLI-CLXXXII; NAVARRETE ET AL. 1991, 42-49 Fig. 2-6; 143-235 Tab. 1, 2, 7, 8, 10, 11, 14; PELLICER 1964, 49-53 Fig. 21-24; VAN WILLIGEN 2006, Plate 23, 3; 24, 5.

	Car/GR: LITHIC ASSEMBLAGE	*n*	*%*
BLANKS	flakes*	191	52.5%
	blades*	51	14.0%
	cores*	26	7.2%
	prismatic blades: max. length	*5.7cm*	
	prismatic blades: min. length	*3.93cm*	
	prismatic blades: Ø length	*4.84±0.66cm*	
	prismatic blades: max. width	*2.42cm*	
	prismatic blades: min. width	*0.91cm*	
	prismatic blades: Ø width	*1.6±0.37cm*	
	prismatic blades: max. thickness	*0.87cm*	
	prismatic blades: min. thickness	*0.23cm*	
	prismatic blades: Ø thickness	*0.44±0.15cm*	
	artifacts with cortex*	*139*	*38%*
	complete artifacts*	*158*	*44%*
BUTTS	plain	163	75.50%
	point	34	15.70%
	diedric	8	3.70%
	facetted	11	5.10%
	with platform remant	216	100%
TOOLS	lateral retouches or use traces	45	48.4%
	borers	20	21.5%
	denticulates	8	8.5%
	notched pieces	6	6.5%
	end scrapers	6	6.5%
	truncations	4	4.3%
	splintered pieces	1	1.1%
	others	3	3.2%
	Σ tools*	93	25.5%
Σ total assemblage		364	100%

Tab. 244 Car/GR. Summary table of the Early Neolithic assemblage of levels XIV to XVI of the excavation of Pellicer 1960 according to MARTÍNEZ FERNÁNDEZ (1985; *referring to Σ total assemblage).

Ground stone tools:

1 polished stone axe, 1 frag. schist arm ring (MARTÍNEZ FERNÁNDEZ 1985, 175), grinding stones, abraders, 1 probable pottery burnishing stone, 1 egg-shaped gneiss and stone beads from CIV, V/unit I, II (FERNÁNDEZ ET AL. 2007, 79; WIGAND 1978, 226; 229 Fig. 31 E; 231; 232). Levels VIII, IX/excavation Pellicer 1959 (NAVARRETE 1976, 231-238): In addition to a schist plate and a calcite arm ring frag., NAVARRETE (1976, 231) also mentions the presence of grinding stones with red ocher traces. Red ocher was used diachronically (WIGAND 1978, 231; 251-252).

Bone industry:

Small amounts (MARTÍNEZ FERNÁNDEZ 1985, 175); worked bone from CIV, V/unit II and I (FERNÁNDEZ ET AL. 2007, 79; WIGAND 1978, 287-288).

Figures: PELLICER 1964, 49 Fig. 21.

Faunal remains/fauna:

Very little in total; 28.2% wild game in levels XIV to XVI, Pellicer 1960: deer, wild cattle, boar, horses, *capra pyranaica hispanica*, lagomorphs (MARTÍNEZ FERNÁNDEZ 1985, 175);
unit I and II, VEGA-TOSCANO ET AL. 1988: lagomorphs, rodents, carnivores, horses, pigs, deer, boar, sheep, cattle and goats (FERNÁNDEZ ET AL. 2007, 78-79) and similar examples of WSU-excavation in CIV (VEGA TOSCANO ET AL. 1997, 72; WIGAND 234 Tab. 7).
Domestic fauna: *ovicapridae* (rather young individuals); cattle and pig gained relevance in the following Neolithic stages (domesticates in the Middle Neolithic: 84%; MARTÍNEZ FERNÁNDEZ 1985, 175-176). WIGAND (1978, 262) documented additionally domesticated dogs.

SAMPLE				MINERALOGY								MINERALOGY: PHILOSILICATES							MANUFACTURE		
level	sample	remarks	VUs	philosilicate	quarts	calcite	feldspath (K)	plagioclase	diopside & wollastonite	gehlenite	hematite	crystallinity	illite 002/illite 001	crystalline size	amounts of Ilita	amounts of paragonite	amounts of smectite	amounts of chlorite	density gr/cm³	porosity	estimated firing temp. °C
XVI	1			67%	12%	20%	T	T	1%	T		2.8	0.36	429	S	?		S	1.5	43%	710
XVI	2			64%	21%	12%	2%		T	1%		3.2	0.34	344	L	S	S	S	1.4	49%	724
XVI	3			38%	58%	1%	1%	1%	1%	T					S		S		1.7	36%	724
XV	4	*almagra*		69%	21%	5%	2%	2%		1%		4.8	0.21	191	M	?	S		1.7	37%	750
XV	5	red incrustation		46%	44%	5%	2%	2%	1%						S		?		1.6	40%	750
XV	6		254	71%	26%	1%	1%	T	1%	T		2	0.64	854	S			S	1.8	32%	717
XV	7			49%	36%	3%	3%	1%	7%	1%					S		?		1.3	50%	764
XV	8	graphitite ?		67%	20%	10%	T	1%	1%	1%		5	0.14	181	S				1.5	44%	718
XV	9	red incrustation	259	25%	68%	2%	2%	1%	1%	1%		1.4		3321	S		S	S	1.8	33%	739
XV	10	graphitite	271	69%	24%	1%	2%	4%	T	T	T	2	0.48	854	L		S	S	1.7	34%	777
XVI	11	famous vessel	1145	69%	21%	4%	2%	3%	1%	T		3	0.28	382	M		?	?	1.4	46%	765

Tab. 245 Car/GR. Summery table of pottery mineralogy and manufacture of the Early Neolithic samples according to NAVARRETE ET AL. (1991, 143 Tab. 1; 150 Tab 2; 200 Tab. 7; 206 Tab. 8; 226 Tab. 11; frequency of dolomite and talc not available; temp. = temperature, T = traces, S = small, M = medium, L = large).

Botanic remains:

Various arboreal and non-arboreal pollen; carbonized grains of wheat and barley; pollen zone 21 of FERNÁNDEZ ET AL. (2007, 83-84; with further palynological studies concerning Pleistocene therein) corresponds to the Neolithic with high frequencies of oaks, *Poaceae, Asteraceae*. Generally, the Early Holocene paleo-environment (Carigüela pollen zones 19-21 = Padul 3 zones m-t) is characterized by a "mixed oak forest ecosystem with diversity of trees and understory" and optionally pines (FERNÁNDEZ ET AL. 2007, 86; 87-88). So far there are neither explicit finds nor hints for agriculture in the Early Neolithic levels of Carigüela (cf. wheat find in the latest ceramic levels: impressed pottery; excavation of Irwing). Seeds are only available from Chalcolithic levels (WIGAND 1978, 255).

Other:

1 frag. of a ring and a pendant of bone (level XVI); stone, bone and shell beads, shell pendants, schist and shell bracelet frags., jewelry and idols are probably of later periods (CIV, V/unit I, II; FERNÁNDEZ ET AL. 2007, 79; WIGAND 1978, 288). These special finds could indicate trade.

FEATURES

Rests of fireplaces in level VIII/Pellicer 1959, XVI and XIV/Pellicer 1960; hearths, gravels and burials in unit II and I/VEGA-TOSCANO ET AL. (1988).

INTERPRETATION

During the Early Neolithic Car was a settlement with probably only seasonal occupation within yearly transhumance-cycles (WIGAND 1978, 288). It is situated in a specific environmental and cultural zone separated from the costal development (PELLICER 1964, 7). PELLICER (1964, 67-68) assumed that influences from Valencia, Alicante and Murcia carried the Neolithization. The interior chambers were probably used as waste disposals of the people living in the entrance areas. Objects could also belong to burials (WIGAND 1978, 287) and a few human bones remained from sporadic burials (WIGAND 1978, 263). Especially in later Neolithic periods people used the cave also as burial place (MARTÍNEZ FERNÁNDEZ 1985, 175). Faunal and botanical remains imply agriculture and stock breading since the Neolithic (FERNÁNDEZ ET AL. 2007, 88). The relative large amount of wild animals could be due to an adaptation on the mountainous region. The dominance of remains from young domestic animals implies pastoralism (MARTÍNEZ FERNÁNDEZ 1985, 175). The lithic assemblage is apparently *not* in Epipaleolithic tradition. Shells documented contacts to the coast S of the Sierra Nevada (WIGAND 1978, 278). Pottery raw material origins up to 50km distance imply further contacts, mobility or trade (WIGAND 1978, 278-230 cf. **5.3. Raw materials: Mineralogical and chemical analyses of pottery and clay deposits**).

Cueva de la Higuera/Murcia

Isla Plana, Cartagena, Murcia

Name short: **CH**
ID site: **2**

Longitude:
1°12'15"W [37°34'45"]

Latitude:
37°34'45"N [2°29'08"]

(coordinates estimated; cf. Remarks)

Altitude asl:
48m

Orientation:
to S

Distance to coastline:
today approx. 600m

Type of site:
cave

Publications:
ARQUEOMURCIA 2011; MARÍNEZ ANDREU n.d.; 1985; MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 1986; 2005; 2006; 2008. A publication of the finds is in prep. (pers. comm. M. Martínez Andreu).

Remarks:
Publications focus on the rock art of the cave, whereas the excavations are so far only published in preliminary reports (MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2005 to 2008). The site is also known as Los Cochinos (MARTÍNEZ ANDREU n.d.).
The coordinates by MARTÍNEZ ANDREU (1985, 79; here in []) do not match the site location of the map (MARTÍNEZ ANDREU 1985, 86 Fig.1).

RECORDING

Relevant stages:
Epipaleolithic

Depository:
Cartagena, Museo Arqueologico

Recorded artifacts:
Lithic artifacts

Lithic IDs:
2000-2999

Pottery VUs:
/

Remarks:
Based on the preliminary reports (MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2005, 238; 2006, 45 and 2008, 47) the following excavation seasons and levels could contain Epipaleolithic material: 2004 square 14F level 3 (Upper Paleolithic); 2005 13/14F level 3 (Final Upper Paleolithic); 2007 13/14F (Final Paleolithic/Epipaleolithic; "*laminaridad*"). I recorded and evaluated lithic artifacts of these units in this study. Indeed artifacts from other seasons (1986, 1987, 2002) or without year were recorded, but the data sets were never corrected nor included in this study.
Information concerning Early Neolithic finds from season 2007 is vague (MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2008, 47) and I did *not* analyze any Early Neolithic artifacts.

SETTING

The cave is situated in the foothills of Cabezo del Horno and in the bay of Mazarrón (directions cf. MARTÍNEZ ANDREU 1985, 79 with a map on p. 86 Fig. 1).

DESCRIPTION

CH consists of three cavities with two small galleries (*sala* A, B) of 40m² (width and depth: 8 and 4m; MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 1986, 213 with a photo; cf. MARTÍNEZ ANDREU 1985, 87, Fig. 2 with a ground plan).

RESEARCH

Since 1979 CH was known as archaeological site and the rock art was discovered and investigated (MARTÍNEZ ANDREU 1985, 79).
Various excavation seasons took place in the years 1982, 1986, 1987, 2001, 2002, 2004, 2005 and 2007. These are so far briefly summed up in preliminary reports (MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2005, 2006, 2008):
<u>1982-2001</u>: ?
<u>2004:</u> flotation of the deposits by Ernestina Badal and geological studies by Mario Sánchez; excavations in the vestibule/squares 16, 17, 18/A, B, C level 2/Roman republic, Punic, Romanization and in "*sala central*"/14F level 3 base (almost bedrock)/Upper Paleolithic with many mollusks;

2005: excavations in "*sala central*"/13/14F level 3 base (-2.75m to -2.85m)/Final Upper Paleolithic and in the vestibule/16C level 3, 16D level 3, 17C level 2 and initial level 3, 17D level 2, 17E level 2, 18B level 2, 18C level 2 base, 18D level 2 base and level 3/up to -1.02m few Prehistoric and Roman finds; -1.09m: Prehistoric; level 3 Neolithic and prospection of the cave walls ("*Reflectografía Infrarroja*");
2007: excavations in the vestibule in -1.27m/Early Neolithic, in "*camarín*" in -1.55m/transition Roman time/Romanization and Neolithic and in "*sector central*"/14/13F in -2.94m to -3.00m/"*horizonte finipaleolítico*"/Epipaleolithic ("*laminaridad*") and 13F level 4 in -2.88m to -2.97m.

LITHIC ARTIFACTS		*number*			*weight*				
		Σ (n)	*%*	*ratio (% Σn)*	*Σ (g)*	*%*	*Ø (g)*	*SD*	*ratio (% Σg)*
Σ (reference amount)		257	100.0%		435.0	100.0%	1.7	2.991	
chips		85		0% 100%					0% 100%
blanks	flakes	136	52.9%		205.9	47.3%	1.5	1.885	
	blades	85	33.1%		87.2	20.0%	1.0	1.902	
	art. debris	28	10.9%		55.5	12.8%	2.0	3.319	
	pebbles								
	cores	8	3.1%		86.4	19.9%	10.8	8.457	
	total with cortex	86	33.5%		200.7	46.1%	2.3	3.554	
	non-mod. pieces	208	80.9%		235.7	54.2%	1.1	1.306	
	burin spalls								
	tools	49	19.1%		199.3	45.8%	4.1	5.765	
flakes & blades	total	221	86.0%		293.1	67.4%	1.3	1.902	
	complete*	124	56.1%		154.4	52.7%	1.2	1.848	
	dorsal reduction**	78	44.3%		103.0	42.5%	1.3	1.398	
		index	*ratio*		*index*	*ratio*			
	n flakes : n blades	1.6	03:01		2.4	05:01			
operation chain	0 RM procurment								
	1 decortification	11	4.3%		18.3	4.2%	1.7	1.780	
	2 core preparation	15	5.8%		23.1	5.3%	1.5	1.590	
	3 débitage	125	48.6%		122.0	28.0%	1.0	1.099	
	4 repreparation	9	3.5%		15.2	3.5%	1.7	1.381	
	5 tools&use	89	34.6%		254.5	58.5%	2.9	4.548	
	6 discarding	43	16.7%		88.7	20.4%	2.1	2.928	

Tab. 246 CH/MU. Lithic assemblage (weight in gram (g); *referring to total flakes and blades; **referring to flakes and blades with proximal end: 176 pieces/242.3g).

CHRONOLOGY

14C-ages:
/ (Probably datable material as bones or charcoal present.)

References:
MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2005 to 2008.

Stratigraphy:
Each excavation season provided a stratigraphical sequence, which do not correlate (pers. comm. M. Martínez Andreu).
The preliminary reports (MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2005, 238; 2006, 45 and 2008, 47) indicate Final Paleolithic and Epipaleolithic ("*laminaridad*") and Early Neolithic material in the squares and levels of excavation seasons listed in **RESEARCH** and **RECORDING**.

Remarks:
MARTÍNEZ ANDREU (n.d., 64-65) stated that there are no specific Epipaleolithic-Mesolithic contributions and proposed to merge the Holocene hunter-gatherers to the Upper or Late Paleolithic. The microlithization is thus a progressive adaptation of Paleolithic traditions to changed conditions and a task to limit mobility ("restricted nomadism"). He favors to no longer use the terms Epipaleolithic or Mesolithic. Changes to the following Neolithic were severely.

ARTIFACTS

Lithic assemblage:

Excavation 2005, square 13/14F, level 3: borers, double end scraper for skin treatment (MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2006, 45).

Figures: /

Pottery assemblage:

Frags. incised pottery; Roman ceramics (ARQUEOMURCIA 2011).

Figures: /

Ground stone tools:

Minerals, red ocher frag.

Figures: /

Bone industry:

Present (not further specified, amongst others bone point ? of excavation season 2002, 13F level 3).

Figures: /

Faunal remains/fauna:

Remains of mammals (deer, sheep, goat, rabbits, etc.), fish, malacofauna (MARTÍNEZ ANDREU n.d., 61; MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 2008, 47).

Botanic remains:

Charcoal; no cultivated plants.

Other:

Arm ring frags. (Neolithic level).

FEATURES

Paleolithic and Neolithic rock art is present: In gallery A/between "*sala central*" and vestibule a human figure in schematic style and in gallery B a caprine animal in Levantine style and a female figure are depicted (MARTÍNEZ ANDREU n.d., 60-61; MARTÍNEZ ANDREU 1985, 81-83; MARTÍNEZ ANDREU 1985, 81-83; MARTÍNEZ ANDREU/SÁNCHEZ GÓMEZ 1986, 211; 214; 216; 2006, 45-46).

INTERPRETATION

MARTÍNEZ ANDREU (n.d., 61) assumes a seasonal settlement in the interior ("*sala central*" and vestibule) with distinct zones to process and consume flint and bone. Although a limited domestication of ovicaprids took place, the subsistence was still based on marine resources and hunting and gathering. Thus, accordance between the Paleolithic, Epipaleolithic and Neolithic occupations are due to a spatial tradition and the use of similar resources (marine, hunting gathering).

Cueva de las Goteras/Málaga

Molina, Málaga

Name short: **Got**
ID site:

Longitude:
4°39'00"W [-4,65]

Latitude:
37°07'48"N [+37,13]

(coordinates converted)

Altitude asl:
/

Orientation:
cf. NAVARRETE 1976, 383 Fig. 185.

Distance to coastline:
today approx. 50km

Type of site:
cave

Publications:
NAVARRETE 1976, 383-385.

Observations:
/

RECORDING

Relevant stages:
Early Neolithic

Depository:
Málaga, Museo de Málaga

Recorded artifacts:
Pottery

Lithic IDs:
/

Pottery VUs:
1007-1013

Remarks:
Non-decorated pottery was in boxes 1-3 (n° inventario 90-92). But these pieces were neither mentioned nor pictured by NAVARRETE (1976, 383-385 and Plates 386-391) and I did not analyze them. Finally three sherds that Navarrete described in 1976 were found elsewhere. I recorded these as VUs 1007-1009 and VUs 1010-1013 based on the photos of NAVARRETE (1976, Plates 386, 388, 391, 1 and 2).

POTTERY		number VUs		
		Σ (n)	*%*	*ratio (% VU)*
	Σ VU *(reference amount)*	7	100.0%	
	Σ sherds	7		
	Ø sherds/ VU	1.0		0% 100%
VU	with rim frag.	2	28.6%	
VU	with definable DM	2	28.6%	
VU		*cm*		
VU	Ø DM	13.0		
shape	with definable shape	2	28.6%	
shape	shape not definable	5	71.4%	
shape	pots*	2	100.0%	
decoration	decorated	7	100.0%	
decoration	non-decorated			
decoration	n decoration techniques	7		
decoration		*index*	*ratio*	
decoration	n decoration techniques : n decorated VU	1.0	01:01	
decoration	with impressed decoration**	6	85.7%	
decoration	Cardium-impressed***	5	83.3%	
decoration	with incisions**	1	14.3%	
decoration	with sculptured bands**			

Tab. 247 Got/MA. Pottery assemblage (*referring to VUs with definable shape; **referring to n decoration techniques; ***referring to VUs with impressed decoration).

SETTING

The cave is the most N site in MA (NAVARRETE 1976, 383).

DESCRIPTION

Plan: NAVARRETE 1976, 383 Fig. 185.

RESEARCH

? (cf. NAVARRETE 1976, 383).

CHRONOLOGY

14C-ages:	Stratigraphy:	References:
/	/	/

Remarks:

Materials remain from an early period in the Neolithic (NAVARRETE 1976, 385).

ARTIFACTS

Lithic assemblage:

/

Figures: /

Pottery assemblage:

7 frags.: Amongst others of a small pot and a bowl with impressed (5 units including 4 with Cardium-impressions) and incised decoration (2; NAVARRETE 1976, 383-385).

Figures: NAVARRETE 1976, 381 Fig. 184; 384 Fig. 186 and Plates 386-391.

Ground stone tools:

/

Figures: /

Bone industry:

/

Figures: /

Faunal remains/fauna:

/

Botanic remains:

/

Other:

/

FEATURES

/

INTERPRETATION

/

Cueva (de) Nerja/Málaga

Maro, Nerja

Name short: **Ner**
ID site: **11**

Longitude:	Latitude:	
3°50'30"; 424.695 (x)	36°45'54"; 4.069.025 (y)	G.D.E.; UTM 30S VF26
Altitude asl:	Orientation:	Distance to coastline:
178-208m (currently: 158m asl)		1.5-2.5km (currently ca 1km)

Type of site:
cave

Publications:
ADÁN ÁLVAREZ 1988; AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO 2011; AURA TORTOSA ET AL. 2001; 2002; 2005; 2009a, b; 2010; BADAL 1996; CARRASCO CANTOS 1993; CORTÉS-SÁNCHEZ ET AL. 2008; GARCÍA BORJA ET AL. 2010; GARCIA SANCHEZ 1986; JORDÁ PARDO 1986a, b; JORDÁ PARDO/AURA TORTOSA 2008, 2009; JORDÁ ET AL. 2010, 2011; JORDÁ PARDO ET AL. 2003; PELLICER/ACOSTA 1986; PELLICER CATALÁN 1963; NAVARRETE 1976, 315-339; MARTÍNEZ ANDREU 1989 - 1990, 54; MORALES/ROSELLÓ 2004; SIMÓN VALLEJO 2003; http://www.cuevadenerja.es/.

Observations:
The archaeological depositions of Mina, Vestibule and Torca hall belong to one site (JORDÁ PARDO/AURA TORTOSA 2009, 95).

RECORDING

Parts of the archaeological remains are stored in the Museum of Malaga. The selection is random and incoherent: E.g. artifacts that originate from the sieving of the sediment from squares are present, but the associated assemblage from the excavation of the very same squares is missing and vice versa. A good source for the materials available in the museum is a document of revision *"Materiales procedentes de diversas campañas de excavaciones ralizadas en la Cueva de Nerja (Maro, Malaga)"* by M. García Cañadas and L. Péreu Iriarte on 30.12.1990. I recorded several lithic artifacts under IDs 11000-11999, but the datasets are not corrected nor analyzed in the present study.
The material of the recent excavations (70ies and 80ies) is predominantly at the University of Valencia under investigation. Additional material is kept at the *Fundación Cueva de Nerja* (pers. comm. V. Jiménez Jámez).

SETTING

The cave is situated 50km E of Málaga next to Nerja and Maro in the SW slope of Sierra Almijara on 158m asl. Currently its distance to the coast is less than 1km (cf. AURA TORTOSA ET AL. 2002, 20 Fig. 1). While the coast was 3 to 5.5km away in the Upper Pleistocene, the distance decreased to about 2.5km during the Epipaleolithic and ca 1.5km in the Early Neolithic because of the Holocene sea level rise. During this time the cave was 208m and 178m asl, respectively (AURA TORTOSA ET AL. 2002, 28 Fig. 3). Ancient settlers overlooked a plain that sloped to the coast with beaches (SIMÓN VALLEJO 2003, 256 Fig. 2; 262).

DESCRIPTION

Ner is a widely forked cave system of ca 750m length (cf. SIMÓN VALLEJO 2003, 252 Fig. 1; www.cuevadenerja.es/). Three openings lead to three successive large galleries with several halls. Most excavations took place in the entrance area in Vestibule, Mina and Torca hall. This area can be considered as one site (JORDÁ PARDO/AURA TORTOSA 2010, 410). Additional archaeological investigations took place in the near Bethlehem hall and the passageway of Catacysm/Cascada-Ballet and Ghosts/Fantasmas hall to the interior and high galleries. These mentioned areas are opened to tourism. The subsequent high galleries also consist of several halls (Hercules' columns, Fish, Immensity and of Levels). The halls of the Lance and of the Mountain are located in the subsequent New galleries.
Upper Pleistocene to Holocene deposits remained in the cave entry in the biggest galleries of Vestibule, Mina and Torca.

RESEARCH

Numerous investigations took place. Archaeological excavations and prospections in situ took place untill 1987. Epipaleolithic/Mesolithic and Early Neolithic levels are given in parentheses (according to SIMÓN VALLEJO 2003 with a summary table).

1959 discovery;

1959-60 excavations in Vestíbulo, Torca (level 4 to 7), Belén (level VI to VIII), Cascada, Fantasmas and Cataclismo halls by M. Pellicer;

1962-63 excavations in Vestíbulo hall (level III to IV) by A.M. de la Quadra Salcedo;

1965 excavation in Vestíbulo hall (level 3 to 4) by F. Jordá Cerda;

1965-68 excavations in Vestíbulo and Mina halls (level IV to V) by F. Jordá Cerda and A. Arribas Palau;

1971-72 excavations in Mina chamber by M. Muñoz;

1977 excavations in Mina and Torcal chamber by M. Pellicer Catalán;

1979-1982 excavations in Mina hall (NM: levels 9 to 13) by F. Jordá Cerda;

1979-87 excavations in Mina hall (NM/79: levels 4 to 6; NM/80: levels 4 to 6; NM/80B level 10) by M. Pellicer Catalán;

1982 excavation in Vestíbulo and in Cataclismo chamber by F. Jordá Cerda and in Torcal hall (NT782: levels 10 and 12) by M. Pellicer Catalán;

1984-86 excavations in Mina hall (NM/84A: levels 5 to 6 and NM/84B level 5; NM/85 and NM/86) by M. Pellicer Catalán and

1987 excavation in Torcal chamber by M. Pellicer Catalán (for maps of the excavation areas cf. JORDÁ PARDO/AURA TORTOSA 2008, 241 Fig. 1; JORDA ET AL. 2011, 28 Fig. 1; JORDA CERDA ET AL. 1985; BECARES PEREZ/JORDÁ PARDO 1986; PELLICER/ACOSTA 1986, 249 Plate 1).

Additionally various parties investigated the cave art and the *Fundación Cueva de Nerja* was founded (SIMÓN VALLEJO 2003; cf. http://www.cuevadenerja.es/index.php?modulo=inv_proyectos). Meanwhile, results are published in more than 90 papers (JORDÁ PARDO/AURA TORTOSA 2010) and many more works can be expected (JORDÁ PARDO/AURA TORTOSA 2010, 408). JORDÁ PARDO and AURA TORTOSA (2010, 412-413 with citations therein) list seven main research foci: 1. Stratigraphy and chronology; 2. Dispersal of the ancient coastline, paleoenvironment and geology; 3. Taphonomy and processing of terrestrial resources; 4. Exploitation of marine resources; 5. Archaeobotany and exploitation of plant resources; 6. Description of the different archaeological horizons (amongst others Epipaleolithic, Mesolithic and Neolithic) and 7. Late Pleistocene bone industry, burials, microliths and jewelry.

CHRONOLOGY

14C-ages:

Many 14-ages are available for the whole occupation of Ner from the Gravettian to the Cooper age. Recently a critical review (JORDÁ PARDO/AURA TORTOSA 2008; 2006 with citations therein) unfolded that thereof 4 ages of Epipaleolithic contexts and 3 ages of Early Neolithic contexts are reliable:

10040 ± 40 calBP (Beta-156020 11560 ± 130 14C-yrs BP) =Epipaleolithic

7620 ± 40 calBP (Beta-193271 8420 ± 30 14C-yrs BP) =Epipaleolithic

7610 ± 90 calBP (GifA-102.01 8430 ± 90 14C-yrs BP) =Epipaleolithic

7240 ± 80 calBP (Ly-5217 8070 ± 80 14C-yrs BP) =Epipaleolithic

7500 ± 40 calBP (Beta-131577 6590 ± 40 14C-yrs BP) =Early Neolithic

7350 ± 60 calBP (Ly-5218 6420 ± 60 14C-yrs BP) =Early Neolithic

7080 ± 60 calBP (Beta-193269 6180 ± 40 14C-yrs BP) =Early Neolithic

Additionally AGUILERA AGUILAR/ MEDINA ALCAIDE/ROMERO ALONSO (2011) present the following ages from the Early Neolithic:

7260 ± 50 calBP (Beta-270023 6330 ± 40 14C-yrs BP)

7140 ± 90 calBP (Beta-271213 6230 ± 40 14C-yrs BP; from Cataclismo hall)

6890 ± 60 calBP (Beta-270019 6040 ± 40 14C-yrs BP; from Cataclismo hall)

6990 ± 60 calBP (Beta-270034 6040 ± 40 14C-yrs BP)

6550 ± 60 calBP (Beta-270037 5740 ± 40 14C-yrs BP)

6360 ± 40 calBP (Beta-270018 5570 ± 40 14C-yrs BP; from Cataclismo hall).

In total 42 valid 14C-dates exist between 30 and 3.9ka calBP for Gravettian to Chalcolithic occupations (Jordá Pardo/Aura Tortosa 2010, 412) with amongst others Microlaminar Epipaleolithic, (Mesolithic ?) and Neolithic remains.

Only the datings that are explicitly listed above and three valid Middle Neolithic ages were included in the chronological schemes of the present study in **2.2. Chronology**.

Stratigraphy:

Settlement horizons are separated by sedimentation events during site abandonment:
Gravettian, Solutrian, Upper Magdalenian;
Microlaminar Epipaleolithic/Epigravettian (Upper Pleistocene/Younger Dryas - Holocene);
4430 years HIATUS (until 8.2 event);
Geometric Epipaleolithic/ Mesolithic ? (Atlantic) = mixed level of Epipaleolithic and Early Neolithic finds;
Early Neolithic/Advanced Early Neolithic (Atlantic); Late Neolithic; Chalcolithic.

References:

Aura Tortosa et al. 2009b; Aguilera Aguilar/Medina Alcaide/Romero Alonso 2011; Jordá Pardo/Aura Tortosa 2008, 2009; Simón Vallejo 2003 with citations therein. For detailed information about the levels in the different areas in the cave and of different excavation seasons cf. Jordá Pardo/Aura Tortosa (2006, 584 Fig. 2) or Simón Vallejo (2003).

Remarks:

The Pleistocene-Holocene transition is located at the base of an Epipaleolithic shell-midden (Jordá Pardo/Aura Tortosa 2010, 413).

NER excavation*	NEOLITHIC			trans-ition	CHALCOLITHIC		- SURFACE -
	Early	Middle	Late		Early	Late	
NT-79	4	3			2		
NM-79	4	3	2	1			
NM-80A	4	3	2	1			
NM-80B	10A + B	9 + 8	7	6	5 + 4	3 - 1	
NT-82	10 + 9	8	7	6	5	4 + 3	
NM-84A	6 + 5	4 + 3	2		1		
NM-84B	5	4 + 3	2	1			

Tab. 248 Ner/MA. Levels evaluated in the study of Pellicer/Acosta (1986, 347-380 Plate 6; cf. **Tab. 250**, **Tab. 252** to **Tab. 256**; *NT=Nerja Torca or NM=Nerja Mina with year of excavation).

ARTIFACTS

Lithic assemblage:

Neolithic (NV): 985 artifacts; Mesolithic ?/mixed "transitional" level (NV -3; NM -12): backed bladelets, end scrapers, burin, microliths (Aura Tortosa et al. 2009b, 349-350; 351 Fig. 5; cf. **Tab. 249**).
Martínez Andreu (1989-1990, 54) noticed a similar change as in Cueva del Algarrobo (cf. p. 254).
Mina hall, level 7, squares 1K, 2K, 1I, 2I, 1J, 2J (Aguilera Aguilar/Medina Alcaide/Romero Alonso 2011): 1434 knapped artifacts
95.25% of flint: 32.21% debris, 24.19% flakes, 20.99% cores, 15.2% blades; 2.58% tools;
4.75% of rock crystal: 39/2.71% flakes and blades, 11/0.76% cores; 1 flake abruptly retouched;
37 tools in total: geometric microliths (1 triangle, 4 trapezes, 3 segments), 6 backed bladelets, end scrapers, 1 borer.
No local raw materials were available, thus people exploited sources in 25km (Aura Tortosa et al. 2001, 29; 34) and 40-50km distance: 39.6km Benajarafe; 47.2km Cútar, 47.4km Sierra Gorda/GR and rock crystal from Motril area/GR in 56km distance (Aguilera Aguilar/Medina Alcaide/Romero Alonso 2011). Only one small nodule (1.8cm) from a river is preserved on-site, thus Aguilera Aguilar/Medina Alcaide/Romero Alonso (2011) assume a pre-preparation off-site at the source

region and subsequently the transport to Ner. The rest of the reduction sequence took place on-site.

The Neolithic and Chalcolithic lithic industry is in Epipaleolithic tradition cf. **Tab. 250** (PELLICER/ACOSTA 1986, 425): Burins, end scrapers and backed pieces persist (PELLICER/ACOSTA 1986, 436).

Late Epipaleolithic artifacts (level V excavation of Pellicer 1959-60): end scrapers, burins (?), bladelets, backed bladelets, retouched flakes, cores, flakes, colored pebble (NAVARRETE 1976, 328-329; concerning the Chalcolithic lithic assemblage of Sala de la Torca/excavation 1987 cf. RAMOS MUÑOZ 1988).

Figures: AURA TORTOSA ET AL. 2009b, 351 Fig. 5; GONZALEZ-TABLAS SASTRE 1986, 273-277 Figures and Tables; PELLICER/ACOSTA 1986, 426-434 Plate 37-42.

	CUEVA DE NERJA, MÁLAGA; Vestíbulo	Early Neolithic E NEO (NV-2)		Mixed/Meso ? Meso ? (NV-3)		Epipaleolithic/Epimagdalenian NM-13		NM-12	
		n	*%*	*n*	*%*	*n*	*%*	*n*	*%*
BLANKS	flakes	93	34.3%	144	46.2%	*NA*			
	blades	83	30.6%	51	16.3%				
	cores	4	1.5%	14	4.5%				
	nodules	1	0.4%	2	0.6%				
	debris	88	32.5%	100	32.1%				
	thermal fractures	2	0.7%	1	0.3%				
	Σ	271	100%	312	100%				
	n.s.*	88	24.4%	93	24.4%				
TOOLS	1 end scrapers	1	2.3%	1	2.6%	22	14.6%	6	7.1%
	2 borers			2	5.1%	4	2.6%	3	3.5%
	burins					24	15.9%	11	12.9%
	4 retouched flakes	7	15.9%	7	17.9%				
	flakes with lateral retouch					20	13.2%	22	25.9%
	5 backed flakes	2	4.5%	6	15.4%	5	3.3%	3	3.5%
	6 blades with lateral retouch	11	25.0%	2	5.1%				
	7 backed blades	6	13.6%	6	15.4%				
	backed bladelets					31	20.5%	15	17.6%
	8 notched pieces			1	2.6%	14	9.3%	9	10.6%
	8 denticulates	1	2.3%	2	5.1%	7	4.6%	6	7.1%
	9 microliths (trapezes)	2	4.5%	2	5.1%	3	2.0%	3	3.5%
	10 truncations	9	20.5%	6	15.4%	6	4.0%	1	1.2%
	14 other	5	11.4%	4	10.3%	15	9.9%	6	7.1%
	Σ tools*	44	12.3%	39	10.9%	151	100%	85	100%

Tab. 249 Ner/MA. Lithic assemblages summarized according to AURA TORTOSA ET AL. (2005, 982 Tab. 3 to 5) and GONZALEZ-TABLAS SASTRE (1986, 274-276). The Simpson diversity indices account for 0.147 (E NEO), 0.125 (EPI NM-13) and 0.135 (EPI NM-12).

CUEVA DE NERJA/MA: LITHIC ASSEMBLAGES according to Pellicer/Acosta 1986		type Fortea	n	EPI	trans-ition	NEOLITHIC Early	Middle	Late	trans-ition	CHALCOLITHIC Early	Late
end scrapers (diachronic)			42	86%	*NA*	2%	10%	2%			
synchronic	*single end scraper on flake (A)*	R 1		46%	88%	100%					
	single end scraper on retouched flake (B)	R 2		4%				100%			
	core-shaped end scraper (C)	R 4		7%			75%				
	shouldered or nosed end scraper (D)	R 6		11%	10%						
	end scraper on blade (E)	R 8			10%		25%				
	double end scraper (F)	D 8		24%							
	retouched fracture of an end scraper (G)			4%							
	end scraper on flake (H)	D 8		4%							
burins (diachronic)			48	95%	*NA*	3%		2%			
synchronic	*burin with one burin facet (A)*	B 1		8%							
	burin with two burin facets (B)	B 2		17%							
	burin on a break (D)	B 4		42%	50%	50%					
	burin "simple múltiple" (E)	B 5		3%							
	burin on an oblique retouched break (F)	B6 b			50%						
	burin on an convex retouched break (G)	B 6 d		3%							
	multiple burin on a retouched break (H)	B 6 e		8%							
	Mallaetes burin (I)	B 7		3%							
	core-shaped burin (J)	B 8		3%							
	end scraper-burin (K)	C 1		13%							
backed pieces (diachronic)				88%	*NA*	3%	6%	3%			
synchronic	*backed flake (A)*	LBA 1		3%							
	frags. backed blade (B)	LBA 6					100%				
	backed bladelets (C)	lba 1		25%							
	backed bladelets with thinned base (D)	lba 1 bis		11%							
	backed point (E)	lba 2		18%							
	bladelet with partially backed edge (F)	lba 10		2%				100%			
	point with partially backed edge (G)	lba 10 bis		2%							
	frags. backed bladelet (H)	lba 11		37%		100%					
comparison: notched pieces, denticulates, microliths, etc.											
synchronic	*notched flake (A)*	MD 1		17%	12%		7%		5%		5%
	denticulated flake (B)	MD 2		7%		7%	10%	11%		5%	
	notched blade (C)	MD 3		2%	25%				5%		
	denticulated blade (D)	MD 4		1%	12%					5%	
	asymmetric trapeze (E)	G 3						11%			
	geometric trapeze with a concave retouched edge (F)	G 5				7%					
	rectangular microliths (G)	G 19		1%							
	blade with retouched fracture (H)	FR 1		14%		7%	7%		5%		5%
	microburin (I)	M 1		2%							
	blade with lateral retouch (J)	D 2		14%		14%	3%	11%	47%	29%	5%
	side scraper "raedera" (K)	G 19		1%		7%					
	crested blade (L)	D 4		4%							
	points (N)								5%		5%
	blade with use wears (O)	D 8		37%	51%	58%	73%	67%	33%	61%	65%
others		D 8	45								
synchronic	*end scraper on flake (A)*			5%	33%						
	burin on flake (B)			5%	33%						
	notched bladelet (C)			5%				50%			
	fracts. (D)			30%		16%	40%	50%			67%
	microliths (E)			5%							
	splintered pieces (F)			10%	34%						
	crested blade (G)			5%						20%	
	pseudo-sickles (H)					16%					
	cuchillo (I)			5%							
	tranchet (J)			5%			20%				
	flat retouch (K)					16%					
	backed pieces ? (L)			5%		16%					
	diverse retouches (M)			20%		36%	40%		100%	80%	33%
comparison: burins, end scrapers, flakes, blades, etc.											
synchronic	*burins (A)*			26%	10%	10%		14%	*NA*		
	end scrapers (B)			19%	53%	10%	25%	14%	*NA*		
	flakes, blades, bladelets (C)			21%		10%	12%	14%	*NA*		
	denticulates (D)			6%	5%	10%	19%	14%	*NA*	18%	
	notched pieces (E)			13%	16%		12%		*NA*	9%	
	others (F)			15%	16%	60%	31%	43%	*NA*	73%	

Tab. 250 Ner/MA. Lithic assemblages summarized according to PELLICER/ACOSTA (1986, 426-434 Plates 37-42 cf. **Tab. 248**).

Pottery assemblage:

García Borja et al. 2010, 113-120:

981 fragments of the Vestibule hall: 575 of NV-1, 279 of NV-2, 97 of NV-3, 13 of NV-4 (pits) + 17 n.s. Generally, the pottery is highly fragmented with badly preserved surfaces.

The sherds stem from originally at least 48 vessels of various forms predominantly hemispheric cf. **Tab. 251** (cf. García Borja et al. 2010, 116 Fig. 8). Decorations techniques are more or less similar in all levels. The impressed decorations originate from different tools (awls, stamps, single points) and variable in shape. Rocker stamp decoration also occurs. The pottery is typical for a Mediterranean Early Neolithic Impresso assemblage with a large variability of handles, impressed sculptured bands and generally a large variability of impressed decorations. However, no Cardial-decoration (only in Nerja-Mina), dots and dashes and neither *boquique/sillon d'impression* (there is one doubtable frag.) occur. The decorations are mostly horizontally structured and red coloration is important. *Almagra* decoration is connected with impressions or incisions. Probably the inventory can be classified as Pre-Cardial Impresso.

Aura Tortosa et al. 2005, 979-980:

970 pottery fragments of all Neolithic horizons in total: 268 thereof of NV-2/Early Neolithic, 97 of NV-3/mixed level and 13 of NV-4a/Epipaleolithic. All fragments were analzed together. They did not observe obvious changes (cf. Aura Tortosa et al. 2010, 223). The early pottery was oval with sculptured bands, impressed, incised or almagra decoration. Partially Cardium- and similar shell decorations occur (Simón Vallejo 2003, 265 cf. Aura Tortosa et al. 2005, 985 absence of Cardial pottery).

Mina hall, level 7, squares 1K, 2K, 1I, 2I, 1J, 2J (Aguilera Aguilar/Medina Alcaide/Romero Alonso 2011): 682 pottery units: predominantly non-decorated; impressed decoration once with red incrustation, sculptured decoration.

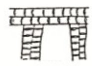
Pellicer/Acosta (1986) studied Neolithic and Chalcolithic pottery of the seven excavation seasons listed in **Tab. 248**. The Early Neolithic pottery has no exclusive, determining elements compared to the following phases with additional special characteristics (Pellicer/Acosta 1986, 372). The ceramic is typically coarse with many sculptured applications especially sculptured bands. Impressed and incised decorations were incrustated. The vessels have no extremely closed profiles and no Z-profiles (Pellicer/Acosta 1986, 374; 376). Furthermore, those were not intentionally fired oxidizing or reducing (Pellicer/Acosta 1986, 403): On a vessel different colorations can appear due to its former exposed or protected location in the oven or fire. Vessels with one surface treatment occur as well as several treatments (Pellicer/Acosta 1986, 403-404). Their attribute comparisons are summarized in **Tab. 252**, **Tab. 254** and **Tab. 255**.

Neolithic pottery of the excavation of Pellicer 1959-60 (Navarrete 1976): non-decorated and decorated pottery with incisions, sculptured bands, impressions (amongst others Cardium), coloration, incrustation.

Figures: Aura Tortosa et al. 2005, 981 Fig. 4; 980 Tab. 1-2; García Borja et al. 2010, 113-117 Fig. 4-9; 118-119 Tab. 1-2; Pellicer/Acosta 1986, 373 Plate 7; 390-417 Plate 15-32.

	CUEVA DE NERJA; MÁLAGA, VESTIBULE POTTERY	*n*	*%*
FORM	"A"	3	6.3%
	"B"	11	22.9%
	"C"	25	25.0%
	"D"	5	19.4%
	n.s.	17	35.4%
	rims	133	*NA*
	everted rims (*labios*)	190	
	bases	5	
	handles	142	
	*applicated handles**	*NA*	64.7%
	*strap handles**		14.8%
	*other**		20.5%
DECORATION	impressions on sculptured bands	*NA*	31.3%
	impressions on everted rims		29.5%
	incision		13.9%
	almagra		5.7%
	red coloration		11.7%
	incrustation	1	*NA*

Tab. 251 Ner/MA. Pottery assemblage summarized according to García Borja et al. 2010 (*refers to handles).

	NER/MA: EARLY NEOLITHIC POTTERY	*%*
geometric motifs		
	*meander (B)*	25%
	*patterns (e.g. herringbone) bounded by parallel lines (D)*	50%
	*strokes (incised herringbone, zigzag; E)*	25%
(Pellicer/Acosta 1986, 414, 50, 1 and 6, 9, 10)		
reticulated motifs		
	*grids (B)*	37%
	*crosswise incisions bounded by parallel lines (C)*	63%
(Pellicer/Acosta 1986, 416, 31, 1 and 9, 10)		
curved motifs		
	*filled curvilinear motifs (B)*	25%
	*impressed circle (F)*	75%
(Pellicer/Acosta 1986, 417, 32, 1 and 6, 15)		

Tab. 252 Ner/MA. Motifs of the Early Neolithic pottery assemblage according to Pellicer/Acosta (1986, cf. **Tab. 248**).

NER/MA: EARLY NEOLITHIC	*%*
Bone industry	
awl (A)	90%
fine awl (B)	10%
Ground stone tools	
pestles (F)	100%
(no adzes, axes, etc.)	
grinding stones (flat, A)	67%
grinding stones (naviform, B)	33%
Personal adornment	
marble arm rings (flat, A)	80%
beads (B)	20%

Tab. 253 Ner/MA. Summary table according to Pellicer/Acosta (1986, 418-424 Plate 33,1; 34, 1; 35, 1; 36, 1 cf. **Tab. 248**).

	CUEVA DE NERJA/MA: POTTERY according to Pellicer/Acosta 1986	n	NEOLITHIC Early	Middle	Late	CHALCOLITHIC Early	Late	Pellicer/Acosta 1986 page, plate, n°
	Σ pottery fragments	13255	11%	23%	31%	19%	16%	402, 24, 9
	ratio with surface treatment		12%	30%	44%	14%		402, 24, 10
FORM	closed profiles	291	6%	28%	25%	13%	27%	390, 15, 6
	with narrowed concave neck and everted rim (E)		6%	42%	32%	10%	9%	390, 15, 15 and 16
	hemispheric vessels	183	9%	18%	32%	18%	23%	391, 16, 6
	spherical calottes (A)		6%		12%	21%	61%	391, 16, 13 and 14
	stilted spherical calottes (D)		1%	14%	63%	32%		391, 16, 16 and 17
	open profiles	177	6%	19%	20%	27%	27%	393, 17, 6
	spherical calottes with prominent, everted rim (A)		11%		11%	33%	45%	393, 17, 18 and 13
	plates	305			4%	43%	54%	394, 18, 4
	carinated vessels	23			44%	56%	10%	395, 19, 5
	pointed bases (A)	22	9%	41%	50%			395, 19, 13
	flat bases (B)		36%	36%	9%	18%		395, 19, 15
	rims	314	6%	28%	36%	18%	2%	396, 20, 6
	vessels with wavy rim (H)		20%	77%		3%		396, 20, 21 and 22
	globular vessels with neck (bottles)	73	28%	9%	22%	37%	3%	398, 21, 6
APPLICATIONS	lug applications	246	16%	35%	17%	21%	10%	399, 22, 6
	flat and thin elongated lug (B)		32%	31%	30%	4%	2%	399, 22, 11, 12
	bowed lug (C)		10%	15%	30%	30%	3%	399, 22, 13, 14
	perforated lug (D)		10%	20%	40%		30%	399, 22, 15, 16, 17
	lug with lug applications on the rim (E)		14%	72%	14%			399, 22, 19, 21
HANDLES	handles		12%	58%	21%	6%	2%	400, 23, 6
	vertically perforated handle ("Montboló", B)		present	- - frequent - -				400, 23, 8; 403
	strap handle (C)		9%	59%	21%	7%	4%	400, 23, 13
	multi-perforated handles (F)		26%	58%	16%			400, 23, 14, 15
	decoration emitting from the handle (G)		18%	75%	7%			400, 23, 16, 19
	nozzle-spout (H)		33%	39%	27%			400, 23, 20, 21
DECORATION	with decoration		15%	19%	5%	5%	1%	402, 24, 1-4
	sculptured decorations (A)		28%	63%	8%	1%	1%	406, 25, 5
	cardialoid decorations (B)	52	25%	73%	2%			409, 27, 4
	impressed decoration: "*estampillado*" (C)	79	11%	42%	39%	7%		411, 28, 5
	empty circles (B)		56%	18%	9%	16%		413; 411, 28, 7
	impressions along line(s) (C)		33%	42%	13%	16%		413; 411, 28, 10
	impressed decoration: "*puntillado*" (D)			24%	19%	67%		413
	impressed or incised strokes (E)	148	7%	45%	42%	6%		408, 26, 5
	impressions on the thickened rim (D)		25%	61%	14%			408, 25, 12 and 13
	incised parallel lines and flutings (F)	76	21%	65%	13%	1%		412, 29, 4
	vertical or horizontal parallel lines (A)		4%	31%	60%			415; 412, 29, 5
	combined stripes of lines (B)		4%	10%				415; 412, 29, 9
	pectinate lines (C)		4%	10%	30%			415; 412, 29, 13
	stripes of parallel vertical lines (D)		36%	62%	2%			415; 412, 29, 15
	almagra (H)		16%	70%	14%			402, 24, 11
	red or white incrustation (I)		37%	59%	4%			402, 24, 12
MOTIFS	geometric motifs	32	13%	38%	37%	12%		414, 30, 4
	reticulated motifs	31	26%	61%	13%			416, 31, 4
	curved motifs	127	15%	74%	11%			417, 32, 4

Tab. 254 Ner/MA. Pottery assemblages summarized according to Acosta Pellicer (1986; cf. **Tab. 248**).

	NER/MA: EARLY NEOLITHIC POTTERY	%
FORM	closed profiles	
	ellipsoid, ovoid (B)	29%
	hemispheric (C)	53%
	with narrowed concave neck and everted rim (E)	17%
	(Pellicer/Acosta 1986, 390, 15, 1 and 9, 10, 16)	
	hemispheric forms	
	spherical calottes (A)	12%
	hemispheric (B)	12%
	(stilted) hemispheric (C)	63%
	stilted spherical calotte (D)	6%
	cylindrical (E)	6%
	(Pellicer/Acosta 1986, 391, 16, 1 and 7, 10, 12, 14, 17)	
	open profiles	
	spherical calottes with prominent, everted rim (A)	9%
	inverted truncated cone with prominent, everted rim (B)	9%
	inverted truncated cone with S-profile (C)	27%
	inverted truncated cone (E)	55%
	(Pellicer/Acosta 1986, 393, 17, 1 and 8, 10, 12, 13)	
	rims	
	globular vessels with prominent, everted rim (A)	33%
	hemispheric vessels with prominent, everted rim (B)	24%
	spherical calottes with prominent, everted rim (F)	14%
	vessels with wavy rim (H)	28%
	(Pellicer/Acosta 1986, 396, 20, 1 and 7, 10, 17, 22)	
	globular vessels with neck (bottles)	
	cylindrical neck (B)	100%
	(Pellicer/Acosta 1986, 398, 21,1 and 9)	
HANDLES	handles	
	"asa de puente" (A)	29%
	vertically perforated ("Montboló", B)	4%
	strap handle (C)	18%
	handle with appendix (D)	2%
	n.s.(E)	2%
	multi-perforated handles (F)	6%
	decoration emitting from the handle (G)	24%
	nozzle-spout (H)	13%
	(Pellicer/Acosta 1986, 400, 23, 1 and 7, 8, 10, 13, 15, 19, 21)	

	NER/MA: EARLY NEOLITHIC POTTERY	%
APPLICATIONS	lug applications	
	lug (A)	18%
	flat and thin elongated lug (B)	72%
	bowed lug (C)	5%
	perforated lug (D)	2%
	lug with lug applications on the rim (E)	3%
	(Pellicer/Acosta 1986, 399, 22, 1 and 7, 12, 14, 16, 17, 21)	
DECORATION	sculptured decorations (A)	49%
	impressed sculptured bands (C)	85%
	plain sculptured bands (B)	14%
	lugs (D)	1%
	(Pellicer/Acosta 1986, 406, 25, 1)	
	cardialoid decorations (B)	6%
	strips of irregular vertical + horizontal impressions (A)	15%
	parallel strips of regular impressions (B)	7%
	alternating strips of simple + triangular impressions (C)	23%
	stripes of parallel vertical impressions (D)	7%
	complex geometric motifs (E)	23%
	(clusters of)	31%
	(Pellicer/Acosta 1986, 409, 27, 1 and 5, 8, 12, 13, 15, 19)	
	impressed decorations (C+D)	4%
	empty circles (B)	56%
	impressions along line(s) (C)	33%
	squares (type F)	11%
	(Pellicer/Acosta 1986, 411, 28, 1 and 7, 10, 17)	
	impressed or incised strokes (E)	5%
	serial, vertical strokes (A)	18%
	impressions on the thickened rim (D)	82%
	(Pellicer/Acosta 1986, 408, 26, 1 and 7, 13)	
	incised parallel lines and flutings (F)	15%
	vertical or horizontal parallel lines (A)	4%
	combined stripes of lines (B)	4%
	pectinate lines (C)	4%
	stripes of parallel vertical lines (D)	88%
	(Pellicer/Acosta 1986, 412, 29, 1 and 5, 9, 13, 15)	
	almagra (H)	10%
	red incrustation (I)	11%

Tab. 255 Ner/MA. Early Neolithic pottery assemblage summarized according to Acosta/Pellicer (1986; cf. **Tab. 248**).

Ground stone tools:

Mina hall, level 7, squares 1K, 2K, 1I, 2I, 1J, 2J (AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO 2011): 4 ground stone tools once with red ocher traces, pieces of schist, iron ore and red ocher.
Non-decorated marble arm rings and pestles occure the Early Neolithic levels analyzed by PELLICER/ACOSTA (1986, 376). The ground stone tools have red ocher traces (cf. **Tab. 253** and **Tab. 256**).

Figures: AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO 2011, Fig. 2; PELLICER/ACOSTA 1986, 375 Plate 8; 420 Plate 34, 1 and 5; 422 Plate 35.

Bone industry:

Mina hall: 28 awls, spatula, tubes and other pieces (Early Neolithic levels 10-7; ADÁN ÁLVAREZ 1988); 6 awls, 52 chips (Early Neolithic level 7, squares 1K, 2K, 1I, 2I, 1J, 2J; AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO 2011). 24 Neolithic pieces (points, awls) were found in the Vestibule hall. They are very fragmented.
Microlaminar Epipaleolithic bone industry is in Magdalenian tradition (AURA TORTOSA ET AL. 2009b, 346; cf. **Tab. 253** and **Tab. 256**)

Figures: AURA TORTOSA ET AL. 2005, 983 Tab. 6; PELLICER/ACOSTA 1986,418 Plate 33.

Faunal remains/fauna:

Epipaleolithic prey: predominantly rabbit and ibex (NM-13/1981; NV-4/1982-85), seal, stags, fox, boar (PELLICER/ACOSTA 1986, 440 Plate 43);
Mixed level/prey: rabbit and *Capra pyreanaica* equally dominant (NM-12/1981 and 1983; NV-3/1982-85);
Early Neolithic: ibex, rabbit, ovicaprid (NM-10/1981 and 1983; AURA TORTOSA ET AL. 2009b cf. AURA ET AL. 2009a, 6 Tab. 1; CORTÉS-SÁNCHEZ ET AL. 2008, 2186 Tab. 6; AURA TORTOSA ET AL. 2002, 23-26; AURA TORTOSA ET AL. 2005, 985 Tab. 8; PEREZ RIPOLL 1986), cattle, pigs, stags (PELLICER/ACOSTA 1986, 440 Plate 43);
malacofauna: Epipaleolithic shell-midden with predominantly marine mollusks (JORDÁ PARDO 1986b; JORDÁ ET AL. 2011; 2011 cf. PELLICER/ACOSTA 1986, 442 Plate 45); fish (MORALES/ROSELLÓ 2004);
Mina hall, level 7, squares 1K, 2K, 1I, 2I, 1J, 2J (AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO 2011): 698 units macrofauna; 382 microfauna; 12001 malacofauna, 6120 ichtiofauna, 1126 echinoids (cf. JORDÁ PARDO ET AL. 2003; RIQUELME CANTAL 2004; VILLALBA CURRÁS/AURA TORTOSA 2007; AURA TORTOSA ET AL. 2001, 19-25 Tab. 1-4);
avifauna (EASTHAM 1986); Mediterranean monk seal (ALCLÁ MARTÍNEZ ET AL. 1987).

Botanic remains:

NV-4/Epipaleolithic: *Leguminosae, Olea europea var. Sylvestris, Quercus, Quercus ilex-coccifera, Pistacia lentiscus, Arbustus unedo, Buxus sp., Lavendula, Rosmarinus sp.* etc.;
NV-3/mixed level: --*Leguminosae*, ++*Olea europea var. Sylvestris, Pinus halepeniss, Quercus, Quercus ilex-coccifera, Juniperus sp. Cistus sp., Rosmarinus sp., Pistacia lentiscus* (cf. BADAL 1996);
NV-2/Early Neolithic: *Olea europea var. Sylvestris, Leguminosae* (AURA TORTOSA ET AL. 2005, 977 cf. AURA TORTOSA ET AL. 2002, 22-23) and cultivated *Hordeum vulgare var. nudum* (AURA TORTOSA ET AL. 2005, 984; 985 Tab. 9; cf. JORDÁ PARDO ET AL. 2003; GUILLEN OTERINO 1986).

Other:

158 objects of personal adornment from Neolithic levels: shells, bones (AURA TORTOSA ET AL. 2005, 983 cf. 984 Tab. 7), marble arm rings of Early Neolithic origin; personal ornaments of gastropods and rocks partly perforated or with red ocher traces (JORDÁ ET AL. 2011, 2010; AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO 2011; cf. **Tab. 253** and **Tab. 256**);
human bones remained from the Magdalenian, Epipaleolithic (two individuals) and Early Neolithic (10 individuals; cf. PELLICER/ACOSTA 1986, 442 Plate 45). Further burials originated from later Neolithic and Chalcolithic times (49; SIMÓN VALLERO 2003, 269). mtDNA analyses of recent prehistoric remains proved a "proximity […] to North African [populations]" (SIMÓN VALLEJO 2003, 271).

CUEVA DE NERJA/MA according to Pellicer/Acosta 1986		n	NEOLITHIC Early	Middle	Late	CHALCOLITHIC Early	Late	Pellicer/Acosta 1986 page, plate, n°
diachronic	bone industry	65	24%	68%	27%	22%	11%	418, 33, 5
	ground stone tools	21	4%	14%	44%	24%	14%	422, 35, 6
	grinding stones	23	13%	13%	48%	26%		420, 34, 5
	loom weights	136			17%	29%	55%	420, 34, 9
	objects of personal adornment	44	5%	57%	22%	5%		424, 36, 12

Tab. 256 Ner/MA. Summary table of bone industry, ground stone tools, loom weights and jewelry according to PELLICER/ACOSTA (1986; cf. **Tab. 248**)

FEATURES

Epipaleolithic burial structures (MT/82/13; SIMÓN VALLEJO 2003, 269; GARCIA SANCHEZ 1986);
The art in the interior of the cave originates from Solutrean and Magdalenian and later Neolithic/Chalcolithic occupations. It is not of Epipaleolithic or Early Neolithic origin (SIMÓN VALLEJO 2003, 266; SANCHIDRIAN TORTI 1986).
AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO (2011) described stone tablets and a burial (Mina hall, level 7, squares 1K, 2K, 1I, 2I, 1J, 2J), a fireplace with human bones and red ocher, i.e. a burial and engravings (Cataclismo hall) from Early Neolithic contexts.

INTERPRETATION

During the Epipaleolithic people occupied and lived in the entrance area year-round during sporadic frequentations and exploited marine resources and hunted ibex and deer (AURA TORTOSA ET AL. 2009a, 13). Avifauna implies an occupation during early autumn and winter (October-December; EASTHAM 1986). The mobility decreased (SIMÓN VALLEJO 2003, 262) and Ner is characterized as "*asentamiento residencial de prolongada ocupación anual*" (SIMÓN VALLEJO 2003, 264 cf. 270). The Epipaleolithic remains are in Magdalenian tradition (SIMÓN VALLEJO 2003, 263). Subsequently during the recent Prehistory (amongst others the Neolithic), people herded domestic animals, hunted and fished in the surrounding (SIMÓN VALLEJO 2003, 264). Additionally, Ner was a site of symbolic value with burials and engravings. Especially the interior of the cave was no residence (AGUILERA AGUILAR/MEDINA ALCAIDE/ROMERO ALONSO 2011). GACIA BORJA ET AL. 2010 assume a Precardial Impresso horizon similar as in Cova de l'Or, de les Cendres and Sarsa/Valencia. Similarities with Italian sites also occur (red coloration, rocker-stamp decoration with non-dented tools, impressions in various patterns, combination of impression and incision, less Cardial). Thus, GARCIA BORJA ET AL. 2010 propose and Neolithic dispersal from N Africa to Nerja.
Because of the missing adzes, PELLICER/ACOSTA (1986, 421) assumed that no forest clearances took place during the Early Neolithic and cereals were introduced in the Middle Neolithic. The grinding stones should be used to process other goods (roots, acorns, red ocher; PELLICER/ACOSTA 1986, 421).

Cueva de los Zagales/Murcia

Jumilla, Murcia

Name short: **CZ**
ID site: **6**

Longitude:
1°24' W [2°14'23"]

Latitude:
38°26'N [38°26'25"]

(cf. Observations)

Altitude asl:
600m

Orientation:
to S

Distance to coastline:
today approx. 75km

Type of site:
cave

Publications:
Martínez Andreu 1981, 131-145; Martínez Andreu 1983, 45; 47; 50-51 Fig. 3-4; Molina Grande/Molina García 1991, 102-114.

Observations:
Modern occupations and bioturbation displaced the finds partially. Coordinates of Molina Grande/Molina García (1991, 102, given here in []) are wrong (cf. maps of Molina Grande/Molina García 1991, 86 Fig. 16 and Martínez Andreu 1981, 131 Fig. 24).

RECORDING

Relevant stages:
Epipaleolithic

Depository:
Jumilla, Museo Arqueológico Municipal "Jerónimo Molina"

Recorded artifacts:
Lithic artifacts

Lithic IDs:
6000-6999

Pottery VUs:
/

Remarks:
The lithic assemblages of AM and CZ were partly mixed in their storage boxes. Several pieces could be sorted according to the figures of Martínez Andreu (1981, 1983) and Molina Grande/Molina García (1991). All artifacts without illustration were assigned to one of the sites: I assigned all non-illustrated pieces of a bag to the same site as the illustrated artifacts in the same bags. Artifacts with ID 6300-6329 were sorted to CZ (cf. Remarks of **Abrigo del Monje/Murcia**).

LITHIC ARTIFACTS		number			weight				
		Σ (n)	*%*	*ratio (% Σn)*	*Σ (g)*	*%*	*Ø (g)*	*SD*	*ratio (% Σg)*
Σ (reference amount)		395	100.0%		528.7	100.0%	1.3	2.733	
chips		400		0% 100%					0% 100%
blanks	flakes	235	59.5%		275.1	52.0%	1.2	1.658	
	blades	102	25.8%		54.0	10.2%	0.5	0.591	
	art. debris	47	11.9%		85.1	16.1%	1.8	2.208	
	nat. debris	3	0.8%		7.1	1.3%	2.4	2.376	
	cores	8	2.0%		107.4	20.3%	13.4	10.508	
	total with cortex	96	24.3%		196.8	37.2%	2.1	3.481	
	non-mod. pieces	335	84.8%		448.8	84.9%	1.3	2.894	
	burin spalls								
	tools	60	15.2%		79.9	15.1%	1.3	1.571	
flakes & blades	total	337	85.3%		329.1	62.2%	1.0	1.452	
	complete*	105	31.2%		119.5	36.3%	1.1	2.032	
	dorsal reduction**	105	53.0%		93.8	46.3%	0.9	1.369	
		index	*ratio*		*index*	*ratio*			
	n flakes : n blades	2.3	07:03		5.1	05:01			
operation chain	0 RM procurment	3	0.8%		7.1	1.3%	2.4	2.376	
	1 decortification	7	1.8%		6.3	1.2%	0.9	0.981	
	2 core preparation	22	5.6%		49.8	9.4%	2.3	3.578	
	3 débitage	221	55.9%		161.1	30.5%	0.7	0.890	
	4 repreparation	15	3.8%		14.9	2.8%	1.0	0.910	
	5 tools&use	133	33.7%		206.1	39.0%	1.5	2.091	
	6 discarding	195	49.4%		319.1	60.4%	1.6	3.426	

Tab. 257 CZ/MU. Lithic assemblage (weight in gram (g); *referring to total flakes and blades; **referring to flakes and blades with proximal end: 198 pieces/202.4g).

SETTING

CZ is situated between Barranco del Timonal (SE) and Barranco de los Gargantones (N) (MARTÍNEZ ANDREU 1983, 45) in the foothills of Sierra del Molar on Monte n° 96 of communal property at Cañada del Judío. To the SW the plain of La Dehesilla extends and provided resources (MARTÍNEZ ANDREU 1981, 132; map on p. 131 and in MARTÍNEZ ANDREU 1997b, 351 Fig 3, 22).

DESCRIPTION

The site is rather a 6.8m-deep rock shelter with terrace. The entry is 9.6m wide and 2.7 m high (MOLINA GRANDE/MOLINA GARCÍA 1991, 103-104, Fig. 27-28).

Fig. 74 CZ/MU. Situation and view from the cave.

RESEARCH

Members of a speleological group, Cayetano Herrero, Francisco Lencina and Antonio Navarro identified the cave as archaeological site (MOLINA GRANDE/MOLINA GARCÍA 1991, 102). The former curator of the *Museo Arqueológico de Jumilla* Jerónimo Molina García collected surface-finds and excavated a small test pit of 1m² and 0.9m depth (MARTÍNEZ ANDREU 1983, 42). MARTÍNEZ ANDREU (1981, 132-145; 1983, 47) presented the lithic assemblage.

CHRONOLOGY

14C-ages:

/

Stratigraphy:

5 levels (I-V): The levels do not reveal a relative chronology and the remains have to be classified typologically.

References:

stratigraphy: MARTÍNEZ ANDREU 1981, 132-133; 1983, 42; MOLINA GRANDE/MOLINA GARCÍA 1991, 109 Fig. 33;

relative chronology: MARTÍNEZ ANDREU 1981, 133-134; 144 Fig. 30; 1983, 42-43; 45;

MOLINA GRANDE/MOLINA GARCÍA 1991, 114.

Remarks:

The lithic artifacts are similar to the Epigravettian stages of Mallaetes (MARTÍNEZ ANDREU 1981, 133; accumulative graphs of tool types on p. 144 Fig. 30; 1983, 42-43) and the Epigravettian materials of Barranc Blanc de Rótova/Valencia (MOLINA GRANDE/MOLINA GARCÍA 1991, 114).
Due to baked bladelets, MARTÍNEZ ANDREU (1983, 43; 45) considered a Microlaminar Epipaleolithic occupation with lots of end scrapers and baked blades as in San Gregori, besides probable Magdalenian, Epigravettian or Azilian origin. Burins and the large amount of blades especially in levels IV and V could originate from the Paleolithic/Magdalenian. The vicinity to AM with a microgravette indicates a similar occupation (MARTÍNEZ ANDREU 1981, 134).

ARTIFACTS

Lithic assemblage:

The small assemblage is uniform throughout all levels (MARTÍNEZ ANDREU 1981, 132): Generally microlithic artifacts appear. A diedric end scraper-burin and an end scraper on blade point to Paleolithic traditions (MARTÍNEZ ANDREU 1983, 42).
MARTÍNEZ ANDREU (1983, 47) registered 51 tools:
29.01% (18) baked bladelets
24.17% (15) end scrapers
6.45% (4) burins
6.45% (4) notched pieces and denticulates
6.45% (4) retouched fractures
4.83% (3) baked flakes and blades
1.61% (1) borer
1.61% (1) micro burin
1.61% (1) composite tool (end scraper-burin)
In his thesis MARTÍNEZ ANDREU (1981, 136) mentioned additionally 11 pieces with other retouches and blanks: 1 core; 3 flakes; 12 blades/bladelets.
MOLINA GRANDE/MOLINA GARCÍA (1991, 104-114) listed 689 artifacts according to their level: I sterile; II: 187 flint pieces and 2 quartz pieces; III: 147 flint pieces; IV: 278 flint pieces; V: 74 flint pieces and 1 frag. baked point of rock crystal.

Figures: MARTÍNEZ ANDREU 1981, 136-145 amongst others Fig. 25-31; MARTÍNEZ ANDREU 1983, 47; 50-51, Fig. 3-4; MOLINA GRANDE/MOLINA GARCÍA 1991, 105-108 Fig. 29-32; 110-113 Fig. 34-37.

Pottery assemblage:

III (bioturbation): Eneolithic pottery frag. of a non-decorated globular vessel (MOLINA GRANDE/MOLINA GARCÍA 1991, 102; 109).

Ground stone tools:

/

Bone industry:

/

Faunal remains/fauna:

/

Botanic remains:

Carbonized acorn frag.

Other:

/

FEATURES

/

INTERPRETATION

/

El Duende/Málaga

Ronda, Málaga

Name short: **Du**
ID site:

Longitude:	Latitude:	
05°11'04" W	36°45'01" N	
Altitude asl:	Orientation:	Distance to coastline:
580m	/ (open-air site)	today approx. 35km

Type of site:
open-air site

Publications:
AFONSO MARRERO 1993, 167-173; AGUAYO DE HOYOS ET AL. 2004, 97; MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984.

Observations:
Du is one of the few present open-air sites that were occupied by hunter-gatherers.

RECORDING
/ (Finds stored in Ronda).

SETTING

The site is situated in the Meseta in Cortijo del Duende area. In the surrounding several fresh water springs are present (cf. MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 10 Fig. 1).

DESCRIPTION

/ (for photos of the site and the surrounding cf. FERNÁNDEZ MARTÍNEZ/AGUAYO DE HOYOS 1984, 37 Plate I).

RESEARCH

People discovered Du during constructions of a well and excavated 50m² (MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 9). People collected the finds from the surface and the two levels unsystematically and mixed (AFONSO MARRERO 1993, 167).

CHRONOLOGY

14C-ages:	Stratigraphy:	References:
/	/	/

Remarks:
Two levels of Upper Magdalenian and Epipaleolithic origin are separated by a sterile layer. A probable sickle indicates an intermixed Neolithic occupation horizon (MARTÍNEZ FERNANDEZ/AGUAYO DE HOYOS 1984, 13). Recently the occupation is predominantly attributed to the Upper Mediterranean Magdalenian stage C (AGUAYO DE HOYOS ET AL. 2004, 97 with citations therein). Additionally, Roman and modern structures and find exist (MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 9). However, AFONSO MARRERO (1993, 167) ascribed the assemblage "at a single moment" occupation.

ARTIFACTS

Lithic assemblage:

The lithic assemblage is very large (4217 artifacts) and originates from an Upper Magdalenian to Epipaleolithic (to Neolithic?) occupation. MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS (1984) and AFONSO MARRERO (1993) analyzed all those finds in one mixed assemblage (cf. AGUAYO DE HOYOS ET AL. 2004, 97; cf. **Tab. 258**).

Very few cores are present compared to the large number of artifacts (MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 16). Possibly people needed only few cores and maintained the reduction of those. Accordingly the blanks are very small. More cores remained from blade production. However, in the assemblage flakes dominate the blanks. The flake-cores have no clearly limited platform and the shape is irregular (possibly discoid). In contrast blade-cores consist mostly of one platform and are prismatic or pyramidal (MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 16-17). All platforms are rather plain and became hardly modified during blank production. Few crested pieces indicate no previous preparation of the cores by ridges.

One of the flakes was probably removed from a hammer stone. The blade with gloss differs morphotechnologically from the rest of the assemblage and is probably not anthropogenic (MARTÍNEZ

FERNÁNDEZ/AGUAYO DE HOYOS 1984, 18).
The percussion techniques unfolded three differing production cycles: 1. Large blanks consist predominantly of flakes. 2. The largest amount of the production is small flakes of less than 7cm length: 50% of those are shorter than 1.5cm. Those were due to preparation, re-preparation or people used these as tools. 3. The largest amount of tools consists of small, regular blades (MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 20-21). So the blade production was not specialized and standardized during the Epipaleolithic. Core sizes and percussion techniques indicate an indifferent and mixed production, besides a few blade cores.
Only very few tools are preserved. Therefore, people modified predominantly blades (8.4% of those) and few flakes (1.3%). Most tools (128 pieces) have only one tool modification. 14 have two and one piece has three tool endings. For the classification according to the typology of Fortea cf. MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS (1984, 22-31). The tools are in Paleolithic tradition and the raw material supply influenced the lithic production (MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 32-33). Many bladelets were obviously used without any intentional modification.
Generally it is a microlaminar assemblage (AGUAYO DE HOYOS ET AL. 2004, 97) and thus fits in the Levantine Epipaleolithic (MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 34-35). However, the following differences are evident: Size and typology of the end scrapers, borers, many burins, no composite tools, many backed bladelets, few notched and denticulated pieces and an isosceles triangle. Similarities exist especially to Filador VI, Hoyo de la Mina, Cueva de Nerja and Cueva del Gato.

Figures: AFONSO MARRERO 1993, 168-173 Fig. 5-13; 402-462 Fig. 200-213; MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984, 19-32 Fig. 4-10.

Pottery assemblage:

Terra sigillata and modern pottery.

Figures: /

Ground stone tools:

/

Figures: /

Bone industry:

/

Figures: /

Faunal remains/fauna:

/

Botanic remains:

/

Other:

/

FEATURES

/

INTERPRETATION

/

EL DUENDE MALÁGA		Martínez Fernández/Aguayo de Hoyos 1984 n	%	Afonso Marrero 1993, 167-173; 402-462 *n*	%
BLANKS	flakes*	2000	47.40%	1166	61.92%
	blades*	1089	25.80%		
	irregular blades*	*NA*	*NA*	411	21.83%
	prismatic blades*			281	11.92%
	cores*	30	0.70%	25	1.33%
	flake-cores**	7	33.3%	*NA*	*NA*
	blade-cores**	11	52.4%		
	mixed cores**	3	14.3%		
	Σ blanks*	3119		1883	
	n.s.*	1098	26.10%		
PRESERVATION	complete flakes (ref. flakes)	764	32.8%	*NA*	
	dimensions (Ø ± σ in cm)	L: *NA*	Wi: *NA*	L 1.99±0.89	Wi 1.73±0.81
	complete blades (ref. Blades)	217	62.2%	*NA*	
	dimensions (Ø ± σ in cm)	L: *NA*	Wi: *NA*	L 2.43±0.82	Wi 0.86±0.33
	with cortex	*NA*	10.70%	*NA*	
	complete artifacts*	1008	23.90%	527	28.24%
	incomplete artifacts*	3209	76.10%		71.76%
	heat treatment	*NA*	18.90%	*NA*	24.25%
	chemical alteration		87.60%		75.28%
	mechanical alteration				0.38%
	gloss n.s.				0.09%
	sickle gloss	1			
	Σ alteration*	*NA*			56.30%
PLATFORM REMNANT	with platform remant	1728	55.94%	*NA*	
	w/o platform remnant	1361	44.1%		
	removed by retouch**	37	2.7%		
	w/o due to fracture**	1324	97.3%		
	flakes and blades	3089	73.25%		

TYPE	flakes *n*	flakes %	blades *n*	blades %	Σ *n*	Σ %	flakes *n*	flakes %	irreg. blades *n*	irreg. blades %	pris. blades *n*	pris. blades %	Σ *n*	Σ %
plain	835	65.6%	205	45.1%	1040	60.2%	535	71.91%	94	56.29%	50	45.05%	679	66.44%
point	379	29.8%	236	51.9%	615	35.6%	137	18.41%	60	35.93%	44	39.64%	241	23.58%
diedric	44	3.5%	8	1.8%	52	3.0%	42	4.64%	6	3.59%	4	3.60%	52	5.09%
facetted	15	1.2%	6	1.3%	21	1.2%	23	3.09%	4	2.39%	10	9.01%	37	3.62%
removed by retouch					37	2.7%	7	0.94%	3	1.80%	3	2.70%	13	1.27%
Σ (refering to total Σ)*	1273	30.2%	455	10.8%	1765	41.0%	744	39.37%	167	8.84%	111	5.87%	1022	54.07%

		Martínez Fernández/Aguayo de Hoyos 1984 n	%	Afonso Marrero 1993 *n*	%
TOOLS	blades with modification	*NA*	64.3%	*NA*	
	flakes with modification		18.2%		
	blanks n.s. with modification		17.5%		
	1A flakes with use traces			3	3.37%
	1B flakes with lateral retouch			19	21.35%
	2A blades with use traces			5	5.62%
	2B blades with lateral retouch	10	7.0%	30	33.71%
	4 denticulates	4	2.8%		
	5 truncations				1.12%
	6 backed bladelets	70	49.0%	24	26.96%
	7 microliths	1	0.7%		
	9 borers	1	0.7%		
	10 end scrapers	15	10.5%	6	6.78%
	burins	9	6.2%		
	retouched fractures	8	5.6%		
	microburin technique	1	0.7%		
	n.s.	24	16.8%		
	Σ tools	143	3.4%		
Σ total assemblage		4217	100%	1890	100%

Tab. 258 Du/MA. Summary table of the lithic assemblage according to MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS (1984) and AFONSO MARRERO (1993). The assemblage evaluated by Afonso Marrero is smaller because the whole collection was not available and he did not analyze indeterminable blanks. The Simpson diversity index accounts for 0.287 (based on the tool numbers of MARTÍNEZ FERNÁNDEZ/AGUAYO DE HOYOS 1984).

Hondo de Cagitán/Murcia

Mula, Murcia

Name short: **HC**
ID site:

Longitude:
01°30'36"W [-1.51]

Latitude:
38°02'24"N [+38.04]
(UTM: 30SXH245242)

(coordinates converted)

Altitude asl:
380m

Orientation:
/ (open-air site)

Distance to coastline:
today approx. 55km

Type of site:
open-air site

Publications:
MARTÍNEZ SÁNCHEZ 1988, 181-182; MARTÍNEZ SÁNCHEZ 1995; MUÑOZ AMILIBIA 1987.

Observations:
MARTÍNEZ SÁNCHEZ (1995, 38-39; 42) could not discover a site to the finds that are associated with HC in the literature: Modern agriculture changed the original topography and disturbed the ground, but she conjectures a corresponding site in the area of Hondo de Cagitán. Thus, the artifacts of HC are isolated finds without context (MARTÍNEZ SÁNCHEZ 1995, 40).

RECORDING

Relevant stages:
Early Neolithic

Depository:
MAM Murcia

Recorded artifacts:
Pottery

Lithic IDs:
/

Pottery VUs:
1-6

Remarks:
I recorded only the 8 decorated pottery frags. in 6 VUs that are exhibited in the MAM in Murcia (VU 1 with 2 frags.; VU 3 with 2 frags.; MARTÍNEZ SÁNCHEZ 1995, 41 Fig. 2, 31; 43 Fig. 3, 21). 1 frag. (MARTÍNEZ SÁNCHEZ 1995, 43 Fig. 3, 23/MUÑOZ AMILIBIA 1987, 629 Fig. 1, 7) is missing.

POTTERY		number VUs		
		Σ (n)	*%*	*ratio (% VU)*
Σ VU *(reference amount)*		6	100.0%	
Σ sherds		8		
Ø sherds/ VU		1.3		0% 100%
VU	with rim frag.	3	50.0%	
	with definable DM	2	33.3%	
		cm		
	Ø DM	21.0		
shape	with definable shape	1	16.7%	
	shape not definable	5	83.3%	
	pots*	1	100.0%	
decoration	decorated	6	100.0%	
	non-decorated			
	n decoration techniques	13		
		index	*ratio*	
	n decoration techniques : n decorated VU	2.2	02:01	
	with impressed decoration**	10	76.9%	
	Cardium-impressed***	3	30.0%	
	with incisions**			
	with sculptured bands**	3	23.1%	

Tab. 259 HC/MU. Pottery assemblage (*referring to VUs with definable shape; **referring to n decoration techniques; ***referring to VUs with impressed decoration).

SETTING

HC is in the area of Campo de Cagitán between the districts of Calasparra, Cieza and Mula (map: MARTÍNEZ SÁNCHEZ 1988, 167 Fig. 48, 4; MUÑOZ AMILIBIA 1987, 630).

DESCRIPTION

/ (No site located cf. Observations).

RESEARCH

1974, during agricultural work, José Buitrago found the majority of the archaeological remains connected with HC. MUÑOZ AMILIBIA (1987, 628) assumed the site in immediate vicinity in approximately 1m depth. MUÑOZ AMILIBIA (1987) and MARTÍNEZ SÁNCHEZ (1988, 1995) studied and published the finds. MARTÍNEZ SÁNCHEZ (1995, 39-40) prospected the region systematically to find the exact location of the site, but she could not register any find concentrations. Generally she found only very few artifacts on the surface. Subsequently test trenches 1 to 10 (each of a 1m² or 1 x 2m) and I to VI (0.6 x 11 to 19m) were excavated and two levels (I, II) documented. Finds originate from the sublevels Ib in sondage II, sections A and B and sondage IV (MARTÍNEZ SÁNCHEZ 1995, 40). The sherds probably belong to one assemblage with the finds already presented by MUÑOZ AMILIBIA (1987), because the fractures are similar (MARTÍNEZ SÁNCHEZ 1995, 41). The only decorated sherd, she newly presented, is the sherd with Cardial-impressed decoration (MARTÍNEZ SÁNCHEZ 1995, 43 Fig. 3, 32). All other sherds from this season were non-decorated (MARTÍNEZ SÁNCHEZ 1995, 41). Finally a site (archaeological sediment) was not found (MARTÍNEZ SÁNCHEZ 1995, 40).

CHRONOLOGY

14C-ages:	Stratigraphy:	References:
/	/	/

Remarks:

Impressed decorated pottery with Cardium-impressions that would characterize an Advanced Early Neolithic is hardly present (MUÑOZ AMILIBIA 1987, 628; 631; MARTÍNEZ SÁNCHEZ 1995, 38).

ARTIFACTS

Lithic assemblage:

1 frag. probable flint end scraper (MUÑOZ AMILIBIA 1987, 631).

Figures: MARTÍNEZ SÁNCHEZ 1995, 43 Fig. 3, 25/MUÑOZ 1987, 629 Fig. 1, 9.

Pottery assemblage:

17 sherds: 9 decorated + 8 non-decorated:

MUÑOZ AMILIBIA (1987, 628-631) presented the stray finds of 1974: 2 frags. pot with strap handle and geometric impressed decoration (herringbone; comb and Cardium; MUÑOZ AMILIBIA 1987, 628); 4 frags. with impressed/incised sculptured bands and 2 frags. with impressed decoration (MUÑOZ AMILIBIA 1987, 631);

MARTÍNEZ SÁNCHEZ (1995) presented the sherds of the additional season: 9 frags.: 8 wall sherds, including on with closely set, carved Cardium-impressions and 1 rim sherd (MARTÍNEZ SÁNCHEZ 1995, 40-41 cf. MARTÍNEZ SÁNCHEZ 1988, 181: 5 frags.).

Figures: MARTÍNEZ SÁNCHEZ 1995, 39-43 Fig. 1-3; MUÑOZ AMILIBIA 1987, 629 Fig. 1.

Ground stone tools:

1 frag. grinding stone more than 20cm wide (MARTÍNEZ SÁNCHEZ 1995).

Figures: MARTÍNEZ SÁNCHEZ 1995, 44 Fig. 4.

Bone industry:

/

Faunal remains/fauna:

/

Botanic remains:

/

Other:

1 frag. loam, 3 helices (MUÑOZ AMILIBIA 1987, 631).

FEATURES & INTERPRETATION

/

Los Castillejos/Granada

Montefrío, Granada

Name short: **Cast**
ID site:

Longitude:

Latitude:
37°20'N

Altitude asl:
1050m

Orientation:
/ (open-air site)

Distance to coastline:
today approx. 65km

Type of site:
open-air site

Publications:
AGUILERA ET AL. 2008; BLÁZQUEZ GONZÁLEZ 2011; CÁMARA SERRANO/MOLINA GONZÁLEZ/AFONSO MARRERO 2005; MARTÍNEZ FERNÁNDEZ ET AL. 2009; 2010; SÁNCHEZ ROMERO 1999, 2000; YANES ET AL. 2011 (and citations therein).

Observations:
The Early Neolithic assemblage from the excavations 1990-91 is stored at the University in Granada. Martínez Fernández et al. analyzed the lithic inventory, while Blázquez González studied the ceramic. Other finds of the excavations of Tarradell in 1946, 1947, 1953, 1955, 1982 are stored in boxes with the following numbers in the Museum of Granada: 1351-1399, 1410, 1415-1421. These finds originate from later periods.

RECORDING

The site and finds were subject of study and not available for the present analysis.

SETTING

Cast is situated 4km distant of the municipality of Montefrío (Granada) in the region Los Montes in the Sierras Subbéticas on the hill Las Peñas de los Gitanos (cf. ROVIRA 2007, 440 Fig. 1.7). The site consists of several sites (megaliths, medieval necropolis; BLÁZQUEZ GONÁLEZ 2011, 51-53) and was reoccupied throughout time.

DESCRIPTION

Cast is on a terrace of 125m length and 30m width.

RESEARCH

1868 first written record by D.M. de Góngora y Martínez;
1926 excavations focused on the megaliths and Roman remains by C. de Mergelina;
1946-47 excavations in the surrounding and in the Neolithic-Chalcolithic settlement by M. Tarradell;
1953 test trench in the settlement by A.E. van Giffen;
1971-1974 excavations by A. Arribas and F. Molina (Department of Prehistory and Archaeology of the University of Granada);
1991-1994 excavations by J.A. Afonso Marrero and F. Molina González and others (Department of Prehistory and Archaeology of the University of Granada; cf. in detail Martínez FERNÁNDEZ ET AL. 2009, 16).
Especially the last two excavation seasons in the 70ies and 90ies provide broad finds and sample material for various analyses: Fauna (UERPMANN 1979; ZIEGLER 1990, RIQUELME CANTAL 1996), plant remains (ROVIRA 2007) and artifacts (SALVATIERRA CUENCA 1982; CARRIÓN MÉNDEZ 1985; CORRAL ARROYO 2007; MARTÍNEZ FERNÁNDEZ 1985; AFONSO MARRERO 1993; SÁNCHEZ ROMERO 1999; 2000 cf. MARTÍNEZ FERNÁNDEZ ET AL. 2009, 16).

CHRONOLOGY

14C-ages:
Early Neolithic 14C-ages (stages 1-6):
7240±50 calBP (Ua-36215 6310±45 14C-yrs BP)
7040±90 calBP (Ua-36213 6120±40 14C-yrs BP)
7180±70 calBP (Ua-36214 6260±45 14C-yrs BP)
7040±90 calBP (ß-135663 6120±40 14C-yrs BP)

7050±80 calBP (Ua-37844 6140±45 14C-yrs BP)
6200±70 calBP (Ua-36211 5400±45 14C-yrs BP)
7150±80 calBP (Ua-36212 6240±45 14C-yrs BP)
(more ages for Middle Neolithic: 500-600 years lasting hiatus in Middle Neolithic).

Non-published TL-dates.

Stratigraphy:

Occupations from the Early Neolithic till Middle Ages in 25 stratigraphic levels, 16 thereof dated in the Neolithic. The Evolved Early Neolithic comprises levels 1-6 between approximately 5300-4800 calBC. Changes occurred within a generation every 20-50 years.

References:
CÁMARA SERRANO/MOLINA GONZÁLEZ/AFONSO MARRERO 2005; MARTÍNEZ FERNANDEZ ET AL. 2010, 163; 168 Tab. 1; SÁNCHEZ ROMERO 2000, iv; 85 Tab. 1.

Remarks:
/

ARTIFACTS

Lithic assemblage:
The Early Neolithic assemblage is characterized by pressure technique, thermal treatment and blade industry (CÁMARA SERRANO/MOLINA GONZÁLEZ/AFONSO MARRERO 2005, 842-843 Tab. 1).
MARTÍNEZ FERNÁNDEZ ET AL. 2010 evaluated and compared the Early Neolithic lithic assemblage with other Early Neolithic assemblages of Car (excavation Pellicer 1960, zone G, levels XVI-XIV), CNP (exclusively lithics of Cabecicos Negros cf. MARTÍNEZ FERNÁNDEZ/AFONSO MARRERO 1999: study includes lithic artifacts of El Pajarraco) and La Molaina (Middle Neolithic). The evaluations are summarized in **Tab. 260** and the following:
Raw Material: The raw material supply was sufficient and stem from surrounding nearby outcrops. Flint from Los Gallumbares was mostly used and imported in nodules and already pre-prepared objects. Thus, Neolithic blade cores are present in Los Gallumbares. MARTÍNEZ FERNÁNDEZ ET AL. (2010, 165; 166) assume a direct access of the people of Los Castillejos to Los Gallumbares. All kinds of products (nodules, [pre-]prepared cores and blanks) were brought on-site where processing continued.
Heat treatment: Since approximately 5400 calBC heat treatment was used in Cast and 346/48.2% artifacts of the blade production (Σ=718) are treated: 327/94.5% blades and 19/5.5% cores (MARTÍNEZ FERNÁNDEZ ET AL. 2010, 165). These cores were seemingly reduced by pressure technique.
Blanks (cf. MARTÍNEZ FERNÁNDEZ ET AL. 2010, 169 Fig. 1): In distinct areas either flake-cores or blade-cores are dominant and blades were used for various activities such as cutting (multifunctional; MARTÍNEZ FERNÁNDEZ ET AL. 2010, 166). Despite an apparently standardized blade production, the dimensions of prismatic blades are variable. This is possibly due to various percussion techniques (r^2 = 0.23 of width and length; MARTÍNEZ FERNÁNDEZ ET AL. 2010, 165; 170 Fig. 3). A cluster-analysis concerning the percussion technique of 201 blade and blade frags. with 4 indices (1.: length x width of platform remnant = estimated surface of platform remnant, 2.: ratio of thickness at the bulb : width of platform remnant, 3.: quotient of maximum thickness/thickness at the bulb, 4.: quotient length platform remnant/maximum width) assorts 197 artifacts significantly within one group (besides two additional groups with 3 and 1 piece[s]). Thus, the fluctuation is likely due to the variability of the initial core, the decreasing dimensions of blanks during the blank production, and accidents during percussion and does *not* express a particular specialization (MARTÍNEZ FERNÁNDEZ ET AL. 2010, 166).
Tools: Blades with retouch dominate (115/6.2%). Microliths and borers (types 9-16) are rare (cf. MARTÍNEZ FERNÁNDEZ ET AL. 2010, 169 Fig. 2).
SÁNCHEZ ROMERO (2000; 1999) also comparatively analysed lithic material (cf. **Tab. 260**). Generally, the Early and Middle Neolithic artifacts are spatially connected with fires and point to a communal utilization of the settlement area and similar maintenance activities such as food preparation and consumption, storage, handcrafting of clothes, child and elderly care and of sick group members

during both periods.
Initial cortex removal, preparation of the pre-core and the core took obviously place off-site (SÁNCHEZ ROMER 2000, 160). Only one single nodule of the Early Neolithic occupation is present on-site. Probably people gathered the raw materials in the immediate surroundings in approximately 5km radius around the site during pastoralism (SÁNCHEZ ROMERO 2000, 186; 198). The blanks were removed on-site partially in Kombewa technique (SÁNCHEZ ROMERO 2000, 186). Intentional thermal treatment facilitated the blank production (SÁNCHEZ ROMERO 2000, 162-167). Spatially the artifacts cluster around hearths and in various other concentrations (SÁNCHEZ ROMERO 2000, 170-180). Apart from blank production, settlers processed also bone and produced and repaired tools on-site (SÁNCHEZ ROMERO 2000, 187-188). Occasionally end scrapers were used to light fires (SÁNCHEZ ROMERO 2000, 188).

Figures: MARTÍNEZ FERNÁNDEZ ET AL. 2010, 168-171 Tab. 2-3 and Fig. 1-4.

Pottery assemblage:

The Early Neolithic pottery of Cast is generally globular, with a low amount of Cardial or comb impressions and *almagra* decoration (MARTÍNEZ FERNÁNDEZ ET AL. 2010, 164; CÁMARA SERRANO/MOLINA GONZÁLEZ/AFONSO MARRERO 2005, 842-843 Tab. 1).
Analyses of the Ancient Advanced Neolithic Pottery (phases 1-4/stage I; excavations 1991-94) by BLÁZQUEZ GONZÁLEZ 2011: Study of formal and technical attributes, decoration and archaeometric analyses (thin-section, X-ray diffraction, X-ray fluorescence, thermoluminescence).

Figures: /

Ground stone tools:

A few adzes and axes (cf. Tab. 1 of CÁMARA SERRANO/MOLINA GONZÁLEZ/AFONSO MARRERO 2005, 842-843).

Figures: /

Bone industry:

Points, needles.

Figures: /

Faunal remains/fauna:

Cattle, ovicaprids and swine are present since phase 1 (MARTÍNEZ FERNÁNDEZ ET AL. 2010, 164; CÁMARA SERRANO/MOLINA GONZÁLEZ/AFONSO MARRERO 2005, 848 Fig. 4; RIQUELME CANTAL 1996); land snails (YANES ET AL. 2011).

Botanic remains:

Cereals predominate the domestic plants in the Early Neolithic. Especially naked barley and durum wheat are common besides emmer. People used legumes (peas, lentils, bitter vetch, garbanzo) and wild plants sporadically (ROVIRA 2007).
Isotope analyses on charred grains of naked wheat and barley (AGUILERA ET AL. 2008, 1653) unfold that the available water/precipitation remained stable during crop growth in the Neolithic. But a decrease of grain size and yield imply declining soil fertility. Fertilizing is probable (ANTOLÍN/BUXÓ 2012).

Other:

Arm ring frags. (marble, calcite), jewelry.

FEATURES

Hearths, ovens and stone rings around fireplaces (MARTÍNEZ FERNÁNDEZ ET AL. 2010, 164; BLÁZQUEZ GONZÁLEZ 2011, 55): Initially the surface of the settlement area was prepared.
stage 1: big hearth/oven 119: clay ring of 1.2m diameter with small pit of 20cm depth and 25cm diameter, small hearth 121 of clay; stage 2: hearth/oven 115 of clay and rocks of 1.5m diameter with a small pit 116 of 25cm diameter, clay ring 120 n.s.; stage 3: semi-circled structure 129 with a small hearth 130 with clay ring, hearth/oven 114 with a diameter of 1.5m stratigraphically above structure 119; sub-stage 4a: 10 structures, hearth/oven 124 with a clay ring of 1.6m diameter around a pit, artificial floor surface (127, 128) of yellow clay, fire place 112 with a clay and rock ring

of 1.25m diameter, bench 113 of clay; sub-stage 4b: hearth-oven 124, hearth-oven 111 with a clay ring connected with structure 110, hearth-oven 126 with a pit and clay ring of 85cm diameter, rectangular bench 110 of yellow clay, bench 118 with pit 117; stage 5: floor surface of yellow clay (125) with post-holes (?), circular clay structures 106, 108, 109 of 50-60cm diameter; stage 6: abandonment (SÁNCHEZ ROMERO 2000, 85-90 with Fig. 3-8).

INTERPRETATION

The dispersal, organization and function of the site are unknown (MARTÍNEZ FERNÁNDEZ ET AL. 2010). But apparently the stability of the settlement increased since the Early Neolithic: People lived semi-sedentary, exploited and processed the surrounding resources (MARTÍNEZ FERNÁNDEZ ET AL. 2010, 163), roasted and stored cereals (durum wheat; MARTÍNEZ FERNÁNDEZ ET AL. 2010, 164) and the importance of cattle increased (BLÁZQUEZ GONZÁLEZ 2011).

The excavations of 1991-94 uncovered specialized areas. There are areas on-site, where people conducted only/predominantly blank production or heat treatment. Within a community area with hearths they processed animal remains, cereals and conducted blank production by pressure technique (BLÁZQUEZ GONZÁLEZ 2011 cf. SÁNCHEZ ROMERO 2000, iv).

YANES ET AL. (2011) and AGUILERA ET AL. (2008) attested wetter and more stable water supply in prehistoric times at least around 7200calBP. Nevertheless, decreasing grain sizes show decreasing yield of cereals resulting from a loss in soil fertility throughout the Neolithic (AGUILERA ET AL. 2008).

	LOS CASTILLEJOS Granada	Martínez Fernández et al. 2010		Sánchez Romero 2000 Early Neolithic															
				stage 1		stage 2		stage 3		stage 4a		stage 4b		stage 5		stage 6		Σ stages 1-6[c]	
		n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
BLANKS	flakes*	631	35.3%	308	53.47%	183	50.83%	118	45.73%	280	48.35%	617	51.54%	70	39.77%	40	47.05%	1616	50.02%
	blades*	702	39.2%	170	29.51%	131	36.38%	89	34.49%	218	37.65%	461	38.51%	85	48.29%	34	40.00%	1188	36.77%
	crested/lateral core flakes***[c]							6	2.90%	4	0.80%			2	1.29%			12	0.43%
	prismatic blades*/***	*605*	*84.3%*	168	35.14%	129	39.09%	89	40.09%	218	40.59%	459	41.35%	85	54.86%	34	42.05%	1182	42.15%
	prismatic blades: max. length			*4.56cm*		*6.05cm*		*5.64cm*		*5.92cm*		*5.49cm*		*5.04cm*		*3.35cm*		*6.05cm*	
	prismatic blades: Ø length			*NA*		*NA*		*NA*		*NA*		*2.56cm*		*NA*		*NA*			
	common length in mm of x%			*41.93%:30-40*		*43.75%:30-40*		*33.33%:20-30*		*70.22%:10-30*		*72.98%:10-30*		*50%:30-40*					
	prismatic blades: max. width			*1.96cm*		*2.90cm*		*2.06cm*		*1.88cm*		*2.34cm*		*1.66cm*		*1.65cm*		*2.90cm*	
	prismatic blades: Ø width	*NA*		*NA*		*NA*		*NA*		*1.05cm*		*1.07cm*		*93.75%:5-15*					
	common width in mm of x%			*90.31%:5-15*		*87.50%:5-15*		*76.16%:5-15*		*93.42%:10-15*		*91.79%:5-15*							
	prismatic blades: max. thickness									*0.9cm*		*1.3cm*		*NA*		*NA*			
	prismatic blades: Ø thickness			*NA*		*NA*		*NA*		*NA*		*0.91cm*							
	common thickness in mm of x%									*(% NA) 1-5*		*95.11%:1-5*							
	*esquirlas (< 2cm)**	420	23.5%																
	cores*	34	1.9%	4	0.69%	4	1.11%	5	2.32%	12	2.07%	26	2.17%	5	2.84%	2	2.35%	58	1.80%
	core tablet*			1	0.17%													1	0.03%
	nodules*	3	0.2%	1	0.17%													1	0.03%
	Σ blanks*	1790	97.0%	484	84.03%	318	88.33%	212	82.17%	510	88.08%	1104	92.23%	160	90.91%	76	89.41%	2864	88.64%
	n.s.*	53	2.9%	37	2.87%	17	4.71%	37	4.71%	39	6.63%	43	3.58%	9	5.11%	6	7.05%	188	5.82%
	hammer stones*	2	0.1%			1	0.27%	1	0.38%	2	0.34%							4	0.12%
PRESERVATION	with cortex*	*NA*		47	8.15%	23	6.38%	9	3.48%	31	5.35%	52	4.34%	4	2.27%	4	4.70%	170	5.26%
	complete artifacts*	*NA*		90	15.62%	70	19.44%	58	24.78%	84	16.24%	166	13.86%	47	26.70%	12	14.28%	527	16.31%
	incomplete artifacts*			439	84.37%	270	80.55%	276	75.21%	469	83.75%	990	86.13%	122	68.75%	72	85.71%	2638	81.65%
	heat treatment	346	48.2%	180	31.25%	142	39.44%	92	31.25%	221	38.16%	452	37.76%	44	25.00%	34	40.00%	1165	38.41%
	intentional heat treatment			253	43.92%	155	43.05%	122	43.92%	347	59.93%	730	60.98%	95	53.79%	42	49.41%	1744	57.50%
	thermal fractures*			47	8.15%	20	5.50%	24	9.30%	26	4.40%	41	3.40%	7	3.97%	1	1.17%	166	5.14%
	chemical alteration	*NA*		12	2.08%	42	11.66%	26	2.08%	3	0.50%	6	2.08%	13	7.30%	9	10.85%	111	3.66%
	mechanical alteration			2	0.34%	1	0.27%			2	0.34%	3	0.25%	2	1.13%			10	0.33%
	sickle gloss									2	0.34%	1	0.08%					3	0.10%
	Σ alteration*	*NA*		447	77.60%	340	94.44%	240	93.02%	575	99.3%	1192	99.58%	154	87.50%	85	100%	3033	93.87%
Σ total assemblage		1845	100%	576	100%	360	100%	258	100%	579	100%	1197	100%	176	100%	85	100%	3231	100%
	+ thermal fractures	622																	
	=	2467																	

Tab. 260 continues with legend on the next page.

	LOS CASTILLEJOS Granada	Martínez Fernández et al. 2010		Sánchez Romero 2000 Early Neolithic stage 1		stage 2		stage 3		stage 4a		stage 4b		stage 5		stage 6		Σ stages 1-6ᶜ	
		n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
PLATFORM REMNANT	w/o platform remnant***	*NA*		248	52.21%	165	52.88%	111	54.14%	270	54.12%	598	59.95%	80	51.61%	43	58.10%	1515	46.89%
	removed by retouch**					1	0.70%	1	0.90%			1	0.17%	1	1.25%	*NA*		4	0.26%
	w/o due to fracture**			248	100%	164	99.39%	110	99.10%	270	100%	587	98.16%	79	98.75%			1458	96.24%
	plain	313	73.82%	170	74.88%	108	73.50%	72	75.78%	192	84.12%	412	85.83%	51	69.33%	25	80.64%	1030	80.34%
	point	71	16.75%	43	18.94%	27	18.40%	20	21.27%	35	15.35%	63	13.20%	10	13.33%	6	19.35%	204	15.91%
	diedric	24	3.77%	13	5.72%	10	6.80%	2	2.12%	1	0.43%	5	0.43%	13	17.33%			44	3.43%
	facetted	16	3.77%	1	0.44%	2	1.30%											3	0.23%
	with cortex			1	0.44%													1	0.08%
	with platform remant***	424	22.98%	227	48%	147	47.12%	94	37.60%	228	45.78%	480	40.10%	75	48.38%	31	41.89%	1282	39.68%
TOOLS	blades with modification	*NA*		77	75.49%	48	69.56%	52	89.65%	67	77.27%	184	84.40%	50	89.12%	16	69.56%	494	80.06%
	flakes with modification			19	18.62%	16	18.62%	5	8.62%	19	21.59%	26	11.92%	6	10.71%	7	30.43%	98	15.88%
	cores with modification			6	5.58%	23.18	5.79%	1	1.72%	1	1.13%	7	3.21%					38.18	6.19%
	blank n.s. with modification					1	1.44%					1	0.46%					2	0.32%
	1A flakes with use traces		13%%	8	7.84%	5	7.24%	1	1.72%	4	13.63%	7	9.17%	2	3.57%	2	8.69%	29	4.70%
	1B flakes with lateral retouch			8	7.84%	7	10.14%	4	6.89%	8		13		2	3.57%	4	17.39%	46	7.46%
	2A blades with use traces		75%%	64	63.72%	39	56.52%	43	74.13%	58	76.13%	161	84.40%	38	67.85%	12	52.17%	415	67.26%
	2B blades with lateral retouch			11	10.78%	6	8.69%	8	13.79%	9		23		10	17.85%	4	17.39%	71	11.51%
	3 notched pieces		5%%			1	1.45%	1	1.69%					1	1.72%			3	0.49%
	4 denticulates		4%%																
	5 truncations		2%%																
	6 backed bladelets		1%%																
	7 microliths		1%%			1	1.45%											1	0.16%
	9 borers		2%%	3	2.94%	2	2.90%	1	1.69%	2	2.27%	2	0.92%	5	8.62%	1	4.35%	16	2.59%
	10 end scrapers		1%%	6	5.88%	7	10.14%	1	1.69%	5	5.68%	10	4.59%					29	4.70%
	14 splintered pieces		1%%	1	0.98%	1	1.45%			2	2.27%	2	0.92%					6	0.97%
	Σ tools	115	6.2%	102	17.70%	69	19.16%	59	22.86%	88	15.19%	218	18.21%	58	32.95%	23	27.06%	617	19.10%
Σ total assemblage		1845	100%	576	100%	360	100%	258	100%	579	100%	1197	100%	176	100%	85	100%	3231	100%

Tab. 260 continued: Cast/GR. Early Neolithic lithic assemblages according to MARTÍNEZ FERNÁNDEZ ET AL. (2010) and SÁNCHEZ ROMERO (2000; *(*)referring to the general category or to the blanks in SÁNCHEZ ROMERO 2000, respectively; ***referring to flakes and blades; ᶜ = calculated; %% = estimated percentages). The Simpson tool diversity index accounts for 0.273 (based on Σ stages 1-6ᶜ w/o tool types 1A and 2A/use weares).

Appendix to the statistic evaluation of the lithic artifacts

(to **4.6. Grouping by intra-assemblage similarities: Distances within blank and tool spectra**)

Underlying data tables (= Queries "Tab204_gf" and "Tab205_to" of the database that is available in NESPOS (2013) associated with the DOI 10.12853/RESDB.NESPOS.0001. For their import in "R", process these e.g. in MS Exel: No space in row/column names and enter 0 manually.)

Blank spectra of the assemblages. In the R-script abbreviated as "gf" (= *Grundform*):

	flakes	blades	debris	pebbles	cores	stage	bioc	region	location
A6EPI	279	144	53	5	10	EPI	XTH	W	coast
A6NEO	409	78	82	14	18	NEO	XTH	W	coast
AL	271	191	36	0	15	EPI	XTH	E	coast
AM	59	28	4	0	0	EPI	MS	E	interior
CA	985	442	121	0	65	EPI	XTH	E	interior
Car	325	90	38	0	30	NEO	MS	W	interior
CH	136	85	28	0	8	EPI	XTH	E	coast
CNP	103	126	8	0	9	NEO	XTH	E	coast
CZ	235	102	50	0	8	EPI	MS	E	interior
Hoz	78	123	10	0	8	EPI	XTH	E	interior

Tool spectra of the assemblages. In the R-script abbreviated as "to":

	projectiles	borers	sickles	burins	truncations	endscrapers	lateralR	splinteredP	notchedP	denticulates	other	stage	bioc	region	location
A6EPI	3	1	0	7	6	11	4	19	5	1	2	EPI	XTH	W	coast
A6NEO	2	2	0	10	7	21	12	45	6	4	0	NEO	XTH	W	coast
AL	20	2	0	7	9	27	10	29	1	1	2	EPI	XTH	E	coast
AM	3	0	0	2	3	1	1	5	0	1	0	EPI	MS	E	interior
CA	24	3	0	14	7	29	10	43	6	5	5	EPI	XTH	E	interior
Car	0	8	0	0	11	12	31	51	9	2	11	NEO	MS	W	interior
CH	5	4	0	0	3	8	15	9	0	2	3	EPI	XTH	E	coast
CNP	12	4	3	3	7	4	16	6	4	4	2	NEO	XTH	E	coast
CZ	19	2	0	1	9	9	5	11	1	3	0	EPI	MS	E	interior
Hoz	3	4	0	4	8	14	7	14	2	4	1	EPI	XTH	E	interior

R-script: Statistical evaluation and comparison of blank- and tools spectra

1) Calculation of distance matrices for blanks (a; cf. **Tab. 204**) and tools (b; cf. **Tab. 205**) using Chrod-distance and Hellinger-distance
2) Grouping concerning stage (a), bioclimate (b), region (c) or location (d; cf. **Tab. 206**) with adonis-algorithm
3) Mantel test of the two distance matrices

# Download and install "R" according to the instructions given at http://www.r-project.org/
# Type R-commands in the R-console and hit "enter"; try:
license()
# "R" in archaeology: http://www.rchaeology.tk/

To reporduce the results given in the study, follow the subsequent instructions.
Run the R-commands: select R-command(s), copy/paste these in the R-console by using Str+r (OR: type the R-commands given below) and run by "enter".
NOTE: Command 'read.table ("clipboard"...)'has to be entered manually! Details in [...] have to be adapted.
Comments are marked by
For detailed scripts and comments see Roth (2011b)!

###

# 0) preparation:
install.packages("vegan")
require(vegan)
citation("vegan")
setwd("C:/[...]") # set working directory
getwd() # check working directory

import table with abundances/types of blanks ("Grundformen" gf) and tools (to; cf. p. 295) = **Tab. 204** and **Tab. 205**:
"gf": select and copy table of blank spectra (11 rows x 10 columns)
read.table("clipboard", header=TRUE, row.names=1)->gf
"to": select and copy table of tool spectra (11 rows x 16 columns)
read.table("clipboard", header=TRUE, row.names=1)->to

1a) Chord- and Hellinger-distance matrices for blanks (gfchd/gfhed) with selection of columnes 1 to 5 containing the types
dist(decostand(gf[, 1:5], "norm"))->gfchd
dist(decostand(gf[, 1:5], "hel"))->gfhed

1b) Chord- and Hellinger-distance matrices for tools (tochd/tohed) with selection of columnes 1 to 11 containing the types
dist(decostand(to[, 1:11], "norm"))->tochd
dist(decostand(to[, 1:11], "hel"))->tohed

###

2) grouping of the distance matrices with adonis-algorithm
2a) concerning "stage" EPI/NEO
adonis(gfchd ~gf$stage, permutations=9999) # blanks, Chord-distance matrix

```
adonis(gfhed ~gf$stage, permutations=9999) # blanks, Hellinger-distance matrix
adonis(tochd ~to$stage, permutations=9999) # tools, Chord-distance matrix
adonis(tohed ~to$stage, permutations=9999) # tools, Hellinger-distance matrix

# 2b) concerning "bioc" bioclimatic zone
adonis(gfchd ~gf$bioc, permutations=9999) # blanks, Chord-distance matrix
adonis(gfhed ~gf$bioc, permutations=9999) # blanks, Hellinger-distance matrix
adonis(tochd ~to$bioc, permutations=9999) # tools, Chord-distance matrix
adonis(tohed ~to$bioc, permutations=9999) # tools, Hellinger-distance matrix

# 2c) concerning "region" E/W
adonis(gfchd ~gf$region, permutations=9999) # blanks, Chord-distance matrix
adonis(gfhed ~gf$region, permutations=9999) # blanks, Hellinger-distance matrix
adonis(tochd ~to$region, permutations=9999) # tools, Chord-distance matrix
adonis(tohed ~to$region, permutations=9999) # tools, Hellinger-distance matrix

# 2d) concerning "location" coast/interior
adonis(gfchd ~gf$location, permutations=9999) # blanks, Chord-distance matrix
adonis(gfhed ~gf$location, permutations=9999) # blanks, Hellinger-distance matrix
adonis(tochd ~to$location, permutations=9999) # tools, Chord-distance matrix
adonis(tohed ~to$location, permutations=9999) # tools, Hellinger-distance matrix

###

# 3) Mantel test for gf and to distance matrices
mantel(gfchd,tochd,permutations=9999) # Chrod-distance matrices
mantel(gfhed,tohed,permutations=9999) # Hellinger-distance matrices

######
```

Appendix to the statistic evaluation of the pottery

(to **5.5. Similarities in pottery decoration: Sequence as defined by correspondence analyses (CA)**)

Underlying data tables (= Queries “Tab_dectech_CA” and “Tab_motif_CA” of the database that is available in NESPOS (2013) associated with the DOI 10.12853/RESDB.NESPOS.0001. For their import in “R”, process these e.g. in MS Exel: No space in row/column names and enter 0 manually.)

Vessel units with decoration techniques. In the R-script abbreviated as “te”:

VU	1A	3A	6A	7A	7B	7C	8A	8B	9A	9B	10A	11A	11B	12A	13	14A	14B	14C	15	16
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
5	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
11	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
76	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
81	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
128	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
151	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
159	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
166	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
178	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
179	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
180	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
182	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
183	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
184	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
185	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
187	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
189	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
190	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0
192	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
193	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
194	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
217	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
219	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
221	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
223	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
252	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
253	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
254	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
255	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

256	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
257	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
258	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
259	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
260	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
261	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
262	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
263	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
264	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
265	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
266	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
267	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0
268	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
269	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
270	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
271	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
272	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
273	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
274	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
275	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
276	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
277	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
278	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
279	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
280	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
281	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
282	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
283	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
284	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
285	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
286	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
287	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
288	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
289	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
290	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
291	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
292	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
293	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
294	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
295	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
296	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
297	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
298	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
299	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
300	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
301	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
302	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
303	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
304	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
305	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
306	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
307	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
308	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
309	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
310	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
311	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0
312	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
313	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
314	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
315	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

316	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
335	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
337	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
347	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
349	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
353	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	1	0	0	0	0
356	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
358	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
376	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
379	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
380	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
381	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
384	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
387	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
389	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
408	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
426	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
428	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
429	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
430	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
431	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
432	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
433	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
435	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
436	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
437	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
439	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
443	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
444	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
455	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
457	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
458	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
459	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
460	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
461	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
462	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
463	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
464	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
487	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
488	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
489	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
490	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
493	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
503	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
505	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
506	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
507	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
508	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
509	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
510	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
512	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
513	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
515	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
516	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
517	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
518	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
519	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
521	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
522	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

523	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
524	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
525	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
526	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
527	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
528	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
532	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
533	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
539	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
541	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
546	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
559	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
561	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
564	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
565	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
566	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
567	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
568	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
569	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
570	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
571	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
572	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
573	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
574	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
575	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
576	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
577	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
580	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
582	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
583	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
585	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
589	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
590	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
591	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
593	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
594	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
595	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
596	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
597	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
666	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
676	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
687	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
688	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
689	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
690	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
691	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
692	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
717	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
875	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
902	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
903	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
985	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
986	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
993	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
996	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
998	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0
999	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1007	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1008	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

1009	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1010	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1011	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1012	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1013	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1145	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Vessel units with motifs. In the R-script abbreviated as “mo”:

VU	A1	B1	B3	D1	D2	D5	E1	H3	Site
1	0	1	0	0	1	0	1	0	HC
2	0	1	0	0	0	0	1	0	HC
3	0	1	0	0	0	0	1	0	HC
4	1	0	0	0	0	0	0	0	HC
5	0	0	1	1	0	0	0	0	HC
6	1	0	0	0	0	0	1	0	HC
11	0	1	0	0	0	0	1	0	Car
14	1	0	0	0	0	0	1	0	Car
30	0	0	0	0	0	0	1	0	Car
35	0	0	0	0	0	0	1	0	Car
48	0	1	0	0	0	0	0	0	Car
54	0	0	0	0	0	0	1	0	Car
59	0	0	0	0	0	0	1	0	Car
60	0	0	0	0	0	0	1	0	Car
62	0	0	0	0	0	0	1	0	Car
72	0	1	0	0	0	0	0	0	Car
76	0	0	0	1	0	0	1	0	Car
79	1	0	0	0	0	0	0	0	Car
81	1	0	0	0	0	0	1	0	Car
101	0	0	0	0	0	0	1	0	Car
103	0	0	0	0	0	0	1	0	Car
116	0	0	0	0	0	0	1	0	Car
128	1	0	1	0	0	0	0	0	Car
151	0	1	0	0	0	0	0	0	Car
159	0	0	0	0	0	0	1	0	Car
166	0	1	0	0	0	0	0	0	Car
176	0	0	0	0	0	0	1	0	Car
178	0	1	0	0	0	0	1	0	Car
179	0	1	1	0	0	0	1	0	Car
180	0	1	0	0	0	0	1	0	Car
181	0	1	0	0	0	0	1	0	Car
182	0	1	0	0	0	0	1	0	Car
183	0	0	0	0	0	0	1	0	Car
184	0	1	0	0	0	0	0	0	Car
185	0	0	0	1	0	0	0	0	Car
186	0	0	0	0	0	0	1	0	Car
187	0	1	0	0	0	0	1	0	Car
189	0	0	0	0	1	0	0	0	Car
190	0	0	0	1	0	0	0	0	Car
191	0	0	0	0	0	1	1	0	Car
192	0	0	0	1	0	0	1	0	Car
193	1	1	0	0	0	0	0	0	Car
194	0	1	0	0	0	0	1	0	Car
217	0	0	0	0	0	0	1	0	Car
219	0	1	0	0	0	0	1	0	Car
221	0	1	0	0	0	0	0	0	Car
223	0	1	0	0	0	0	0	0	Car
252	0	0	1	0	1	0	0	0	Car
253	0	1	1	1	0	0	0	0	Car
254	0	0	1	0	0	0	0	0	Car
255	1	0	0	1	0	0	1	0	Car

256	0	0	0	0	1	0	1	0	Car
257	0	1	0	1	1	0	1	0	Car
258	0	1	0	0	0	0	1	0	Car
259	0	0	0	1	1	0	1	0	Car
260	0	1	0	0	0	0	1	0	Car
261	0	0	0	1	1	0	1	0	Car
262	0	0	0	0	0	1	1	0	Car
263	0	0	0	1	0	0	1	1	Car
264	0	1	0	1	1	0	1	0	Car
265	0	1	0	0	0	0	1	0	Car
266	0	1	0	0	0	0	1	0	Car
267	0	1	0	0	0	0	1	0	Car
268	1	0	0	0	0	0	1	0	Car
269	0	0	0	0	0	0	1	0	Car
270	0	1	1	1	0	0	0	0	Car
271	1	1	0	0	0	1	1	0	Car
272	0	1	0	0	0	0	0	1	Car
273	0	0	0	1	0	0	1	0	Car
274	0	0	0	1	0	0	1	0	Car
275	0	1	0	0	0	0	1	0	Car
276	0	1	0	0	0	0	1	0	Car
277	0	0	0	0	0	0	1	0	Car
278	0	0	0	0	0	0	1	0	Car
279	0	1	0	0	0	0	0	1	Car
280	0	0	0	1	0	0	1	0	Car
281	0	1	0	1	0	0	0	0	Car
282	1	1	0	0	0	0	1	1	Car
283	0	0	0	0	0	0	1	0	Car
284	0	0	0	0	0	0	1	0	Car
285	0	0	0	0	0	0	1	0	Car
286	0	0	0	1	0	0	1	0	Car
287	0	1	0	0	0	0	1	0	Car
288	1	0	0	0	0	0	0	0	Car
289	1	1	0	0	0	0	0	0	Car
290	0	1	0	0	0	0	1	0	Car
291	0	1	0	0	0	0	1	0	Car
292	0	0	0	0	0	0	1	0	Car
293	0	0	0	0	0	0	1	0	Car
294	0	0	0	0	1	0	0	0	Car
295	0	1	1	0	0	0	0	0	Car
296	1	0	0	0	0	0	1	0	Car
297	1	0	0	0	0	0	1	0	Car
298	0	0	0	0	0	0	1	0	Car
299	0	0	0	0	0	0	1	0	Car
300	0	1	0	0	1	0	0	0	Car
301	0	0	0	0	0	0	1	0	Car
302	0	0	0	0	0	0	1	0	Car
303	0	0	0	0	0	0	1	1	Car
304	0	1	1	0	0	0	0	0	Car
305	0	0	0	0	0	0	1	0	Car
306	1	1	1	0	0	0	0	0	Car
307	0	1	0	0	0	0	0	0	Car
308	0	1	0	0	0	0	0	0	Car
309	0	0	0	0	0	0	1	0	Car
310	0	1	0	0	0	0	0	0	Car
311	1	0	0	0	0	0	1	0	Car
312	0	0	0	1	0	0	1	0	Car
313	0	0	0	0	0	0	1	0	Car
314	0	0	0	0	0	0	1	0	Car
315	0	1	0	1	0	0	0	0	Car

316	1	0	0	0	0	0	0	0	Car
335	1	0	0	0	0	0	0	0	CNP
337	0	1	0	0	0	0	1	0	CNP
347	1	0	0	0	0	0	1	0	CNP
349	0	0	0	0	0	0	1	0	CNP
353	1	0	0	0	0	0	1	0	CNP
356	1	0	0	0	0	0	0	0	CNP
358	1	0	0	0	0	0	1	0	CNP
376	1	0	0	0	0	0	0	0	CNP
379	1	0	0	0	0	0	1	0	CNP
380	1	0	0	0	0	0	0	0	CNP
381	0	1	0	0	0	0	1	0	CNP
384	1	0	0	0	0	0	1	0	CNP
387	1	0	0	0	0	0	0	0	CNP
389	0	0	0	1	0	0	1	0	CNP
408	0	0	0	0	0	0	1	0	CNP
426	0	0	0	0	0	0	1	0	CNP
428	0	0	0	0	0	1	0	0	CNP
429	0	1	0	0	0	0	0	0	CNP
430	0	0	1	0	0	0	0	0	CNP
431	1	0	0	0	0	0	1	0	CNP
433	0	0	1	0	0	0	0	0	CNP
435	0	0	0	1	0	0	1	0	CNP
436	1	0	0	0	0	0	0	0	CNP
437	0	0	0	0	0	0	1	0	CNP
439	1	0	0	1	0	0	0	0	CNP
443	0	0	0	1	1	0	0	0	CNP
444	0	0	0	0	1	0	1	0	CNP
455	0	1	0	0	0	0	1	0	CNP
457	0	0	0	0	0	1	1	0	CNP
458	1	1	0	0	0	0	1	0	CNP
459	0	1	0	0	0	1	0	0	CNP
460	1	0	0	0	0	0	0	0	CNP
461	1	0	0	0	0	0	0	0	CNP
462	1	0	0	0	0	0	0	0	CNP
463	1	0	0	0	0	0	0	0	CNP
464	1	0	0	0	0	0	1	0	CNP
487	1	0	0	0	0	0	0	0	CNP
488	0	1	0	0	0	0	0	0	CNP
489	1	1	0	0	0	0	0	0	CNP
490	0	1	0	0	0	0	1	0	CNP
493	0	0	0	0	0	0	1	0	CNP
503	1	0	0	0	0	0	0	0	CNP
505	1	1	0	0	0	0	1	0	CNP
506	1	0	0	1	0	0	0	0	CNP
507	1	0	0	0	0	0	0	0	CNP
508	0	1	0	0	0	0	0	0	CNP
509	1	1	0	0	0	0	0	0	CNP
510	0	1	0	0	0	0	1	0	CNP
512	1	0	0	0	0	0	0	0	CNP
513	1	0	0	0	0	0	0	0	CNP
515	0	1	0	0	0	0	0	0	CNP
516	1	0	0	0	0	0	1	0	CNP
517	1	0	0	0	0	0	0	0	CNP
518	1	0	0	0	0	0	0	0	CNP
519	1	0	0	1	0	0	1	0	CNP
521	1	0	0	0	0	0	1	0	CNP
522	1	0	0	0	0	0	0	0	CNP
523	1	0	0	0	0	0	0	0	CNP
524	0	0	0	1	0	0	1	0	CNP

525	1	0	0	0	0	0	1	0	CNP
526	0	0	0	1	0	0	1	0	CNP
527	1	0	0	0	0	0	0	0	CNP
528	1	1	0	0	0	0	0	0	CNP
532	0	1	0	0	0	0	1	0	CNP
533	1	0	0	0	0	0	0	0	CNP
539	1	0	0	0	0	0	0	0	CNP
546	1	0	0	0	0	0	1	0	CNP
559	0	1	0	0	0	0	0	0	CNP
561	0	1	0	0	0	0	1	0	CNP
564	0	1	0	0	0	0	0	0	CNP
565	1	0	0	0	0	0	1	0	CNP
566	0	1	0	0	0	0	0	0	CNP
567	1	0	0	0	0	0	0	0	CNP
568	1	0	0	0	0	0	1	0	CNP
569	0	1	0	0	0	0	0	0	CNP
570	0	0	0	0	1	0	1	0	CNP
571	0	1	0	0	0	0	1	0	CNP
572	0	0	0	1	0	0	0	0	CNP
573	0	0	0	1	0	0	1	0	CNP
574	1	0	0	0	0	0	1	0	CNP
575	1	0	0	0	0	0	0	0	CNP
576	1	0	0	0	0	0	0	0	CNP
577	0	0	0	0	0	0	1	0	CNP
580	1	0	0	0	0	0	0	0	CNP
582	0	1	0	0	0	0	1	0	CNP
583	0	0	0	0	0	0	1	0	CNP
585	1	0	0	0	0	0	0	0	CNP
589	0	1	0	0	0	0	1	0	CNP
590	0	0	1	0	0	0	0	0	CNP
591	1	0	0	0	0	0	1	0	CNP
593	0	0	0	0	1	1	1	0	CNP
594	1	0	0	0	0	0	1	0	CNP
595	1	0	0	0	0	0	0	0	CNP
596	1	0	0	0	0	0	1	0	CNP
597	0	0	0	1	0	0	1	0	CNP
666	0	1	1	0	0	0	1	0	CNP
676	1	0	0	1	0	0	1	0	CNP
687	1	0	0	0	0	0	0	0	CNP
688	0	1	0	0	0	0	0	0	CNP
689	0	0	0	0	0	1	1	0	CNP
690	0	1	0	1	0	1	1	0	CNP
691	0	1	0	1	0	0	1	0	CNP
692	0	0	1	0	0	0	0	0	CNP
717	1	0	0	0	0	0	0	0	CNP
875	0	0	0	0	0	1	1	0	CNP
902	0	0	0	0	0	0	1	0	CNP
903	1	0	0	0	0	0	1	0	CNP
985	0	0	0	0	0	0	1	0	CNP
986	1	0	0	0	0	0	0	0	CNP
993	0	1	0	0	0	0	1	0	A6
995	1	0	0	0	0	0	0	0	A6
996	1	0	0	1	0	0	0	0	A6
998	1	1	1	0	1	1	1	0	A6
999	1	1	0	0	0	0	1	0	A6
1007	0	1	0	0	0	0	0	0	Got
1008	0	0	0	1	0	0	0	0	Got
1009	0	0	0	1	0	0	1	1	Got
1010	0	0	1	1	0	0	0	0	Got
1011	0	0	1	0	0	0	0	0	Got

1012	0	1	0	0	0	0	1	1	Got
1013	1	0	0	0	0	0	0	0	Got
1145	0	1	1	1	1	0	1	1	Car

Motifs of VUs from Car/GR with levels and from CNP/AL. In the R-script abbreviated as "Car" and "CNP":

Car/GR with levels

VU	A1	B1	B3	D1	D2	D5	E1	H3	Phase
263	0	0	0	1	0	0	1	1	XVI
254	0	0	1	0	0	0	0	0	XVI
81	1	0	0	0	0	0	1	0	XVI
11	0	1	0	0	0	0	1	0	XVI
14	1	0	0	0	0	0	1	0	XVI
30	0	0	0	0	0	0	1	0	XVI
35	0	0	0	0	0	0	1	0	XVI
48	0	1	0	0	0	0	0	0	XVI
54	0	0	0	0	0	0	1	0	XVI
59	0	0	0	0	0	0	1	0	XVI
60	0	0	0	0	0	0	1	0	XVI
62	0	0	0	0	0	0	1	0	XVI
72	0	1	0	0	0	0	0	0	XVI
76	0	0	0	1	0	0	1	0	XVI
79	1	0	0	0	0	0	0	0	XVI
101	0	0	0	0	0	0	1	0	XVI
103	0	0	0	0	0	0	1	0	XVI
116	0	0	0	0	0	0	1	0	XVI
128	1	0	1	0	0	0	0	0	XVI
151	0	1	0	0	0	0	0	0	XVI
159	0	0	0	0	0	0	1	0	XVI
166	0	1	0	0	0	0	0	0	XVI
176	0	0	0	0	0	0	1	0	XVI
178	0	1	0	0	0	0	1	0	XVI
179	0	1	1	0	0	0	1	0	XVI
180	0	1	0	0	0	0	1	0	XVI
181	0	1	0	0	0	0	1	0	XVI
182	0	1	0	0	0	0	1	0	XVI
183	0	0	0	0	0	0	1	0	XVI
184	0	1	0	0	0	0	0	0	XVI
185	0	0	0	1	0	0	0	0	XVI
186	0	0	0	0	0	0	1	0	XVI
187	0	1	0	0	0	0	1	0	XVI
189	0	0	0	0	1	0	0	0	XVI
190	0	0	0	1	0	0	0	0	XVI
191	0	0	0	0	0	1	1	0	XVI
192	0	0	0	1	0	0	1	0	XVI
193	1	1	0	0	0	0	0	0	XVI
217	0	0	0	0	0	0	1	0	XVI
219	0	1	0	0	0	0	1	0	XVI
221	0	1	0	0	0	0	0	0	XVI
223	0	1	0	0	0	0	0	0	XVI
256	0	0	0	0	1	0	1	0	XVI
257	0	1	0	1	1	0	1	0	XVI
279	0	1	0	0	0	0	0	1	XVI
289	1	1	0	0	0	0	0	0	XVI
307	0	1	0	0	0	0	0	0	XVI
####	0	1	1	1	1	0	1	1	XVI
255	1	0	0	1	0	0	1	0	XV
260	0	1	0	0	0	0	1	0	XV
261	0	0	0	1	1	0	1	0	XV

CNP/AL

VU	A1	B1	B3	D1	D2	D5	E1
335	1	0	0	0	0	0	0
337	0	1	0	0	0	0	1
347	1	0	0	0	0	0	1
349	0	0	0	0	0	0	1
353	1	0	0	0	0	0	1
356	1	0	0	0	0	0	0
358	1	0	0	0	0	0	1
376	1	0	0	0	0	0	0
379	1	0	0	0	0	0	1
380	1	0	0	0	0	0	0
381	0	1	0	0	0	0	1
384	1	0	0	0	0	0	1
387	1	0	0	0	0	0	0
389	0	0	0	1	0	0	1
408	0	0	0	0	0	0	1
426	0	0	0	0	0	0	1
428	0	0	0	0	0	1	0
429	0	1	0	0	0	0	0
430	0	0	1	0	0	0	0
431	1	0	0	0	0	0	1
433	0	0	1	0	0	0	0
435	0	0	0	1	0	0	1
436	1	0	0	0	0	0	0
437	0	0	0	0	0	0	1
439	1	0	0	1	0	0	0
443	0	0	0	1	1	0	0
444	0	0	0	0	1	0	1
455	0	1	0	0	0	0	1
457	0	0	0	0	0	1	1
458	1	1	0	0	0	0	1
459	0	1	0	0	0	1	0
460	1	0	0	0	0	0	0
461	1	0	0	0	0	0	0
462	1	0	0	0	0	0	0
463	1	0	0	0	0	0	0
464	1	0	0	0	0	0	1
487	1	0	0	0	0	0	0
488	0	1	0	0	0	0	0
489	1	1	0	0	0	0	0
490	0	1	0	0	0	0	1
493	0	0	0	0	0	0	1
503	1	0	0	0	0	0	0
505	1	1	0	0	0	0	1
506	1	0	0	1	0	0	0
507	1	0	0	0	0	0	0
508	0	1	0	0	0	0	0
509	1	1	0	0	0	0	0
510	0	1	0	0	0	0	1
512	1	0	0	0	0	0	0
513	1	0	0	0	0	0	0
515	0	1	0	0	0	0	0

275	0	1	0	0	0	0	1	0	XV
276	0	1	0	0	0	0	1	0	XV
280	0	0	0	1	0	0	1	0	XV
281	0	1	0	1	0	0	0	0	XV
282	1	1	0	0	0	0	1	1	XV
299	0	0	0	0	0	0	1	0	XV
300	0	1	0	0	1	0	0	0	XV
301	0	0	0	0	0	0	1	0	XV
302	0	0	0	0	0	0	1	0	XV
303	0	0	0	0	0	0	1	1	XV
304	0	1	1	0	0	0	0	0	XV
305	0	0	0	0	0	0	1	0	XV
310	0	1	0	0	0	0	0	0	XV
311	1	0	0	0	0	0	1	0	XV
314	0	0	0	0	0	0	1	0	XV
315	0	1	0	1	0	0	0	0	XV
316	1	0	0	0	0	0	0	0	XV
259	0	0	0	1	1	0	1	0	XIV
271	1	1	0	0	0	1	1	0	XIV
194	0	1	0	0	0	0	1	0	XIV
252	0	0	1	0	1	0	0	0	XIV
253	0	1	1	1	0	0	0	0	XIV
258	0	1	0	0	0	0	1	0	XIV
265	0	1	0	0	0	0	1	0	XIV
266	0	1	0	0	0	0	1	0	XIV
267	0	1	0	0	0	0	1	0	XIV
268	1	0	0	0	0	0	1	0	XIV
269	0	0	0	0	0	0	1	0	XIV
270	0	1	1	1	0	0	0	0	XIV
272	0	1	0	0	0	0	0	1	XIV
273	0	0	0	1	0	0	1	0	XIV
274	0	0	0	1	0	0	1	0	XIV
277	0	0	0	0	0	0	1	0	XIV
278	0	0	0	0	0	0	1	0	XIV
283	0	0	0	0	0	0	1	0	XIV
284	0	0	0	0	0	0	1	0	XIV
285	0	0	0	0	0	0	1	0	XIV
286	0	0	0	1	0	0	1	0	XIV
287	0	1	0	0	0	0	1	0	XIV
288	1	0	0	0	0	0	0	0	XIV
290	0	1	0	0	0	0	1	0	XIV
291	0	1	0	0	0	0	1	0	XIV
292	0	0	0	0	0	0	1	0	XIV
293	0	0	0	0	0	0	1	0	XIV
294	0	0	0	0	1	0	0	0	XIV
295	0	1	1	0	0	0	0	0	XIV
296	1	0	0	0	0	0	1	0	XIV
297	1	0	0	0	0	0	1	0	XIV
298	0	0	0	0	0	0	1	0	XIV
306	1	1	1	0	0	0	0	0	XIV
308	0	1	0	0	0	0	0	0	XIV
309	0	0	0	0	0	0	1	0	XIV
312	0	0	0	1	0	0	1	0	XIV
313	0	0	0	0	0	0	1	0	XIV

516	1	0	0	0	0	0	1
517	1	0	0	0	0	0	0
518	1	0	0	0	0	0	0
519	1	0	0	1	0	0	1
521	1	0	0	0	0	0	1
522	1	0	0	0	0	0	0
523	1	0	0	0	0	0	0
524	0	0	0	1	0	0	1
525	1	0	0	0	0	0	1
526	0	0	0	1	0	0	1
527	1	0	0	0	0	0	0
528	1	1	0	0	0	0	0
532	0	1	0	0	0	0	1
533	1	0	0	0	0	0	0
539	1	0	0	0	0	0	0
546	1	0	0	0	0	0	1
559	0	1	0	0	0	0	0
561	0	1	0	0	0	0	1
564	0	1	0	0	0	0	0
565	1	0	0	0	0	0	1
566	0	1	0	0	0	0	0
567	1	0	0	0	0	0	0
568	1	0	0	0	0	0	1
569	0	1	0	0	0	0	0
570	0	0	0	0	1	0	1
571	0	1	0	0	0	0	1
572	0	0	0	1	0	0	0
573	0	0	0	1	0	0	1
574	1	0	0	0	0	0	1
575	1	0	0	0	0	0	0
576	1	0	0	0	0	0	0
577	0	0	0	0	0	0	1
580	1	0	0	0	0	0	0
582	0	1	0	0	0	0	1
583	0	0	0	0	0	0	1
585	1	0	0	0	0	0	0
589	0	1	0	0	0	0	1
590	0	0	1	0	0	0	0
591	1	0	0	0	0	0	1
593	0	0	0	0	1	1	1
594	1	0	0	0	0	0	1
595	1	0	0	0	0	0	0
596	1	0	0	0	0	0	1
597	0	0	0	1	0	0	1
666	0	1	1	0	0	0	1
676	1	0	0	1	0	0	1
687	1	0	0	0	0	0	0
688	0	1	0	0	0	0	0
689	0	0	0	0	0	1	1
690	0	1	0	1	0	1	1
691	0	1	0	1	0	0	1
692	0	0	1	0	0	0	0
717	1	0	0	0	0	0	0
875	0	0	0	0	0	1	1
902	0	0	0	0	0	0	1
903	1	0	0	0	0	0	1
985	0	0	0	0	0	0	1
986	1	0	0	0	0	0	0

R-script: Correspondence analyses (CA) of pottery decoration with R-package "ca"

```
# 1) decoration techniques (cf. Fig. 64 and Tab. 220)
# 2) decoration motifs  (cf. Fig. 65 and Tab. 218)
# 3) motifs of Car/GR of levels XVI-XIV (cf. Fig. 66)
# 4) motifs of CNP/AL (cf. Fig. 68)

# Download and install "R" according to the instructions given at http://www.r-project.org/
# Type R-commands in the R-console and hit "enter"; try:
license()
# "R" in archaeology: http://www.rchaeology.tk/

# To reporduce the results given in the study, follow the subsequent instructions.
# Run the R-commands: select R-command(s), copy/paste these in the R-console by using Str+r (OR: type the R-commands given below) and run by "enter".
# NOTE: Command "read.table ("clipboard"...)" has to be entered manually! Details in [...] have to be adapted.
# Comments are marked by #
# Save images by hand! Hit "History"-"Aufzeichnen".
# For detailed scripts and comments see Roth (2011a)!

# 0) preparation:
install.packages(„ca“)
require(ca)
citation("ca")
setwd("C:/[...]") # set working directory
getwd() # check working directory

###

# 1. CA: DECORATION TECHNIQUES ON VUs
# copy table of decoration techniques "te" ( 238 rows, 21 columns; cf. p. 298-302) in clipboard
read.table("clipboard", header=TRUE, row.names=1)->te # enter by hand!
c("1A", "3A", "6A", "7A", "7B", "7C", "8A", "8B", "9A", "9B", "10A", "11A", "11B", "12A", "13", "14A", "14B", "14C", "15", "16")->na # creation of column names
na->colnames(te) # add column names to table "te"
str(te) # tabel header and VUs = row names >  237 rows, 20 columns

plot(ca(te, suprow=c(11, 116), supcol=c(8, 17))) # simple biplot of 1st and 2nd axis
# CA w/o VUs 48 (row 11) and 349 (row 116), decoration techniques 8B (column 8) and 14B (column 17)
# suprows/-cols were kept and ploted (empty triangles/dots), but do not influence the CA-result.
# further outliers: VUs 166, 190, 308 (rows 26, 39, 104), decoration techniques 6A and 7C (columnes 3, 6)
# CAs w/o these:
ca(te, suprow=c(11, 26, 39, 104, 116), supcol=c(3, 6, 8, 17)) -> cate # CA-result "cate"
summary(cate) # tabular summary of results
barplot(cate$sv^2/sum(cate$sv^2), col=0) # inertia on each axis
title(xlab="inertia motif",cex.lab=.75) # save barplot as image file!
plot(cate) # simple biplot of 1st and 2nd axis of "cate"
```

```
# graphical presentation: (save images one by one!)
palette(gray(seq(0,.9,len=50))) # creation of gray levels
palette()
# biplot with VUs in rowprincipals (black dots) and decoration techniques in standard column
coordinates (triangles):
plot(cate, map="rowprincipal", col=c(1,30), labels=c(0,2)) # decoration techniques labeled
title(xlab="1. main axis", ylab="2. main axis",cex.lab=.75)
plot(cate, map="rowprincipal", col=c(1,30), labels=c(2,0)) # VUs labeled
title(xlab="1. main axis", ylab="2. main axis",cex.lab=.75)
# biplot with weighted dots: mass = size and contribution = color:
# therefore CA w/o suprows and -cols (w/o any mass or contribution):
ca(te[-c(11, 26, 39, 104, 116),-c(3, 6, 8, 17)])->cate2
plot(cate2, map="rowprincipal", mass=c(TRUE,TRUE), contrib=c("relative","relative"), xlim=c(-3,3),
ylim=c(-3,3), col=c(1,1), labels=c(0,2)) # labeled decoration techniques
title(xlab="1. main axis", ylab="2. main axis",cex.lab=.75)
plot(cate2, map="rowprincipal", mass=c(TRUE,TRUE), contrib=c("relative","relative"), xlim=c(-3,3),
ylim=c(-3,3), col=c(1,1), labels=c(2,0)) # labeled VUs
title(xlab="1. main axis", ylab="2. main axis",cex.lab=.75)
# biplot of 1st and 3rd axis of CA with suprows/-cols "cate"
plot(cate, map="rowprincipal", dim=c(1,3), labels=c(0,2))
title(xlab="1. main axis", ylab="3. main axis",cex.lab=.75)
# biplot of 2nd and 3rd axis of CA with subrows/-cols "cate"
plot(cate, map="rowprincipal", dim=c(2,3), labels=c(0,2))
title(xlab="2. main axis", ylab="3. main axis",cex.lab=.75)

# export of specific values for rows and columns
getwd() # working directory
summary(cate)->sucate
sucate$rows->terqlt
sucate$columns->tecqlt
write.csv2(terqlt, "1_cate_rowquality.csv", quote=FALSE, row.names=FALSE)
write.csv2(tecqlt, "1_cate_columnquality.csv", quote=FALSE, row.names =FALSE)
# principal row coordinates
cate$rowcoord %*% diag(cate$sv)->terowprc
cate$rownames->rownames(terowprc)
paste("axis", sep="", 1:ncol(terowprc))->nate1
nate1->colnames(terowprc)
write.csv2(terowprc,"1_cate_rowprc.csv", quote=FALSE, row.names=TRUE)
# principal column coordinates
cate$colcoord %*% diag(cate$sv)->tecolprc
cate$colnames->rownames(tecolprc)
paste("axis", sep="", 1:ncol(tecolprc))->nate2
nate2->colnames(tecolprc)
write.csv2(tecolprc,"1_cate_colprc.csv", quote=FALSE, row.names=TRUE)

###

# 2. CA: MOTIFS ON VUs
# copy table of motifs "mo" (335 rows, 10 columns; cf. p. 302-306) in clipboard
read.table("clipboard", header=TRUE, row.names=1)->mo # enter by hand!
str(mo) # tabel header and VUs = row names > 334 rows, 9 columns
```

```
ca(mo[,1:8])->camo # CA w/o col 9 "Site" and result "camo"
summary(camo) # tabular summary of results
barplot(camo$sv^2/sum(camo$sv^2), col=0) # inertia on each axis
title(xlab="inertia motif",cex.lab=.75) # save barplot as image file!
plot(camo) # simple biplot of 1st and 2nd axis of "camo"

# graphical presentation: (save images!)
palette(gray(seq(0,.9,len=50))) # creation of gray levels
palette()
# biplot with VUs in rowprincipals (black dots) and motifs in standard column coordinates (triangles):
plot(camo, map="rowprincipal", col=c(1,30), labels=c(0,2)) # motifs labeled
title(xlab="1. main axis", ylab="2. main axis",cex.lab=.75)
plot(camo, map="rowprincipal", col=c(1,30), labels=c(2,0)) # VUs labeled
title(xlab="1. main axis", ylab="2. main axis",cex.lab=.75)
# biplot with weighted dots: mass = size and contribution = color:
plot(camo, map="rowprincipal", mass=c(TRUE,TRUE), contrib=c("relative","relative"), xlim=c(-2,2),
ylim=c(-4,2), col=c(1,1), labels=c(0,2))
title(xlab="1. main axis", ylab="2. main axis",cex.lab=.75)
# biplot with VU colored according to the sites
plot(camo, map="rowprincipal", xlim=c(-2.5,2.5), ylim=c(-4,2), what = c("none","none") )
camo$rowcoord %*% diag(camo$sv)->rowprc # creation of principal row coordinates
# dots of sites became coloured in desending grey levels (black to light gray) according to their
affiliation to a site in alphabetical order (A6 to HC):
points(rowprc[,1:2], pch=21, bg=c(1,17,34,49,50) [mo$Site])
# adding of motifs in standard column coordinates as triangles and labels:
points(camo$colcoord[,1:2], pch=24, bg=0, cex=1.1)
text(camo$colcoord[,1:2], camo$colnames, cex=.75, adj=-.5)
title(xlab="1. main axis", ylab="2. main axis", cex.lab=.75)
# biplot of 1st and 3rd axis
plot(camo, map="rowprincipal", dim=c(1,3), labels=c(0,2))
title(xlab="1. main axis", ylab="3. main axis",cex.lab=.75)
# biplot of 2nd and 3rd axis
plot(camo, map="rowprincipal", dim=c(2,3), labels=c(0,2))
title(xlab="2. main axis", ylab="3. main axis",cex.lab=.75)

# export of specific values for rows and columns
getwd() # working directory
summary(camo)->sucamo
sucamo$rows->morqlt
sucamo$columns->mocqlt
write.csv2(morqlt, "2_camo_rowquality.csv", quote=FALSE, row.names=FALSE)
write.csv2(mocqlt, "2_camo_columnquality.csv", quote=FALSE, row.names =FALSE)
# principal row coordinates
camo$rowcoord %*% diag(camo$sv)->morowprc
camo$rownames->rownames(morowprc)
paste("axis", sep="", 1:ncol(morowprc))->namo1
namo1->colnames(morowprc)
write.csv2(morowprc,"2_camo_rowprc.csv", quote=FALSE, row.names=TRUE)
# principal column coordinates
camo$colcoord %*% diag(camo$sv)->mocolprc
camo$colnames->rownames(mocolprc)
paste("axis", sep="", 1:ncol(mocolprc))->namo2
```

```
namo2->colnames(mocolprc)
write.csv2(mocolprc,"2_camo_colprc.csv", quote=FALSE, row.names=TRUE)

###

# 3. CA for VUs and motifs of Car of levels XVI-XIV:
# copy table of motifs from Car "Car" (106 rows, 10 columns; cf. p. 306-307) in clipboard
read.table("clipboard", header=TRUE, row.names=1)->Car # enter by hand!
str(Car) # tabel header and VUs = row names > 105 rows, 9 columns
ca(Car[,1:8])->caar # CA w/o col 9 "Phase"
summary(caar)
caar$rowcoord %*% diag(caar$sv)->rprcCar # creation principal row coordinates
plot(caar, map="rowprincipal", xlim=c(-3,3), ylim=c(-2,0), what = c("none","none") )
points(rprcCar[,1:2], pch=22, bg=c(30,10,49)[Car$Phase]) # adding principal row coordinates (VU)
colored according to their stage
points(caar$colcoord[,1:2], pch=24, bg=0, cex=1.1) # adding motifs as triangles
text(caar$colcoord[,1:2], caar$colnames, cex=0.75,adj=-.4) # labeling
title(xlab="1. main axis", ylab="2. main axis", cex.lab=.8)

###

# 4. CA for VUs and motifs of CNP
# copy table motifs from CNP "CNP" (110 rows, 8 columns [w/o motif H3]; cf. p. 306-307) in clipboard
read.table("clipboard", header=TRUE, row.names=1)->CNP # enter by hand!
str(CNP) # tabel header and VUs = row names > 109 rows, 7 columns
ca(CNP, suprow=c(19,21,89,96,103), supcol=c(3))->cacnp # CA w/o outliers
summary(cacnp)
plot(ca(CNP, suprow=c(19,21,89,96,103), supcol=c(3)), map="rowprincipal" , col=c(1,0), xlim=c(-2,7),
ylim=c(-2,2), labels=c(0,2))
points(cacnp$colcoord, pch=24, bg=0, cex=1.1)
title(xlab="1. main axis", ylab="2. main axis",cex.lab=.75)

#######
```

Specific values

CA of decoration techniques

Column quality (decoration techniques)

name	mass	qlt	inr	k=1	cor	ctr	k=2	cor	ctr
1A	45	467	77	-1895	219	189	2016	248	221
3A	60	301	70	-1097	107	84	1475	194	158
(*)6A	NA	14	NA	-1279	5	NA	1779	10	NA
7A	93	864	77	-1466	272	233	-2161	592	525
7B	15	4	65	374	3	2	-169	1	1
(*)7C	NA	64	NA	-1424	16	NA	-2419	47	NA
8A	9	13	80	979	11	10	392	2	2
(*)8B	NA	4	NA	654	4	NA	230	0	NA
9A	27	32	79	863	27	23	392	6	5
9B	162	47	60	-339	33	22	227	15	10
10A	15	57	72	-484	5	4	-1537	52	43
11A	204	48	52	329	44	26	93	4	2
11B	33	1	60	-146	1	1	-52	0	0
12A	36	143	49	1351	142	77	-136	1	1
13	9	46	46	1485	46	23	-93	0	0
14A	207	471	50	1042	470	262	-46	1	1
(*)14B	NA	NA	NA	NA	NA	NA	NA	NA	NA
14C	21	48	68	614	12	9	-1048	36	28
15	39	23	54	-506	19	12	227	4	2
16	24	53	42	-888	47	22	320	6	3

Row quality (VUs)

name	mass	qlt	inr	k=1	cor	ctr	k=2	cor	ctr
1	6	721	5	-1615	299	18	1917	422	27
2	6	235	4	1292	234	12	-100	1	0
3	9	131	14	1396	130	20	-101	1	0
4	3	29	11	932	24	3	431	5	1
5	3	257	5	-1184	90	5	1620	168	10
6	6	235	4	1292	234	12	-100	1	0
11	3	38	2	-366	26	0	249	12	0
14	6	384	1	740	383	4	26	0	0
30	3	332	1	1126	331	4	-51	1	0
35	3	38	15	663	9	2	-1151	28	5
(*)48	NA	NA	NA	NA	NA	NA	NA	NA	NA
54	3	332	1	1126	331	4	-51	1	0
59	3	332	1	1126	331	4	-51	1	0
60	3	332	1	1126	331	4	-51	1	0
62	3	332	1	1126	331	4	-51	1	0
72	3	332	1	1126	331	4	-51	1	0
76	3	836	3	-1584	257	9	-2374	578	20
79	3	38	15	663	9	2	-1151	28	5
81	6	235	4	1292	234	12	-100	1	0
101	3	332	1	1126	331	4	-51	1	0
103	3	332	1	1126	331	4	-51	1	0
116	3	332	1	1126	331	4	-51	1	0
128	6	384	1	740	383	4	26	0	0
151	3	38	2	-366	26	0	249	12	0
159	3	332	1	1126	331	4	-51	1	0
(*)166	NA	NA	NA	NA	NA	NA	NA	NA	NA
176	3	332	1	1126	331	4	-51	1	0
178	6	48	7	-662	40	3	300	8	1
179	9	32	12	474	18	2	-411	14	2
180	3	38	2	-366	26	0	249	12	0

181	6	384	1	740	383	4	26	0	0
182	3	38	2	-366	26	0	249	12	0
183	3	332	1	1126	331	4	-51	1	0
184	3	38	2	-366	26	0	249	12	0
185	3	38	2	-366	26	0	249	12	0
186	3	38	2	-366	26	0	249	12	0
187	3	38	2	-366	26	0	249	12	0
189	6	10	8	-352	10	1	96	1	0
(*)190	NA	NA	NA	NA	NA	NA	NA	NA	NA
191	9	25	6	-357	22	1	147	4	0
192	3	429	7	-2046	198	15	2214	231	18
193	6	285	12	-1053	60	8	-2031	225	30
194	3	836	3	-1584	257	9	-2374	578	20
217	3	38	2	-366	26	0	249	12	0
219	6	384	1	740	383	4	26	0	0
221	3	38	2	-366	26	0	249	12	0
223	3	332	1	1126	331	4	-51	1	0
252	3	257	5	-1184	90	5	1620	168	10
253	3	836	3	-1584	257	9	-2374	578	20
254	6	721	5	-1615	299	18	1917	422	27
255	6	218	8	-1271	134	11	-1011	85	7
256	3	836	3	-1584	257	9	-2374	578	20
257	6	573	2	-614	130	3	-1136	443	9
258	6	67	18	1364	67	13	-76	0	0
259	9	291	4	-832	186	7	-625	105	4
260	6	208	3	-414	39	1	861	169	5
261	6	170	6	-865	78	5	934	91	6
262	6	39	4	-456	30	1	249	9	0
263	3	257	5	-1184	90	5	1620	168	10
264	3	257	5	-1184	90	5	1620	168	10
265	6	88	1	380	83	1	99	6	0
266	6	235	4	1292	234	12	-100	1	0
267	9	166	3	740	166	6	16	0	0
268	6	18	1	-5	0	0	176	17	0
269	3	332	1	1126	331	4	-51	1	0
270	3	836	3	-1584	257	9	-2374	578	20
271	6	18	1	-5	0	0	176	17	0
272	3	257	5	-1184	90	5	1620	168	10
273	3	836	3	-1584	257	9	-2374	578	20
274	3	836	3	-1584	257	9	-2374	578	20
275	3	836	3	-1584	257	9	-2374	578	20
276	3	836	3	-1584	257	9	-2374	578	20
277	3	332	1	1126	331	4	-51	1	0
278	3	332	1	1126	331	4	-51	1	0
279	3	257	5	-1184	90	5	1620	168	10
280	3	257	5	-1184	90	5	1620	168	10
281	3	257	5	-1184	90	5	1620	168	10
282	6	208	3	-414	39	1	861	169	5
283	3	332	1	1126	331	4	-51	1	0
284	3	332	1	1126	331	4	-51	1	0
285	3	332	1	1126	331	4	-51	1	0
286	6	31	5	484	30	2	-54	0	0
287	6	235	4	1292	234	12	-100	1	0
288	3	35	1	355	32	0	102	3	0
289	6	244	9	-461	16	1	-1762	229	23
290	6	88	1	380	83	1	99	6	0
291	6	235	4	1292	234	12	-100	1	0
292	3	332	1	1126	331	4	-51	1	0
293	3	332	1	1126	331	4	-51	1	0
294	6	39	4	-456	30	1	249	9	0

295	6	10	9	192	3	0	340	8	1
296	6	384	1	740	383	4	26	0	0
297	6	235	4	1292	234	12	-100	1	0
298	3	332	1	1126	331	4	-51	1	0
299	3	332	1	1126	331	4	-51	1	0
300	3	836	3	-1584	257	9	-2374	578	20
301	3	332	1	1126	331	4	-51	1	0
302	3	332	1	1126	331	4	-51	1	0
303	3	836	3	-1584	257	9	-2374	578	20
304	3	332	1	1126	331	4	-51	1	0
305	3	836	3	-1584	257	9	-2374	578	20
306	6	96	8	894	66	6	-601	30	3
307	3	836	3	-1584	257	9	-2374	578	20
(*)308	NA	NA	NA	NA	NA	NA	NA	NA	NA
309	3	836	3	-1584	257	9	-2374	578	20
310	3	836	3	-1584	257	9	-2374	578	20
311	9	174	7	1082	148	12	-450	26	2
312	3	836	3	-1584	257	9	-2374	578	20
313	3	836	3	-1584	257	9	-2374	578	20
314	3	332	1	1126	331	4	-51	1	0
315	3	836	3	-1584	257	9	-2374	578	20
316	3	80	8	1459	80	7	-149	1	0
335	3	29	11	932	24	3	431	5	1
337	6	384	1	740	383	4	26	0	0
347	6	384	1	740	383	4	26	0	0
(*)349	NA	NA	NA	NA	NA	NA	NA	NA	NA
353	9	33	12	606	29	4	210	4	0
356	3	12	35	1058	10	4	431	2	1
358	6	9	11	380	9	1	-41	0	0
376	3	12	35	1058	10	4	431	2	1
379	6	384	1	740	383	4	26	0	0
380	3	29	11	932	24	3	431	5	1
381	6	488	4	-1206	239	10	1232	249	11
384	9	1	9	71	1	0	55	0	0
387	3	35	1	355	32	0	102	3	0
389	3	3	21	404	2	1	-185	1	0
408	3	38	2	-366	26	0	249	12	0
426	3	38	2	-366	26	0	249	12	0
428	3	38	2	-366	26	0	249	12	0
429	3	35	1	355	32	0	102	3	0
430	3	429	7	-2046	198	15	2214	231	18
431	6	18	1	-5	0	0	176	17	0
432	3	15	8	-547	12	1	249	3	0
433	3	429	7	-2046	198	15	2214	231	18
435	3	429	7	-2046	198	15	2214	231	18
436	3	35	1	355	32	0	102	3	0
437	3	257	5	-1184	90	5	1620	168	10
439	9	138	6	-596	59	4	691	79	5
443	9	138	6	-596	59	4	691	79	5
444	6	170	6	-865	78	5	934	91	6
445	3	15	8	-547	12	1	249	3	0
455	6	384	1	740	383	4	26	0	0
457	3	38	2	-366	26	0	249	12	0
458	6	384	1	740	383	4	26	0	0
459	6	42	11	-444	11	1	-719	30	4
460	3	35	1	355	32	0	102	3	0
461	3	35	1	355	32	0	102	3	0
462	3	35	1	355	32	0	102	3	0
463	3	29	11	932	24	3	431	5	1
464	6	384	1	740	383	4	26	0	0

487	3	35	1	355	32	0	102	3	0
488	3	35	1	355	32	0	102	3	0
489	3	35	1	355	32	0	102	3	0
490	3	35	1	355	32	0	102	3	0
493	3	1	9	-157	1	0	-57	0	0
503	3	35	1	355	32	0	102	3	0
505	6	1	5	99	1	0	23	0	0
506	6	18	1	-5	0	0	176	17	0
507	3	35	1	355	32	0	102	3	0
508	3	38	2	-366	26	0	249	12	0
509	3	35	1	355	32	0	102	3	0
510	3	836	3	-1584	257	9	-2374	578	20
512	3	836	3	-1584	257	9	-2374	578	20
513	3	35	1	355	32	0	102	3	0
515	3	35	1	355	32	0	102	3	0
516	6	1	5	99	1	0	23	0	0
517	3	35	1	355	32	0	102	3	0
518	3	35	1	355	32	0	102	3	0
519	9	199	4	-462	52	2	-776	147	7
521	6	50	11	301	5	1	-869	45	5
522	3	35	1	355	32	0	102	3	0
523	3	35	1	355	32	0	102	3	0
524	6	644	2	-975	294	7	-1062	350	8
525	6	384	1	740	383	4	26	0	0
526	6	10	5	-261	8	0	96	1	0
527	3	35	1	355	32	0	102	3	0
528	6	18	1	-5	0	0	176	17	0
532	6	67	18	1364	67	13	-76	0	0
533	3	35	1	355	32	0	102	3	0
539	3	35	1	355	32	0	102	3	0
541	3	15	8	-547	12	1	249	3	0
546	6	116	6	1029	112	7	190	4	0
559	3	38	2	-366	26	0	249	12	0
561	6	88	1	380	83	1	99	6	0
564	3	1	9	-157	1	0	-57	0	0
565	6	384	1	740	383	4	26	0	0
566	3	38	2	-366	26	0	249	12	0
567	3	35	1	355	32	0	102	3	0
568	6	384	1	740	383	4	26	0	0
569	3	38	2	-366	26	0	249	12	0
570	3	38	2	-366	26	0	249	12	0
571	6	235	4	1292	234	12	-100	1	0
572	6	156	9	-1072	85	8	986	72	7
573	3	38	2	-366	26	0	249	12	0
574	6	384	1	740	383	4	26	0	0
575	3	35	1	355	32	0	102	3	0
576	6	384	1	740	383	4	26	0	0
577	3	38	2	-366	26	0	249	12	0
580	3	35	1	355	32	0	102	3	0
582	3	3	21	404	2	1	-185	1	0
583	3	1	9	-157	1	0	-57	0	0
585	3	48	21	-523	4	1	-1688	43	10
589	6	10	5	-261	8	0	96	1	0
590	3	429	7	-2046	198	15	2214	231	18
591	6	20	6	283	8	1	340	12	1
593	3	38	2	-366	26	0	249	12	0
594	6	384	1	740	383	4	26	0	0
595	3	48	21	-523	4	1	-1688	43	10
596	6	384	1	740	383	4	26	0	0
597	6	488	4	-1206	239	10	1232	249	11

666	3	38	2	-366	26	0	249	12	0
676	12	284	5	-1058	282	16	74	1	0
687	3	35	1	355	32	0	102	3	0
688	3	836	3	-1584	257	9	-2374	578	20
689	6	48	7	-662	40	3	300	8	1
690	3	38	2	-366	26	0	249	12	0
691	6	488	4	-1206	239	10	1232	249	11
692	3	38	2	-366	26	0	249	12	0
717	3	29	11	932	24	3	431	5	1
875	6	48	7	-662	40	3	300	8	1
902	3	38	2	-366	26	0	249	12	0
903	6	384	1	740	383	4	26	0	0
985	3	35	1	355	32	0	102	3	0
986	3	35	1	355	32	0	102	3	0
993	6	88	1	380	83	1	99	6	0
995	3	38	15	663	9	2	-1151	28	5
996	6	116	6	1029	112	7	190	4	0
998	12	246	2	-535	146	4	-443	100	3
999	6	208	3	-414	39	1	861	169	5
1007	3	429	7	-2046	198	15	2214	231	18
1008	3	429	7	-2046	198	15	2214	231	18
1009	3	836	3	-1584	257	9	-2374	578	20
1010	3	429	7	-2046	198	15	2214	231	18
1011	3	429	7	-2046	198	15	2214	231	18
1012	3	38	2	-366	26	0	249	12	0
1013	3	35	1	355	32	0	102	3	0
1145	3	257	5	-1184	90	5	1620	168	10

Principal column coordinates

	axis1	axis2	axis3	axis4	axis5
1A	-1.895035902780530	2.016158087026030	-0.154656674739886	0.384472964348997	2.327063039598530
3A	-1.096545979255220	1.474687852317300	-0.861650022260649	-0.304739687352468	-1.589645983384060
6A	-1.278621558657640	1.779095590179200	-1.091095083980190	-0.389737637283518	-2.138406053839100
7A	-1.466494708209450	-2.161202442369990	0.002985542711188	-0.012137709505579	0.008905587219605
7B	0.374020800321281	-0.168551133774865	-1.020137461505980	-0.358263151731425	-1.632153618158090
7C	-1.423606158449050	-2.418969131244500	0.156452770735998	0.091919509208901	0.601080736913083
8A	0.979430119897363	0.392177195055826	4.025488627106010	7.460577812153030	-2.438150702751600
8B	0.654171881869592	0.230269340996568	1.881628677855590	3.298771223432440	-0.754807662342408
9A	0.862661335514885	0.392132999945200	3.714194877257420	-2.993510307419580	-0.306955656581105
9B	-0.338697129823082	0.226810987088809	0.688734734606839	0.208345998548060	0.291506344572829
10A	-0.484055022730189	-1.536702346340460	0.485253401282578	0.323904197566722	1.760606235127480
11A	0.328890676172936	0.093251367156272	-0.566132062403256	-0.050886859976813	-0.477418780971617
11B	-0.145578248470205	-0.052164255969169	0.274479791482955	-0.120909269941672	-0.575962943642498
12A	1.351160155915780	-0.135922477927505	-0.447231359429275	0.130834172499773	0.945778589787381
13	1.484628147474150	-0.092899394204065	-0.473967041443933	0.134084025258870	1.040383610042980
14A	1.042320627977520	-0.046379152360217	-0.256393564937838	0.069101068929704	0.463320043066617
14B	NA	NA	NA	NA	NA
14C	0.613559912328857	-1.047588486828930	-1.033310045730030	-0.051142270485740	0.004881990993264
15	-0.506470733826583	0.226770320752336	0.621868266266441	-0.569195946582676	-1.028085800605370
16	-0.888320864066799	0.320205174061698	-0.181844698509154	-0.000930724891740	-0.500527215814892

	axis6	axis7	axis8	axis9	axis10
1A	-1.146113220792220	0.897111865049000	-0.045227634467086	-0.836053680281056	0.538867524512247
3A	-0.835825824655353	-1.417923103328270	-0.254875535232817	1.017799219704780	0.023965871231763
6A	-1.145254592156230	-2.018559046193830	-0.375034286597174	1.585201298010730	0.040234498951287
7A	-0.693941582657061	-0.068459310249318	0.682537757786547	-0.104702745158585	-0.042665301369722
7B	-0.138189667786271	3.138188652177960	-2.834212424852140	-1.594315855332510	-0.442821650456319
7C	-0.326267402372029	-1.323173793829940	-1.056232828269620	-0.517365977992396	0.241770515750753
8A	-2.387763753248050	0.025600024050577	-0.362884382161499	-0.566991125892692	0.422162739631609
8B	-0.619828919323788	0.003911549482527	-0.020727303724592	0.065180597142945	-0.150986334041222

9A	-1.785266350392040	-0.013290291333310	-0.231570847158671	-0.531949070465897	-0.230624475728973
9B	1.241530784987450	0.293402760784032	0.049499991613485	0.598148011528773	-0.791315025982359
10A	1.129363269052930	-3.512439877014790	-4.918901761442330	-1.014618127196940	0.704042948227589
11A	0.170567226944240	0.069445210513278	0.126627475235535	-0.987441084035049	-0.351289357363405
11B	1.577311616283500	0.560311077434237	0.551042143256710	-0.201099496274177	3.181233756937400
12A	-0.477927143729788	-0.326561722355591	0.400602675683007	1.089860430923030	0.414206455771158
13	-0.514467585320698	-0.675972718754081	0.701694306012825	0.825064778464563	0.596363475825328
14A	-0.210851354790169	-0.310759860668163	0.271125193299630	0.094393278236289	0.099345095976506
14B	NA	NA	NA	NA	NA
14C	-1.518374343105680	2.664000505088210	-2.227849627866710	2.734729300719170	0.131124752612568
15	0.721394168434465	0.346138890040007	-0.182543207330949	0.512545012987746	1.348661250066730
16	0.097666355872773	-0.443759220241340	0.194817590019555	0.518630050843933	-1.022051629608080

	axis11	axis12	axis13	axis14	axis15
1A	-0.011170852401860	0.183752459418219	0.000882758734090	0.050582597864451	0.027223288250212
3A	0.120917665748321	-0.420169559206200	0.080090783201235	-0.613040255058445	-0.294351738181301
6A	0.212028905473212	-0.882238689204201	0.195338618671303	-1.613728265373950	-0.800018602136193
7A	0.247369256066520	-0.063416461225225	0.040712458800429	-0.184617757984756	-0.079909265456453
7B	3.657180713484970	-1.731798068093490	0.208236834441312	-0.303909962002464	0.175792212400985
7C	0.156670211438495	-0.058865983706988	0.034183821081386	-0.179365332970623	-0.240653164658793
8A	-0.134762022045029	0.041031914694440	-0.045589493261560	0.199899918928332	-0.124695231390321
8B	0.068323851642143	-0.049215371000553	0.085613878925994	-0.452707966064644	0.303732655578274
9A	-0.433051162016427	-0.462828564974262	-0.037836935968283	0.088200437158076	-0.202893944530478
9B	0.032513844856880	-0.142452670634899	-0.010095580512429	-0.275999657352085	-0.199745196023306
10A	-0.384718831683415	0.078108781686364	-0.066074545163060	0.281296433171723	-0.114447354693379
11A	-0.615810241613137	0.302288899736968	-0.083716448204983	0.179183998403110	-0.326715504534542
11B	-0.939713460369706	-1.658204180486550	0.038114287390973	-0.010495283287648	0.032238714422426
12A	0.997808379605906	-0.273445529873541	1.261373943739810	1.475812061220460	-1.795794824727900
13	1.654933147272110	-0.520568204207364	-6.148054883130900	0.488039333237211	-1.224186485598070
14A	0.219141116437120	0.031103728385963	0.160992708220047	-0.439838811339976	0.659698513437486
14B	NA	NA	NA	NA	NA
14C	-2.449720116320910	0.430223124230465	-0.343138535465200	0.004223898140428	0.066524155274905
15	1.146565724381890	2.592215300380340	-0.061416117076926	0.523988520860092	0.377145469727108
16	-0.167519264275457	-1.089074960126060	-0.236558927355474	2.889161936922220	2.103986042919580

Principal row coordinates

VU	axis1	axis2	axis3	axis4	axis5	axis6
1	-1.615208110369810	1.917124322783200	-0.571821709386215	0.045084917909272	0.427639745006528	-1.159987812073630
2	1.292282720848660	-0.100117534712339	-0.395892311057092	0.113052721355113	0.817158451875413	-0.403127767898175
3	1.395906523893350	-0.100757731674119	-0.441712233021053	0.125913393470711	0.946995509911150	-0.469489982680161
4	0.931532306699161	0.430708043278642	4.179559713568860	-3.385341015808260	-0.356016822780080	-2.089758726451920
5	-1.184089240359480	1.619756356662490	-0.969609252946780	-0.344628097715886	-1.843721398240390	-0.978383035385073
6	1.292282720848670	-0.100117534712336	-0.395892311057096	0.113052721355115	0.817158451875420	-0.403127767898177
11	-0.365737173589870	0.249122916094208	0.775028786918112	0.235617112329995	0.338098224906415	1.453284430929020
14	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243044	-0.008176079779819	-0.023577464417297
30	1.125534782801530	-0.050941578405243	-0.288518036949040	0.078145942007986	0.537373155132991	-0.246813848566745
35	0.662543754889282	-1.150642224414610	-1.162777178226100	-0.057836455577860	0.005662286669097	-1.777346014968010
48	NA	NA	NA	NA	NA	NA
54	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
59	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
60	1.125534782801520	-0.050941578405242	-0.288518036949038	0.078145942007985	0.537373155132987	-0.246813848566743
62	1.125534782801520	-0.050941578405242	-0.288518036949040	0.078145942007987	0.537373155132992	-0.246813848566745
72	1.125534782801520	-0.050941578405241	-0.288518036949040	0.078145942007986	0.537373155132988	-0.246813848566744
76	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
79	0.662543754889283	-1.150642224414620	-1.162777178226100	-0.057836455577861	0.005662286669096	-1.777346014968020
81	1.292282720848670	-0.100117534712336	-0.395892311057095	0.113052721355114	0.817158451875417	-0.403127767898175
101	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
103	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
116	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
128	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
151	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
159	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
166	NA	NA	NA	NA	NA	NA
176	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
178	-0.662488774651880	0.300413712240307	0.285200056014254	0.117282280851591	-0.121214489583224	0.783804307670269
179	0.473857499286151	-0.411116468588074	-0.982598705558222	-0.173513832941557	-0.813695372578419	-0.579815395809570

180	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
181	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
182	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
183	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
184	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
185	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
186	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
187	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
189	-0.352052808879647	0.095891236542003	0.504327365056217	-0.390217713453770	-0.930213086593853	1.345384813897650
190	NA	NA	NA	NA	NA	NA
191	-0.356614263783056	0.146968463059405	0.594561172343516	-0.181606104859182	-0.507442649427098	1.381351352908110
192	-2.046326980380150	2.214492288903890	-0.174034165825640	0.434797933534429	2.699000888253450	-1.341592588762180
193	-1.053136390486970	-2.030838179901690	0.274706078753001	0.176287330090682	1.026167727092110	0.254843281125072
194	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
217	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
219	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
221	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
223	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
252	-1.184089240359470	1.619756356662490	-0.969609252946782	-0.344628097715884	-1.843721398240380	-0.978383035385073
253	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
254	-1.615208110369810	1.917124322783190	-0.571821709386211	0.045084917909272	0.427639745006536	-1.159987812073630
255	-1.271406687413630	-1.011050244719520	-0.100634531396495	-0.007389503030605	-0.285099111988863	-0.348987521740364
256	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
257	-0.614212590993626	-1.135690137435180	-0.316852586404873	-0.035637034478148	-0.271698167298747	-0.306320154080045
258	1.364344456392120	-0.076489852001464	-0.410935056949008	0.114890339854946	0.872021390557803	-0.424514130405440
259	-0.832071744813109	-0.625201277472149	0.492724259084044	-0.140603091998874	-0.281326344962815	0.495139762981938
260	-0.414470711616670	0.861090539808792	-0.803337018926572	-0.201087855618891	-1.198723356466500	-0.389362057826462
261	-0.865497151047770	0.934417302988644	-0.134912437354690	-0.494164015304051	-1.518063819065190	-0.066974474738023
262	-0.456321117662974	0.249100582704502	0.737406582577758	-0.204041410281112	-0.427154007491789	1.148859258419030
263	-1.184089240359470	1.619756356662490	-0.969609252946782	-0.344628097715884	-1.843721398240380	-0.978383035385073
264	-1.184089240359470	1.619756356662490	-0.969609252946782	-0.344628097715884	-1.843721398240380	-0.978383035385073
265	0.379898804605824	0.099090668844483	0.243255374984537	0.156881527168991	0.437735690019701	0.603235291181140
266	1.292282720848670	-0.100117534712336	-0.395892311057095	0.113052721355114	0.817158451875417	-0.403127767898175
267	0.739609422702487	0.016295948889846	-0.005585278398692	0.153907518346741	0.657471709552416	0.215676298377558
268	-0.005294678231874	0.175773819524650	0.068982001005876	0.089034749404049	-0.107813544893107	0.826471675330588
269	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
270	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
271	-0.005294678231874	0.175773819524650	0.068982001005876	0.089034749404049	-0.107813544893107	0.826471675330588
272	-1.184089240359470	1.619756356662490	-0.969609252946782	-0.344628097715884	-1.843721398240380	-0.978383035385073
273	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
274	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
275	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
276	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
277	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
278	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
279	-1.184089240359470	1.619756356662490	-0.969609252946782	-0.344628097715884	-1.843721398240380	-0.978383035385073
280	-1.184089240359470	1.619756356662490	-0.969609252946782	-0.344628097715884	-1.843721398240380	-0.978383035385073
281	-1.184089240359470	1.619756356662490	-0.969609252946782	-0.344628097715884	-1.843721398240380	-0.978383035385073
282	-0.414470711616670	0.861090539808792	-0.803337018926572	-0.201087855618891	-1.198723356466500	-0.389362057826462
283	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
284	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
285	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
286	0.484167113389152	-0.054118677318015	0.010176157462996	-0.029294776003668	-0.065323389082362	0.799760846659763
287	1.292282720848670	-0.100117534712336	-0.395892311057095	0.113052721355114	0.817158451875417	-0.403127767898175
288	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
289	-0.460514622112048	-1.762223611120030	-0.579708783064745	-0.035781455506129	0.007995633382115	-1.294822621430130
290	0.379898804605824	0.099090668844483	0.243255374984537	0.156881527168991	0.437735690019701	0.603235291181140
291	1.292282720848670	-0.100117534712336	-0.395892311057095	0.113052721355114	0.817158451875417	-0.403127767898175
292	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
293	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
294	-0.456321117662974	0.249100582704502	0.737406582577758	-0.204041410281112	-0.427154007491789	1.148859258419030
295	0.192313622481544	0.339893146296719	2.439672045903130	-2.014520474350240	-0.774211531335037	-0.622662320271445
296	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
297	1.292282720848670	-0.100117534712336	-0.395892311057095	0.113052721355114	0.817158451875417	-0.403127767898175
298	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
299	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
300	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
301	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
302	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
303	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
304	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
305	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
306	0.894039268845403	-0.600791901409929	-0.725647607587572	0.010154743215063	0.271517720901043	-1.012079931767380
307	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240

308	NA	NA	NA	NA	NA	NA
309	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
310	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
311	1.082369732195540	-0.450292431279762	-0.651520600113432	0.056089662377456	0.546659730139977	-0.861200516921456
312	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
313	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
314	1.125534782801520	-0.050941578405242	-0.288518036949039	0.078145942007986	0.537373155132989	-0.246813848566744
315	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
316	1.459030658895810	-0.149293491019429	-0.503266585165151	0.147959500702241	1.096943748617850	-0.559441687229606
335	0.931532306699161	0.430708043278643	4.179559713568870	-3.385341015808260	-0.356016822780083	-2.089758726451920
337	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
347	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
349	NA	NA	NA	NA	NA	NA
353	0.605806996935597	0.209645974551657	1.672122442347950	2.916960392779350	-0.650790824370354	-0.529515536249193
356	1.057623381595140	0.430756585966006	4.529856577074770	8.437118124000070	-2.827843853150460	-2.795017191109860
358	0.379514371484585	-0.041353590674804	-0.892509469224281	-0.231352521623405	-1.223374202202180	0.018949913769653
376	1.057623381595140	0.430756585966006	4.529856577074770	8.437118124000070	-2.827843853150460	-2.795017191109860
379	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
380	0.931532306699161	0.430708043278643	4.179559713568870	-3.385341015808260	-0.356016822780083	-2.089758726451920
381	-1.206032076985010	1.231807602499050	0.300497310546237	0.335207522932212	1.518549556579930	0.055845921083420
384	0.070707893744366	0.055457022655063	-0.361744853403720	-0.368801658713009	-1.213051548098120	0.294111304482778
387	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
389	0.403880925843044	-0.185131904304699	-1.147954153542200	-0.405157429724912	-1.893023089711730	-0.161759092192845
408	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
426	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
428	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
429	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
430	-2.046326980380150	2.214492288903890	-0.174034165825640	0.434797933534429	2.699000888253450	-1.341592588762180
431	-0.005294678231874	0.175773819524650	0.068982001005876	0.089034749404049	-0.107813544893107	0.826471675330588
432	-0.546905061736073	0.249078249314795	0.699784378237403	-0.643699932892218	-1.192406239889990	0.844434085909029
433	-2.046326980380150	2.214492288903890	-0.174034165825640	0.434797933534429	2.699000888253450	-1.341592588762180
435	-2.046326980380150	2.214492288903890	-0.174034165825640	0.434797933534429	2.699000888253450	-1.341592588762180
436	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
437	-1.184089240359470	1.619756356662490	-0.969609252946782	-0.344628097715884	-1.843721398240380	-0.978383035385073
439	-0.596060599649075	0.691295196001330	-0.603767570914249	-0.134409420621531	-0.992657972335289	-0.221466643747137
443	-0.596060599649075	0.691295196001330	-0.603767570914249	-0.134409420621531	-0.992657972335289	-0.221466643747137
444	-0.865497151047770	0.934417302988644	-0.134912437354690	-0.494164015304051	-1.518063819065190	-0.066974474738023
445	-0.546905061736073	0.249078249314795	0.699784378237403	-0.643699932892218	-1.192406239889990	0.844434085909029
455	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
457	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
458	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
459	-0.444218477725216	-0.719374222941863	0.660540666163751	0.300959113972879	1.190052349497750	1.387635110535700
460	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
461	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
462	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
463	0.931532306699161	0.430708043278643	4.179559713568870	-3.385341015808260	-0.356016822780083	-2.089758726451920
464	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
487	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
488	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
489	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
490	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
493	-0.157200556023220	-0.057295776230788	0.308870351875031	-0.136735494015322	-0.668019933297714	1.846335541886270
503	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
505	0.098973630551454	0.022564473362152	-0.164097216515665	-0.097141553768610	-0.610872623995171	1.022997230809210
506	-0.005294678231874	0.175773819524650	0.068982001005876	0.089034749404049	-0.107813544893107	0.826471675330588
507	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
508	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
509	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
510	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
512	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
513	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
515	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
516	0.098973630551454	0.022564473362152	-0.164097216515665	-0.097141553768610	-0.610872623995171	1.022997230809210
517	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
518	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
519	-0.461875246003490	-0.776225350367049	-0.108278273644905	-0.069336520990539	-0.403805422631736	0.411231744575394
521	0.301417500470483	-0.869406470191588	0.128767254230174	0.222223528811875	1.289689814611040	0.537585970787820
522	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
523	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
524	-0.974655086351627	-1.062341040865620	0.389194199507364	0.110945328447799	0.174213602500773	0.320492601518392
525	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
526	-0.261468864806547	0.095913569931710	0.541949569396572	0.049440809157337	-0.164960854195651	1.649809986407650
527	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
528	-0.005294678231874	0.175773819524650	0.068982001005876	0.089034749404049	-0.107813544893107	0.826471675330588

532	1.364344456392120	-0.076489852001464	-0.410935056949008	0.114890339854946	0.872021390557803	-0.424514130405440
533	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
539	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
541	-0.546905061736073	0.249078249314795	0.699784378237403	-0.643699932892218	-1.192406239889990	0.844434085909029
546	1.028533544750340	0.189883232436700	1.945520838309910	-1.653597536900140	0.090678166176453	-1.168286287509330
559	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
561	0.379898804605824	0.099090668844483	0.243255374984537	0.156881527168991	0.437735690019701	0.603235291181140
564	-0.157200556023220	-0.057295776230788	0.308870351875031	-0.136735494015322	-0.668019933297714	1.846335541886270
565	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
566	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
567	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
568	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
569	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
570	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
571	1.292282720848670	-0.100117534712336	-0.395892311057095	0.113052721355114	0.817158451875417	-0.403127767898175
572	-1.071664808036680	0.985730432524449	-0.587118963918194	-0.172840324171349	-1.212124301156620	-0.432029425486781
573	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
574	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
575	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
576	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
577	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
580	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
582	0.403880925843044	-0.185131904304699	-1.147954153542200	-0.405157429724912	-1.893023089711730	-0.161759092192845
583	-0.157200556023220	-0.057295776230788	0.308870351875031	-0.136735494015322	-0.668019933297714	1.846335541886270
585	-0.522699781860558	-1.687871361977930	0.546052545409389	0.366301115615763	2.042006474089100	1.321985790142380
589	-0.261468864806547	0.095913569931710	0.541949569396572	0.049440809157337	-0.164960854195651	1.649809986407650
590	-2.046326980380150	2.214492288903890	-0.174034165825640	0.434797933534429	2.699000888253450	-1.341592588762180
591	0.282897566554643	0.339915479686425	2.477294250243490	-1.574861951739130	-0.008959298936835	-0.318237147761447
593	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
594	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
595	-0.522699781860558	-1.687871361977930	0.546052545409389	0.366301115615763	2.042006474089100	1.321985790142380
596	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
597	-1.206032076985010	1.231807602499050	0.300497310546237	0.335207522932212	1.518549556579930	0.055845921083420
666	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
676	-1.058498134520320	0.073704130604983	-0.253092003381248	0.090617828487831	0.393769337395775	-0.459977178127690
687	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
688	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
689	-0.662488774651880	0.300413712240307	0.285200056014254	0.117282280851591	-0.121214489583224	0.783804307670269
690	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
691	-1.206032076985010	1.231807602499050	0.300497310546237	0.335207522932212	1.518549556579930	0.055845921083420
692	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
717	0.931532306699161	0.430708043278643	4.179559713568870	-3.385341015808260	-0.356016822780083	-2.089758726451920
875	-0.662488774651880	0.300413712240307	0.285200056014254	0.117282280851591	-0.121214489583224	0.783804307670269
902	-0.365737173589874	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
903	0.740341299963825	0.025741572274925	-0.462791410927700	0.010299164243045	-0.008176079779819	-0.023577464417297
985	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
986	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
993	0.379898804605824	0.099090668844483	0.243255374984537	0.156881527168991	0.437735690019701	0.603235291181140
995	0.662543754889283	-1.150642224414620	-1.162777178226100	-0.057836455577861	0.005662286669096	-1.777346014968020
996	1.028533544750340	0.189883232436700	1.945520838309910	-1.653597536900140	0.090678166176453	-1.168286287509330
998	-0.535266854328300	-0.443294777365339	0.210276998086442	-0.119839222379630	-0.349426087395268	0.421269552169491
999	-0.414470711616670	0.861090539808792	-0.803337018926572	-0.201087855618891	-1.198723356466500	-0.389362057826462
1007	-2.046326980380150	2.214492288903890	-0.174034165825640	0.434797933534429	2.699000888253450	-1.341592588762180
1008	-2.046326980380150	2.214492288903890	-0.174034165825640	0.434797933534429	2.699000888253450	-1.341592588762180
1009	-1.583572999113380	-2.373804997825450	0.003359612096615	-0.013726455434398	0.010328980095134	-0.812299227892240
1010	-2.046326980380150	2.214492288903890	-0.174034165825640	0.434797933534429	2.699000888253450	-1.341592588762180
1011	-2.046326980380150	2.214492288903890	-0.174034165825640	0.434797933534429	2.699000888253450	-1.341592588762180
1012	-3.657371735898740	0.249122916094208	0.775028786918113	0.235617112329995	0.338098224906413	1.453284430929020
1013	0.355147817126127	0.102424722955092	-0.637064784906361	-0.057547613521897	-0.553725314692627	0.199658919732150
1145	-1.184089240359470	1.619756356662490	-0.969609252946782	-0.344628097715884	-1.843721398240380	-0.978383035385073

VU	axis7	axis8	axis9	axis10	axis11	axis12
1	-0.310702495067572	-0.182017019401092	0.113408320259853	0.364630128626372	0.072663210318698	-0.171289068169660
2	-0.380209548972338	0.407412906311954	0.738968473961438	0.332703016178503	0.805740544821508	-0.175581636829950
3	-0.522318242937737	0.555333933820207	0.835869884421971	0.479370345740641	1.267646298230260	-0.368496029799276
4	-0.015857287147175	-0.280902300513230	-0.663867192962301	-0.298818914745745	-0.573445127103889	-0.670657695131510
5	-1.691792394778540	-0.309171577812568	1.270203386938610	0.031052452736312	0.160118831874930	-0.608843034909313
6	-0.380209548972342	0.407412906311958	0.738968473961447	0.332703016178504	0.805740544821515	-0.175581636829952
11	0.350072975139703	0.060044956825185	0.746482818443130	-1.025302698417560	0.043054741637856	-0.206419799863998
14	-0.143962069918456	0.241242887431006	-0.557257426446403	-0.163221424192043	-0.262634068276813	0.241549839910157
30	-0.370782567578433	0.328882894627819	0.117801880173139	0.128720915987681	0.290186048188474	0.045070586320635
35	3.178547400501010	-2.702447623886350	3.412915192783610	0.169897649189843	-3.243912467366410	0.623411065617192
48	NA	NA	NA	NA	NA	NA
54	-0.370782567578433	0.328882894627819	0.117801880173137	0.128720915987680	0.290186048188473	0.045070586320637
59	-0.370782567578434	0.328882894627819	0.117801880173134	0.128720915987678	0.290186048188472	0.045070586320632

60	-0.370782567578434	0.328882894627820	0.117801880173136	0.128720915987679	0.290186048188475	0.045070586320636
62	-0.370782567578436	0.328882894627820	0.117801880173133	0.128720915987676	0.290186048188471	0.045070586320627
72	-0.370782567578436	0.328882894627820	0.117801880173136	0.128720915987674	0.290186048188472	0.045070586320629
76	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
79	3.178547400501030	-2.702447623886360	3.412915192783620	0.169897649189844	-3.243912467366430	0.623411065617195
81	-0.380209548972341	0.407412906311957	0.738968473961443	0.332703016178504	0.805740544821511	-0.175581636829951
101	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
103	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
116	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
128	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
151	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
159	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
166	NA	NA	NA	NA	NA	NA
176	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
178	-0.089698769283969	0.148182233598527	0.696864003145930	-1.174784797552140	-0.089386897771750	-0.892267185780599
179	2.335243320556340	-1.995609470216360	0.063635999365105	-0.286342596040802	0.261153910591201	-0.482668908712044
180	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
181	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
182	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
183	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
184	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
185	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
186	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
187	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
189	0.540764572359591	0.223500065116780	0.194340466428719	2.934680513910220	0.136956592237124	0.676710333263469
190	NA	NA	NA	NA	NA	NA
191	0.477200706619629	0.169015029019582	0.378387917100190	1.614686109800960	0.105655975370701	0.382333622220979
192	1.070387404643420	-0.054862460989620	-1.043386746418920	0.698207804516424	-0.014792411237543	0.266264898569998
193	-2.136271705165770	-2.569417543355450	-0.698450704034471	0.428471761391490	-0.090938960284221	0.010644889406459
194	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
217	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
219	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
221	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
223	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
252	-1.691792394778540	-0.309171577812566	1.270203386938620	0.031052452736316	0.160118831874933	-0.608843034909316
253	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
254	-0.310702495067562	-0.182017019401093	0.113408320259847	0.364630128626370	0.072663210318695	-0.171289068169659
255	-0.305576308163206	0.532129019240173	0.258288597322961	-0.689774051129128	0.052868566936365	-0.835003820848088
256	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
257	0.000588162561377	0.490770704171334	-0.681492363134373	-0.255222484971648	-0.243944256844007	0.173068011750353
258	-0.588659099223482	0.590029441732269	0.573737292758082	0.450712960426299	1.240821926618120	-0.354627114708647
259	0.227128621739971	0.222184388176903	0.418488648621814	0.222289784117378	0.629633170151353	1.152638033663490
260	-0.804466983518510	-0.077784348789187	0.018943326936339	-0.212055655817724	-0.327667676433582	-0.085406970704817
261	-0.639398701039783	-0.265300949107758	0.954927253781866	0.889252854538773	0.839198964818528	1.573691967972060
262	0.381533983919340	-0.080692681788883	0.693066969534124	0.361075278961834	0.780666919699988	1.774903585494720
263	-1.691792394778540	-0.309171577812566	1.270203386938620	0.031052452736316	0.160118831874933	-0.608843034909316
264	-1.691792394778540	-0.309171577812566	1.270203386938620	0.031052452736316	0.160118831874933	-0.608843034909316
265	-0.010354796219364	0.194463925726502	0.432142349308134	-0.448290891214943	0.166620394913164	-0.080674606771683
266	-0.380209548972341	0.407412906311957	0.738968473961443	0.332703016178504	0.805740544821511	-0.175581636829951
267	-0.136782040934992	0.291623589816366	0.741473255455340	-0.119965555353518	0.551511943760293	-0.185861024507967
268	0.216465701440613	0.106823918529688	-0.242916957311403	-0.740233231394664	-0.386199721552122	0.115804646817842
269	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
270	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
271	0.216465701440613	0.106823918529688	-0.242916957311403	-0.740233231394664	-0.386199721552122	0.115804646817842
272	-0.169179239477854	-0.309171577812566	1.270203386938620	0.031052452736316	0.160118831874933	-0.608843034909316
273	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
274	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
275	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
276	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
277	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
278	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
279	-1.691792394778540	-0.309171577812566	1.270203386938620	0.031052452736316	0.160118831874933	-0.608843034909316
280	-1.691792394778540	-0.309171577812566	1.270203386938620	0.031052452736316	0.160118831874933	-0.608843034909316
281	-1.691792394778540	-0.309171577812566	1.270203386938620	0.031052452736316	0.160118831874933	-0.608843034909316
282	-0.804466983518510	-0.077784348789187	0.018943326936339	-0.212055655817724	-0.327667676433582	-0.085406970704817
283	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
284	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
285	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
286	0.148875792220886	0.498656672632165	-0.066584153797272	2.125314343733440	-0.477089932549700	-1.178867859002930
287	-0.380209548972341	0.407412906311957	0.738968473961443	0.332703016178504	0.805740544821511	-0.175581636829951
288	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
289	1.548432648941130	-0.937254547888944	1.641123599790410	0.057308221809155	-1.458173398156170	0.265758997809109
290	-0.010354796219364	0.194463925726502	0.432142349308134	-0.448290891214943	0.166620394913164	-0.080674606771683
291	-0.380209548972341	0.407412906311957	0.738968473961443	0.332703016178504	0.805740544821511	-0.175581636829951

292	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
293	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
294	0.381533983919340	-0.080692681788883	0.693066969534124	0.361075278961834	0.780666919699988	1.774903585494720
295	0.198568852775901	-0.251166310458090	-0.012108036168594	0.724317170797742	0.472416985329115	1.542784637860960
296	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
297	-0.380209548972341	0.407412906311957	0.738968473961443	0.332703016178504	0.805740544821511	-0.175581636829951
298	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
299	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
300	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
301	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
302	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
303	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
304	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
305	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
306	1.403882416461300	-1.186782364629270	1.765358536478380	0.149309282588761	-1.476863209588980	0.334240825968913
307	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
308	NA	NA	NA	NA	NA	NA
309	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
310	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
311	0.806042767518782	-0.629207270420816	1.630284046902170	0.278434560515617	-0.544143792574468	0.090749263985764
312	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
313	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
314	-0.370782567578434	0.328882894627820	0.117801880173135	0.128720915987678	0.290186048188472	0.045070586320633
315	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
316	-0.389636530366248	0.485942917996095	1.360135067749750	0.536685116369330	1.321295041454550	-0.396233859980535
335	-0.015857287147173	-0.280902300513230	-0.663867192962303	-0.298818914745746	-0.573445127103892	-0.670657695131508
337	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
347	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
349	NA	NA	NA	NA	NA	NA
353	0.003278343370147	-0.017087219556584	0.052228455375066	-0.116529250365976	0.051596433466087	-0.033964091816459
356	0.030544622549168	-0.440189510122754	-0.707599332491069	0.546994031331958	-0.178451489428065	0.059456938093988
358	1.913591280584000	-1.642190393381350	-1.611003597344150	-0.514462718656125	2.013687099570010	-1.035708895876660
376	0.030544622549168	-0.440189510122754	-0.707599332491069	0.546994031331958	-0.178451489428065	0.059456938093988
379	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
380	-0.015857287147173	-0.280902300513230	-0.663867192962303	-0.298818914745746	-0.573445127103892	-0.670657695131508
381	0.710230189891561	0.002591247917782	-0.148451963987895	-0.163547446950570	0.014131165200156	0.029922549353000
384	1.413392517955660	-1.168603702388550	-0.860785358021064	0.239509273009660	1.848551098967380	0.561603059700035
387	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
389	3.744324133426470	-3.437983666996900	-1.989690461622370	-0.573761672940486	4.842828383882130	-2.509446885253010
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426	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
428	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
429	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
430	1.070387404643420	-0.054862460989620	-1.043386746418920	0.698207804516424	-0.014792411237543	0.266264898569998
431	0.216465701440613	0.106823918529688	-0.242916957311403	-0.740233231394664	-0.386199721552122	0.115804646817842
432	0.412994992698975	-0.221430320402950	0.639651120625115	1.747453256341230	1.518279097762120	3.756226970853430
433	1.070387404643420	-0.054862460989620	-1.043386746418920	0.698207804516424	-0.014792411237543	0.266264898569998
435	1.070387404643420	-0.054862460989620	-1.043386746418920	0.698207804516424	-0.014792411237543	0.266264898569998
436	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
437	-1.691792394778540	-0.309171577812566	1.270203386938620	0.031052452736316	0.160118831874933	-0.608843034909316
439	-0.712801493581555	0.026916937597832	0.228377280573802	-0.582792736107390	-0.292387963349506	-0.582976171035612
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444	-0.639398701039783	-0.265300949107758	0.954927253781866	0.889252854538773	0.839198964818528	1.573691967972060
445	0.412994992698975	-0.221430320402950	0.639651120625115	1.747453256341230	1.518279097762120	3.756226970853430
455	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
457	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
458	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
459	-1.920394166286540	-2.953364328997090	-0.259875298211502	-0.056538985031525	-0.233194424992335	-0.046618475526052
460	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
461	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
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463	-0.015857287147173	-0.280902300513230	-0.663867192962303	-0.298818914745746	-0.573445127103892	-0.670657695131508
464	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
487	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
488	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
489	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
490	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
493	0.668534152020206	0.668430450636510	-0.250970187767678	4.121907771479210	-1.244365913287870	-2.402806304326490
503	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
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506	0.216465701440613	0.106823918529688	-0.242916957311403	-0.740233231394664	-0.386199721552122	0.115804646817842
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508	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
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510	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
512	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
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517	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
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519	0.223236825714320	0.549990619659726	-0.537984971345474	1.203820933845300	-0.577418142325296	-0.685556760275263
521	-2.280821937645610	-2.818945360095780	-0.574215767346500	0.520472822171095	-0.109628771717026	0.079126717566264
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523	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
524	0.134195436260469	0.443991742466830	0.307907412620163	-0.540291951994548	0.185310206345969	-0.149156434931488
525	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
526	0.509303563579956	0.364237703730847	0.247756315337727	1.548302536530820	-0.600655585825010	-1.304613052095250
527	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
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532	-0.588659099223482	0.590029441732269	0.573737292758082	0.450712960426299	1.240821926618120	-0.354627114708647
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541	0.412994992698975	-0.221430320402950	0.639651120625115	1.747453256341230	1.518279097762120	3.756226970853430
546	-0.193319927362804	0.023990297057295	-0.273032656394584	-0.085048999379034	-0.141629539457709	-0.312793554405438
559	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
561	-0.010354796219364	0.194463925726502	0.432142349308134	-0.448290891214943	0.166620394913164	-0.080674606771683
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565	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
566	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
567	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
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569	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
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571	-0.380209548972341	0.407412906311957	0.738968473961443	0.332703016178504	0.805740544821511	-0.175581636829951
572	-1.110631454243090	-0.036426033720349	0.958724287393673	-0.646607221975203	-0.030854852653210	-1.093478803303260
573	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
574	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
575	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
576	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
577	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
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582	3.744324133426470	-3.437983666996900	-1.989690461622370	-0.573761672940486	4.842828383882130	-2.509446885253010
583	0.668534152020206	0.668430450636510	-0.250970187767678	4.121907771479210	-1.244365913287870	-2.402806304326490
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590	1.070387404643420	-0.054862460989620	-1.043386746418920	0.698207804516424	-0.014792411237543	0.266264898569998
591	0.167107843996266	-0.110428671844023	0.041307812740415	-0.662060806581655	-0.265195192733019	-0.438538747497753
593	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
594	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
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597	0.710230189891561	0.002591247917782	-0.148451963987895	-0.163547446950570	0.014131165200156	0.029922549353000
666	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
676	0.135523304014631	0.290749614431230	-0.439781571209735	-0.284126015528399	-0.181127365526728	-0.241428412406624
687	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
688	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
689	-0.089698769283969	0.148182233598527	0.696864003145930	-1.174784797552140	-0.089386897771750	-0.892267185780599
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717	-0.015857287147173	-0.280902300513230	-0.663867192962303	-0.298818914745746	-0.573445127103892	-0.670657695131508
875	-0.089698769283969	0.148182233598527	0.696864003145930	-1.174784797552140	-0.089386897771750	-0.892267185780599
902	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999
903	-0.143962069918457	0.241242887431006	-0.557257426446402	-0.163221424192043	-0.262634068276813	0.241549839910157
985	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
986	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
993	-0.010354796219364	0.194463925726502	0.432142349308134	-0.448290891214943	0.166620394913164	-0.080674606771683
995	3.178547400501030	-2.702447623886360	3.412915192783620	0.169897649189844	-3.243912467366430	0.623411065617195
996	-0.193319927362804	0.023990297057295	-0.273032656394584	-0.085048999379034	-0.141629539457709	-0.312793554405438
998	0.191061073240358	0.205039011191226	0.005787303199876	0.052926396995093	0.268361331427990	0.973985798622534
999	-0.804466983518510	-0.077784348789187	0.018943326936339	-0.212055655817724	-0.327667676433582	-0.085406970704817
1007	1.070387404643420	-0.054862460989620	-1.043386746418920	0.698207804516424	-0.014792411237543	0.266264898569998
1008	1.070387404643420	-0.054862460989620	-1.043386746418920	0.698207804516424	-0.014792411237543	0.266264898569998
1009	-0.081682102618768	0.827938528108475	-0.130667993202807	-0.055281205571533	0.327565671054083	-0.091893069998977
1010	1.070387404643420	-0.054862460989620	-1.043386746418920	0.698207804516424	-0.014792411237543	0.266264898569998
1011	1.070387404643420	-0.054862460989620	-1.043386746418920	0.698207804516424	-0.014792411237543	0.266264898569998
1012	0.350072975139706	0.060044956825184	0.746482818443132	-1.025302698417560	0.043054741637855	-0.206419799863999

1013	0.082858427741521	0.153602880234192	-1.232316733065940	-0.455163764371764	-0.815454184742098	0.438029093499682
1145	-1.691792394778540	-0.309171577812566	1.270203386938620	0.031052452736316	0.160118831874933	-0.608843034909316

VU	axis13	axis14	axis15
1	0.063228943723315	-0.456279066408197	-0.220194713827987
2	1.110668236082800	0.840406208775806	-0.936487304928209
3	-2.460065086949740	0.824210237251035	-1.297058388072700
4	-0.059090647088453	0.143100596493085	-0.334492069750291
5	0.125079266702486	-0.994625752431468	-0.485269889974808
6	1.110668236082810	0.840406208775820	-0.936487304928224
11	-0.015766455976062	-0.447795009543827	-0.329301025691660
14	0.060341886730643	-0.211449401000184	0.274478807382287
30	0.251425308677725	-0.713615468262977	1.087582587452480
35	-0.535885837019647	0.006853053827133	0.109672087246301
48	NA	NA	NA
54	0.251425308677725	-0.713615468262976	1.087582587452480
59	0.251425308677725	-0.713615468262978	1.087582587452480
60	0.251425308677724	-0.713615468262974	1.087582587452480
62	0.251425308677725	-0.713615468262982	1.087582587452480
72	0.251425308677724	-0.713615468262965	1.087582587452490
76	0.063581404612037	-0.299532657003563	-0.131738853303921
79	-0.535885837019649	0.006853053827138	0.109672087246301
81	1.110668236082810	0.840406208775817	-0.936487304928219
101	0.251425308677725	-0.713615468262978	1.087582587452480
103	0.251425308677725	-0.713615468262978	1.087582587452480
116	0.251425308677725	-0.713615468262978	1.087582587452480
128	0.060341886730645	-0.211449401000183	0.274478807382286
151	-0.015766455976062	-0.447795009543826	-0.329301025691663
159	0.251425308677725	-0.713615468262978	1.087582587452480
166	NA	NA	NA
176	0.251425308677725	-0.713615468262978	1.087582587452480
178	-0.192602467723807	2.119859566396000	1.569670952120770
179	-0.113806677457907	-0.065169433022635	-0.046380293307618
180	-0.015766455976062	-0.447795009543826	-0.329301025691663
181	0.060341886730645	-0.211449401000183	0.274478807382286
182	-0.015766455976062	-0.447795009543826	-0.329301025691663
183	0.251425308677725	-0.713615468262978	1.087582587452480
184	-0.015766455976062	-0.447795009543826	-0.329301025691663
185	-0.015766455976062	-0.447795009543826	-0.329301025691663
186	-0.015766455976062	-0.447795009543826	-0.329301025691663
187	-0.015766455976062	-0.447795009543826	-0.329301025691663
189	-0.018195450546552	0.416557961385645	0.337456505653973
190	NA	NA	NA
191	-0.017385785689722	0.128440304409155	0.115203995205428
192	0.001378620744135	0.082067619615078	0.044880462318845
193	-0.019804221144353	0.078428047145737	-0.160208694976165
194	0.063581404612037	-0.299532657003563	-0.131738853303921
217	-0.015766455976062	-0.447795009543826	-0.329301025691663
219	0.060341886730645	-0.211449401000183	0.274478807382286
221	-0.015766455976062	-0.447795009543826	-0.329301025691663
223	0.251425308677725	-0.713615468262978	1.087582587452480
252	0.125079266702493	-0.994625752431466	-0.485269889974815
253	0.063581404612037	-0.299532657003563	-0.131738853303921
254	0.063228943723314	-0.456279066408194	-0.220194713827985
255	-0.152928537429758	2.193990742666140	1.668452038314640
256	0.063581404612037	-0.299532657003563	-0.131738853303921
257	-0.033580065302199	-0.004407995370475	-0.335181912995915
258	-4.675053212168570	0.039101412969248	-0.465308983454596
259	-0.016033248141403	0.034272101488380	0.053574736966090
260	-0.002831134256971	-0.351954543084427	-0.511947431331362
261	0.014582286821154	-0.072240890709469	0.068247099959519
262	-0.055840574518123	0.201174480734351	0.146231532101094
263	0.125079266702493	-0.994625752431466	-0.485269889974815
264	0.125079266702493	-0.994625752431466	-0.485269889974815
265	0.117829426350831	-0.580705238903402	0.379140780880409
266	1.110668236082810	0.840406208775817	-0.936487304928219
267	0.735190005396520	0.411005802669270	-0.734091878516034
268	-0.073253995596249	-0.078539171640607	-0.433962999189786
269	0.251425308677725	-0.713615468262978	1.087582587452480
270	0.063581404612037	-0.299532657003563	-0.131738853303921
271	-0.073253995596249	-0.078539171640607	-0.433962999189786
272	0.125079266702493	-0.994625752431466	-0.485269889974815
273	0.063581404612037	-0.299532657003563	-0.131738853303921
274	0.063581404612037	-0.299532657003563	-0.131738853303921
275	0.063581404612037	-0.299532657003563	-0.131738853303921

276	0.063581404612037	-0.299532657003563	-0.131738853303921
277	0.251425308677725	-0.713615468262978	1.087582587452480
278	0.251425308677725	-0.713615468262978	1.087582587452480
279	0.125079266702493	-0.994625752431466	-0.485269889974815
280	0.125079266702493	-0.994625752431466	-0.485269889974815
281	0.125079266702493	-0.994625752431466	-0.485269889974815
282	-0.002831134256971	-0.351954543084427	-0.511947431331362
283	0.251425308677725	-0.713615468262978	1.087582587452480
284	0.251425308677725	-0.713615468262978	1.087582587452480
285	0.251425308677725	-0.713615468262978	1.087582587452480
286	0.155474550322403	-0.365321758252107	0.570365754433288
287	1.110668236082810	0.840406208775817	-0.936487304928219
288	-0.130741535216435	0.290716666262612	-0.538624972687908
289	-0.236152216203806	-0.146339801588212	-0.011033383028810
290	0.117829426350831	-0.580705238903402	0.379140780880409
291	1.110668236082810	0.840406208775817	-0.936487304928219
292	0.251425308677725	-0.713615468262978	1.087582587452480
293	0.251425308677725	-0.713615468262978	1.087582587452480
294	-0.055840574518123	0.201174480734351	0.146231532101094
295	-0.077502670074319	0.496622283752806	0.143636010071779
296	0.060341886730645	-0.211449401000183	0.274478807382286
297	1.110668236082810	0.840406208775817	-0.936487304928219
298	0.251425308677725	-0.713615468262978	1.087582587452480
299	0.251425308677725	-0.713615468262978	1.087582587452480
300	0.063581404612037	-0.299532657003563	-0.131738853303921
301	0.251425308677725	-0.713615468262978	1.087582587452480
302	0.251425308677725	-0.713615468262978	1.087582587452480
303	0.063581404612037	-0.299532657003563	-0.131738853303921
304	0.251425308677725	-0.713615468262978	1.087582587452480
305	0.063581404612037	-0.299532657003563	-0.131738853303921
306	-0.142230264170962	-0.353381207217920	0.598627337349391
307	0.063581404612037	-0.299532657003563	-0.131738853303921
308	NA	NA	NA
309	0.063581404612037	-0.299532657003563	-0.131738853303921
310	0.063581404612037	-0.299532657003563	-0.131738853303921
311	0.561816878381991	0.562555157126258	-0.587767507536712
312	0.063581404612037	-0.299532657003563	-0.131738853303921
313	0.063581404612037	-0.299532657003563	-0.131738853303921
314	0.251425308677725	-0.713615468262978	1.087582587452480
315	0.063581404612037	-0.299532657003563	-0.131738853303921
316	1.969911163487900	2.394427885814610	-2.960557197308920
335	-0.059090647088454	0.143100596493086	-0.334492069750293
337	0.060341886730645	-0.211449401000183	0.274478807382286
347	0.060341886730645	-0.211449401000183	0.274478807382286
349	NA	NA	NA
353	0.054820297534908	-0.279027771304746	0.184236106461352
356	-0.071197960096939	0.324327163892564	-0.205573242376761
358	0.097232902322963	-0.101180676447521	-0.124406483584577
376	-0.071197960096939	0.324327163892564	-0.205573242376761
379	0.060341886730645	-0.211449401000183	0.274478807382286
380	-0.059090647088454	0.143100596493086	-0.334492069750293
381	-0.007193917615964	-0.182863694964374	-0.142210281686409
384	0.032850370528581	0.215927539372495	0.124317040908233
387	-0.130741535216435	0.290716666262612	-0.538624972687908
389	0.325207339862362	-0.493078019157654	0.289812005518755
408	-0.015766455976062	-0.447795009543826	-0.329301025691663
426	-0.015766455976062	-0.447795009543826	-0.329301025691663
428	-0.015766455976062	-0.447795009543826	-0.329301025691663
429	-0.130741535216435	0.290716666262612	-0.538624972687908
430	0.001378620744135	0.082067619615078	0.044880462318845
431	-0.073253995596249	-0.078539171640607	-0.433962999189786
432	-0.095914693060185	0.850143971012527	0.621764089893852
433	0.001378620744135	0.082067619615078	0.044880462318845
435	0.001378620744135	0.082067619615078	0.044880462318845
436	-0.130741535216435	0.290716666262612	-0.538624972687908
437	0.125079266702493	-0.994625752431466	-0.485269889974815
439	-0.125033582661832	1.327868352055660	0.814916022423493
443	-0.125033582661832	1.327868352055660	0.814916022423493
444	0.014582286821154	-0.072240890709469	0.068247099959519
445	-0.095914693060185	0.850143971012527	0.621764089893852
455	0.060341886730645	-0.211449401000183	0.274478807382286
457	-0.015766455976062	-0.447795009543826	-0.329301025691663
458	0.060341886730645	-0.211449401000183	0.274478807382286
459	-0.059478151438403	0.004296870875605	-0.258989781170037

460	-0.130741535216435	0.290716666262612	-0.538624972687908
461	-0.130741535216435	0.290716666262612	-0.538624972687908
462	-0.130741535216435	0.290716666262612	-0.538624972687908
463	-0.059090647088454	0.143100596493086	-0.334492069750293
464	0.060341886730645	-0.211449401000183	0.274478807382286
487	-0.130741535216435	0.290716666262612	-0.538624972687908
488	-0.130741535216435	0.290716666262612	-0.538624972687908
489	-0.130741535216435	0.290716666262612	-0.538624972687908
490	-0.130741535216435	0.290716666262612	-0.538624972687908
493	0.059523791967082	-0.017028048241236	0.053148921414094
503	-0.130741535216435	0.290716666262612	-0.538624972687908
505	-0.035608871624677	0.136844309010688	-0.242738025636907
506	-0.073253995596249	-0.078539171640607	-0.433962999189786
507	-0.130741535216435	0.290716666262612	-0.538624972687908
508	-0.015766455976062	-0.447795009543826	-0.329301025691663
509	-0.130741535216435	0.290716666262612	-0.538624972687908
510	0.063581404612037	-0.299532657003563	-0.131738853303921
512	0.063581404612037	-0.299532657003563	-0.131738853303921
513	-0.130741535216435	0.290716666262612	-0.538624972687908
515	-0.130741535216435	0.290716666262612	-0.538624972687908
516	-0.035608871624677	0.136844309010688	-0.242738025636907
517	-0.130741535216435	0.290716666262612	-0.538624972687908
518	-0.130741535216435	0.290716666262612	-0.538624972687908
519	-0.002545446212439	-0.008614679660729	-0.205738301525912
521	0.074117730888491	-0.128613358483971	0.449452025402035
522	-0.130741535216435	0.290716666262612	-0.538624972687908
523	-0.130741535216435	0.290716666262612	-0.538624972687908
524	0.023907474317987	-0.373663833273694	-0.230519939497792
525	0.060341886730645	-0.211449401000183	0.274478807382286
526	0.021878667995510	-0.232411528892531	-0.138076052138784
527	-0.130741535216435	0.290716666262612	-0.538624972687908
528	-0.073253995596249	-0.078539171640607	-0.433962999189786
532	-4.675053212168570	0.039101412969248	-0.465308983454596
533	-0.130741535216435	0.290716666262612	-0.538624972687908
539	-0.130741535216435	0.290716666262612	-0.538624972687908
541	-0.095914693060185	0.850143971012527	0.621764089893852
546	0.096167330794635	-0.285257435884946	0.376545258851094
559	-0.015766455976062	-0.447795009543826	-0.329301025691663
561	0.117829426350831	-0.580705238903402	0.379140780880409
564	0.059523791967082	-0.017028048241236	0.053148921414094
565	0.060341886730645	-0.211449401000183	0.274478807382286
566	-0.015766455976062	-0.447795009543826	-0.329301025691663
567	-0.130741535216435	0.290716666262612	-0.538624972687908
568	0.060341886730645	-0.211449401000183	0.274478807382286
569	-0.015766455976062	-0.447795009543826	-0.329301025691663
570	-0.015766455976062	-0.447795009543826	-0.329301025691663
571	1.110668236082810	0.840406208775817	-0.936487304928219
572	-0.122179606384530	1.846444194952180	1.491686519979190
573	-0.015766455976062	-0.447795009543826	-0.329301025691663
574	0.060341886730645	-0.211449401000183	0.274478807382286
575	-0.130741535216435	0.290716666262612	-0.538624972687908
576	0.060341886730645	-0.211449401000183	0.274478807382286
577	-0.015766455976062	-0.447795009543826	-0.329301025691663
580	-0.130741535216435	0.290716666262612	-0.538624972687908
582	0.325207339862362	-0.493078019157654	0.289812005518755
583	0.059523791967082	-0.017028048241236	0.053148921414094
585	-0.103189846900743	0.456388751295036	-0.188678536648410
589	0.021878667995510	-0.232411528892531	-0.138076052138784
590	0.001378620744135	0.082067619615078	0.044880462318845
591	-0.037428551532258	-0.152347206525370	-0.331896547720978
593	-0.015766455976062	-0.447795009543826	-0.329301025691663
594	0.060341886730645	-0.211449401000183	0.274478807382286
595	-0.103189846900743	0.456388751295036	-0.188678536648410
596	0.060341886730645	-0.211449401000183	0.274478807382286
597	-0.007193917615964	-0.182863694964374	-0.142210281686409
666	-0.015766455976062	-0.447795009543826	-0.329301025691663
676	-0.108804997332954	1.190191442802490	0.710789891565054
687	-0.130741535216435	0.290716666262612	-0.538624972687908
688	0.063581404612037	-0.299532657003563	-0.131738853303921
689	-0.192602467723807	2.119859566396000	1.569670952120770
690	-0.015766455976062	-0.447795009543826	-0.329301025691663
691	-0.007193917615964	-0.182863694964374	-0.142210281686409
692	-0.015766455976062	-0.447795009543826	-0.329301025691663
717	-0.059090647088454	0.143100596493086	-0.334492069750293

875	-0.192602467723807	2.119859566396000	1.569670952120770
902	-0.015766455976062	-0.447795009543826	-0.329301025691663
903	0.060341886730645	-0.211449401000183	0.274478807382286
985	-0.130741535216435	0.290716666262612	-0.538624972687908
986	-0.130741535216435	0.290716666262612	-0.538624972687908
993	0.117829426350831	-0.580705238903402	0.379140780880409
995	-0.535885837019649	0.006853053827138	0.109672087246301
996	0.096167330794635	-0.285257435884946	0.376545258851094
998	-0.044710319910161	0.098383242681938	-0.094475190447410
999	-0.002831134256971	-0.351954543084427	-0.511947431331362
1007	0.001378620744135	0.082067619615078	0.044880462318845
1008	0.001378620744135	0.082067619615078	0.044880462318845
1009	0.063581404612037	-0.299532657003563	-0.131738853303921
1010	0.001378620744135	0.082067619615078	0.044880462318845
1011	0.001378620744135	0.082067619615078	0.044880462318845
1012	-0.015766455976062	-0.447795009543826	-0.329301025691663
1013	-0.130741535216435	0.290716666262612	-0.538624972687908
1145	0.125079266702493	-0.994625752431466	-0.485269889974815

CA of motifs

Column quality (motifs)

name	mass	qlt	inr	k=1	cor	ctr	k=2	cor	ctr
A1	205	969	155	1456	868	664	-497	101	89
B1	207	178	115	-501	141	80	258	37	24
B3	48	916	165	-1396	176	143	-2861	740	694
D1	98	65	119	-481	60	35	-145	5	4
D2	40	91	127	-957	91	57	-17	0	0
D5	28	76	133	-446	13	8	984	63	48
E1	354	308	79	-46	3	1	468	305	136
H3	20	30	107	-606	22	11	386	9	5

Row quality (VUs)

name	mass	qlt	inr	k=1	cor	ctr	k=2	cor	ctr
1	8	186	6	-621	148	4	314	38	1
2	5	380	1	-339	125	1	482	254	2
3	5	380	1	-339	125	1	482	254	2
4	3	947	3	1802	835	13	-660	112	2
5	5	791	11	-1162	200	10	-1997	591	36
6	5	819	1	872	819	6	-19	0	0
11	5	380	1	-339	125	1	482	254	2
14	5	819	1	872	819	6	-19	0	0
30	3	213	1	-57	2	0	621	211	2
35	3	213	1	-57	2	0	621	211	2
48	3	131	3	-620	100	1	343	31	1
54	3	213	1	-57	2	0	621	211	2
59	3	213	1	-57	2	0	621	211	2
60	3	213	1	-57	2	0	621	211	2
62	3	213	1	-57	2	0	621	211	2
72	3	131	3	-620	100	1	343	31	1
76	5	68	4	-326	47	1	214	20	0
79	3	947	3	1802	835	13	-660	112	2
81	5	819	1	872	819	6	-19	0	0
101	3	213	1	-57	2	0	621	211	2
103	3	213	1	-57	2	0	621	211	2
116	3	213	1	-57	2	0	621	211	2
128	5	916	9	37	0	0	-2231	916	44
151	3	131	3	-620	100	1	343	31	1
159	3	213	1	-57	2	0	621	211	2
166	3	131	3	-620	100	1	343	31	1
176	3	213	1	-57	2	0	621	211	2
178	5	380	1	-339	125	1	482	254	2
179	8	710	5	-802	297	7	-946	413	12

180	5	380	1	-339	125	1	482	254	2
181	5	380	1	-339	125	1	482	254	2
182	5	380	1	-339	125	1	482	254	2
183	3	213	1	-57	2	0	621	211	2
184	3	131	3	-620	100	1	343	31	1
185	3	43	7	-595	39	1	-193	4	0
186	3	213	1	-57	2	0	621	211	2
187	5	380	1	-339	125	1	482	254	2
189	3	59	19	-1185	59	5	-23	0	0
190	3	43	7	-595	39	1	-193	4	0
191	5	118	14	-305	11	1	965	107	8
192	5	68	4	-326	47	1	214	20	0
193	5	262	2	591	244	3	-159	18	0
194	5	380	1	-339	125	1	482	254	2
217	3	213	1	-57	2	0	621	211	2
219	5	380	1	-339	125	1	482	254	2
221	3	131	3	-620	100	1	343	31	1
223	3	131	3	-620	100	1	343	31	1
252	5	556	16	-1457	204	16	-1912	352	33
253	8	820	7	-981	323	11	-1217	497	20
254	3	879	16	-1729	151	12	-3802	729	64
255	8	155	2	383	149	2	-77	6	0
256	5	81	9	-621	65	3	299	15	1
257	10	249	5	-614	227	6	187	21	1
258	5	380	1	-339	125	1	482	254	2
259	8	123	8	-613	118	4	135	6	0
260	5	380	1	-339	125	1	482	254	2
261	8	123	8	-613	118	4	135	6	0
262	5	118	14	-305	11	1	965	107	8
263	8	53	14	-467	37	3	314	17	1
264	10	249	5	-614	227	6	187	21	1
265	5	380	1	-339	125	1	482	254	2
266	5	380	1	-339	125	1	482	254	2
267	5	380	1	-339	125	1	482	254	2
268	5	819	1	872	819	6	-19	0	0
269	3	213	1	-57	2	0	621	211	2
270	8	820	7	-981	323	11	-1217	497	20
271	10	90	6	143	10	0	403	80	3
272	5	52	20	-685	37	4	428	15	2
273	5	68	4	-326	47	1	214	20	0
274	5	68	4	-326	47	1	214	20	0
275	5	380	1	-339	125	1	482	254	2
276	5	380	1	-339	125	1	482	254	2
277	3	213	1	-57	2	0	621	211	2
278	3	213	1	-57	2	0	621	211	2
279	5	52	20	-685	37	4	428	15	2
280	5	68	4	-326	47	1	214	20	0
281	5	137	4	-608	135	3	75	2	0
282	10	18	9	94	3	0	204	15	1
283	3	213	1	-57	2	0	621	211	2
284	3	213	1	-57	2	0	621	211	2
285	3	213	1	-57	2	0	621	211	2
286	5	68	4	-326	47	1	214	20	0
287	5	380	1	-339	125	1	482	254	2
288	3	947	3	1802	835	13	-660	112	2
289	5	262	2	591	244	3	-159	18	0
290	5	380	1	-339	125	1	482	254	2
291	5	380	1	-339	125	1	482	254	2
292	3	213	1	-57	2	0	621	211	2
293	3	213	1	-57	2	0	621	211	2

294	3	59	19	-1185	59	5	-23	0	0
295	5	807	9	-1175	255	11	-1730	552	27
296	5	819	1	872	819	6	-19	0	0
297	5	819	1	872	819	6	-19	0	0
298	3	213	1	-57	2	0	621	211	2
299	3	213	1	-57	2	0	621	211	2
300	5	131	10	-903	127	6	160	4	0
301	3	213	1	-57	2	0	621	211	2
302	3	213	1	-57	2	0	621	211	2
303	5	40	19	-404	13	1	567	27	3
304	5	807	9	-1175	255	11	-1730	552	27
305	3	213	1	-57	2	0	621	211	2
306	8	801	6	-182	14	0	-1373	787	25
307	3	131	3	-620	100	1	343	31	1
308	3	131	3	-620	100	1	343	31	1
309	3	213	1	-57	2	0	621	211	2
310	3	131	3	-620	100	1	343	31	1
311	5	819	1	872	819	6	-19	0	0
312	5	68	4	-326	47	1	214	20	0
313	3	213	1	-57	2	0	621	211	2
314	3	213	1	-57	2	0	621	211	2
315	5	137	4	-608	135	3	75	2	0
316	3	947	3	1802	835	13	-660	112	2
335	3	947	3	1802	835	13	-660	112	2
337	5	380	1	-339	125	1	482	254	2
347	5	819	1	872	819	6	-19	0	0
349	3	213	1	-57	2	0	621	211	2
353	5	819	1	872	819	6	-19	0	0
356	3	947	3	1802	835	13	-660	112	2
358	5	819	1	872	819	6	-19	0	0
376	3	947	3	1802	835	13	-660	112	2
379	5	819	1	872	819	6	-19	0	0
380	3	947	3	1802	835	13	-660	112	2
381	5	380	1	-339	125	1	482	254	2
384	5	819	1	872	819	6	-19	0	0
387	3	947	3	1802	835	13	-660	112	2
389	5	68	4	-326	47	1	214	20	0
408	3	213	1	-57	2	0	621	211	2
426	3	213	1	-57	2	0	621	211	2
428	3	58	28	-553	9	1	1308	49	8
429	3	131	3	-620	100	1	343	31	1
430	3	879	16	-1729	151	12	-3802	729	64
431	5	819	1	872	819	6	-19	0	0
433	3	879	16	-1729	151	12	-3802	729	64
435	5	68	4	-326	47	1	214	20	0
436	3	947	3	1802	835	13	-660	112	2
437	3	213	1	-57	2	0	621	211	2
439	5	198	4	603	132	3	-426	66	2
443	5	104	12	-890	103	6	-108	2	0
444	5	81	9	-621	65	3	299	15	1
455	5	380	1	-339	125	1	482	254	2
457	5	118	14	-305	11	1	965	107	8
458	8	383	1	375	357	2	101	26	0
459	5	111	14	-586	37	3	825	74	6
460	3	947	3	1802	835	13	-660	112	2
461	3	947	3	1802	835	13	-660	112	2
462	3	947	3	1802	835	13	-660	112	2
463	3	947	3	1802	835	13	-660	112	2
464	5	819	1	872	819	6	-19	0	0
487	3	947	3	1802	835	13	-660	112	2

488	3	131	3	-620	100	1	343	31	1
489	5	262	2	591	244	3	-159	18	0
490	5	380	1	-339	125	1	482	254	2
493	3	213	1	-57	2	0	621	211	2
503	3	947	3	1802	835	13	-660	112	2
505	8	383	1	375	357	2	101	26	0
506	5	198	4	603	132	3	-426	66	2
507	3	947	3	1802	835	13	-660	112	2
508	3	131	3	-620	100	1	343	31	1
509	5	262	2	591	244	3	-159	18	0
510	5	380	1	-339	125	1	482	254	2
512	3	947	3	1802	835	13	-660	112	2
513	3	947	3	1802	835	13	-660	112	2
515	3	131	3	-620	100	1	343	31	1
516	5	819	1	872	819	6	-19	0	0
517	3	947	3	1802	835	13	-660	112	2
518	3	947	3	1802	835	13	-660	112	2
519	8	155	2	383	149	2	-77	6	0
521	5	819	1	872	819	6	-19	0	0
522	3	947	3	1802	835	13	-660	112	2
523	3	947	3	1802	835	13	-660	112	2
524	5	68	4	-326	47	1	214	20	0
525	5	819	1	872	819	6	-19	0	0
526	5	68	4	-326	47	1	214	20	0
527	3	947	3	1802	835	13	-660	112	2
528	5	262	2	591	244	3	-159	18	0
532	5	380	1	-339	125	1	482	254	2
533	3	947	3	1802	835	13	-660	112	2
539	3	947	3	1802	835	13	-660	112	2
546	5	819	1	872	819	6	-19	0	0
559	3	131	3	-620	100	1	343	31	1
561	5	380	1	-339	125	1	482	254	2
564	3	131	3	-620	100	1	343	31	1
565	5	819	1	872	819	6	-19	0	0
566	3	131	3	-620	100	1	343	31	1
567	3	947	3	1802	835	13	-660	112	2
568	5	819	1	872	819	6	-19	0	0
569	3	131	3	-620	100	1	343	31	1
570	5	81	9	-621	65	3	299	15	1
571	5	380	1	-339	125	1	482	254	2
572	3	43	7	-595	39	1	-193	4	0
573	5	68	4	-326	47	1	214	20	0
574	5	819	1	872	819	6	-19	0	0
575	3	947	3	1802	835	13	-660	112	2
576	3	947	3	1802	835	13	-660	112	2
577	3	213	1	-57	2	0	621	211	2
580	3	947	3	1802	835	13	-660	112	2
582	5	380	1	-339	125	1	482	254	2
583	3	213	1	-57	2	0	621	211	2
585	3	947	3	1802	835	13	-660	112	2
589	5	380	1	-339	125	1	482	254	2
590	3	879	16	-1729	151	12	-3802	729	64
591	5	819	1	872	819	6	-19	0	0
593	8	126	14	-598	59	4	635	67	5
594	5	819	1	872	819	6	-19	0	0
595	3	947	3	1802	835	13	-660	112	2
596	5	819	1	872	819	6	-19	0	0
597	5	68	4	-326	47	1	214	20	0
666	8	710	5	-802	297	7	-946	413	12
676	8	155	2	383	149	2	-77	6	0

687	3	947	3	1802	835	13	-660	112	2
688	3	131	3	-620	100	1	343	31	1
689	5	118	14	-305	11	1	965	107	8
690	10	202	7	-456	88	3	520	114	5
691	8	251	2	-424	184	2	257	68	1
692	3	879	16	-1729	151	12	-3802	729	64
717	3	947	3	1802	835	13	-660	112	2
875	5	118	14	-305	11	1	965	107	8
902	3	213	1	-57	2	0	621	211	2
903	5	819	1	872	819	6	-19	0	0
985	3	213	1	-57	2	0	621	211	2
986	3	947	3	1802	835	13	-660	112	2
993	5	380	1	-339	125	1	482	254	2
995	3	947	3	1802	835	13	-660	112	2
996	5	198	4	603	132	3	-426	66	2
998	15	179	8	-390	94	4	-369	84	4
999	8	383	1	375	357	2	101	26	0
1007	3	131	3	-620	100	1	343	31	1
1008	3	43	7	-595	39	1	-193	4	0
1009	8	53	14	-467	37	3	314	17	1
1010	5	791	11	-1162	200	10	-1997	591	36
1011	3	879	16	-1729	151	12	-3802	729	64
1012	8	88	13	-476	42	3	492	45	3
1013	3	947	3	1802	835	13	-660	112	2
1145	15	401	10	-823	317	16	-423	84	5

Principal column coordinates

	axis 1	axis 2	axis 3	axis 4	axis 5
A1	1.45559096943788	-0.49666197131470	0.02024946008684	-0.06703595449938	0.17332637257176
B1	-0.50102482217833	0.25794475002442	1.04832914485266	0.13025753773465	0.29897995094635
B3	-1.39627340707440	-2.86086584601188	0.26958714151978	-0.57394222194037	-0.44822625932528
D1	-0.48092237708661	-0.14512568904111	-1.20297174151459	0.91522082611147	-0.63550638336491
D2	-0.95708996168630	-0.01707640275403	-1.51831878946444	-0.31540533690340	2.58734651076218
D5	-0.44626384166273	0.98410896783148	-0.63557675780223	-3.35459151135975	-0.88484534062602
E1	-0.04618761691635	0.46752746927665	-0.12635405881587	0.01415785538771	-0.24315915409542
H3	-0.60563220643679	0.38608515256310	0.39556991083983	1.24062205998264	-0.35958851618160

	axis 6	axis 7
A1	-0.17778575921481	-0.09141863382128
B1	-0.08695757647699	-0.50224057990797
B3	0.29471695757201	0.49244026302851
D1	-0.29694799232433	-0.92330512911910
D2	-0.10659936292065	0.24316010732044
D5	-1.18312163675238	-0.59669454444458
E1	0.48230278249708	0.43248109039383
H3	-3.16124305803642	2.17086219333847

Principal row coordinates

	axis 1	axis 2	axis 3	axis 4	axis 5	axis 6	axis 7
1	-0.620814370	0.313811519	-0.284895820	-0.084917794	1.411157473	0.164018992	0.101679033
2	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
3	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
4	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
5	-1.162057029	-1.997431549	-0.668869402	0.254230972	-0.867889111	-0.001900973	-0.378977222
6	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
11	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
14	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
30	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
35	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
48	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785

54	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
59	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
60	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
62	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
72	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
76	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
79	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
81	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
101	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
103	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
116	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
128	0.036719873	-2.231021582	0.207698771	-0.477488195	-0.220148964	0.099632278	0.352727908
151	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
159	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
166	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
176	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
178	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
179	-0.802062100	-0.945955780	0.569254099	-0.213313544	-0.209500889	0.391982442	0.247852475
180	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
181	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
182	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
183	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
184	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
185	-0.595419224	-0.192867230	-1.724114560	1.363563241	-1.017869258	-0.506034407	-1.624229035
186	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
187	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
189	-1.184951646	-0.022693973	-2.176074002	-0.469914048	4.144066120	-0.181657889	0.427754265
190	-0.595419224	-0.192867230	-1.724114560	1.363563241	-1.017869258	-0.506034407	-1.624229035
191	-0.304846561	0.964588351	-0.546004519	-2.488411765	-0.903343482	-0.597138998	-0.144437766
192	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
193	0.590913484	-0.158623637	0.765750295	0.047096080	0.378238598	-0.225576937	-0.522166780
194	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
217	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
219	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
221	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
223	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
252	-1.456823240	-1.912344921	-0.894849123	-0.662507673	1.713078578	0.160287286	0.647014428
253	-0.981473890	-1.217354359	0.054913333	0.234176398	-0.418970688	-0.050662638	-0.547156410
254	-1.728694834	-3.801995869	0.386375756	-0.855101298	-0.717908965	0.502232461	0.866274591
255	0.383177167	-0.077195339	-0.625395011	0.428260521	-0.376572694	0.004299507	-0.341416730
256	-0.621067750	0.299317267	-1.178583131	-0.224410317	1.877303130	0.320121473	0.594275942
257	-0.614465584	0.187141832	-0.644700505	0.277202464	0.803900790	-0.003494357	-0.329797984
258	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
259	-0.612518241	0.135255768	-1.360426941	0.304914202	0.912245667	0.044736179	-0.145225717
260	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
261	-0.612518241	0.135255768	-1.360426941	0.304914202	0.912245667	0.044736179	-0.145225717
262	-0.304846561	0.964588351	-0.546004519	-2.488411765	-0.903343482	-0.597138998	-0.144437766
263	-0.467474250	0.313851882	-0.446090314	1.077675522	-0.661089995	-1.690421549	0.985144443
264	-0.614465584	0.187141832	-0.644700505	0.277202464	0.803900790	-0.003494357	-0.329797984
265	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
266	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
267	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
268	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
269	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
270	-0.981473890	-1.217354359	0.054913333	0.234176398	-0.418970688	-0.050662638	-0.547156410
271	0.143033462	0.402982357	0.109872888	-1.220657842	-0.262552442	-0.411357967	-0.333302273
272	-0.685063641	0.427947195	1.034707341	1.021218581	-0.048537353	-2.767658520	1.467674980
273	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
274	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
275	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583

276	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
277	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
278	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
279	-0.685063641	0.427947195	0.103470734	0.102121858	-0.048537353	-0.276765852	1.467674980
280	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
281	-0.607863418	0.074966396	-0.110817878	0.778815246	-0.269501549	-0.327110187	-1.253871910
282	0.093705861	0.204293901	0.479336052	0.490913871	-0.052230882	-1.254096028	0.883832201
283	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
284	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
285	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
286	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
287	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
288	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
289	0.590913484	-0.158623637	0.765750295	0.047096080	0.378238598	-0.225576937	-0.522166780
290	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
291	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
292	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
293	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
294	-1.184951646	-0.022693973	-0.217607400	-0.469914048	0.414406612	-0.181657889	0.427754265
295	-1.174501222	-1.729597924	0.944427279	-0.330517023	-0.119521403	0.177023246	-0.008620097
296	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
297	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
298	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
299	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
300	-0.902629629	0.160053024	-0.336797599	-0.137923398	0.231146614	-0.164921928	-0.227880260
301	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
302	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
303	-0.403501762	0.567211438	0.192921809	0.934731662	-0.482700363	-2.282615119	2.289831182
304	-1.174501222	-1.729597924	0.944427279	-0.330517023	-0.119521403	0.177023246	-0.008620097
305	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
306	-0.182289289	-1.373081047	0.639292115	-0.253636379	0.012856077	0.017026196	-0.059352989
307	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
308	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
309	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
310	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
311	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
312	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
313	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
314	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
315	-0.607863418	0.074966396	-0.110817878	0.778815246	-0.269501549	-0.327110187	-1.253871910
316	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
335	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
337	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
347	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
349	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
353	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
356	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
358	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
376	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
379	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
380	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
381	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
384	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
387	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
389	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
408	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
426	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
428	-0.552509268	1.307848194	-0.910916777	-4.997916944	-1.417227102	-0.201617883	-1.049673151
429	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
430	-1.728694834	-3.801995869	0.386375756	-0.855101298	-0.717908965	0.502232461	0.866274591

431	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
433	-1.728694834	-3.801995869	0.386375756	-0.855101298	-0.717908965	0.502232461	0.866274591
435	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
436	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
437	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
439	0.603357678	-0.426457262	-0.847546387	0.631844075	-0.370129110	-0.404501156	-0.892523905
443	-0.890185435	-0.107780601	-1.950094281	0.446824596	1.563098431	-0.343846148	-0.598237385
444	-0.621067750	0.299317267	-1.178583131	-0.224410317	1.877303130	0.320121473	0.594275942
455	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
457	-0.304846561	0.964588351	-0.546004519	-2.488411765	-0.903343482	-0.597138998	-0.144437766
458	0.374881038	0.101360411	0.450136109	0.038428525	0.122339112	0.123582320	-0.094511980
459	-0.586408439	0.825324108	0.295781013	-2.401924846	-0.469180472	-1.082182399	-0.966593968
460	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
461	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
462	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
463	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
464	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
487	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
488	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
489	0.590913484	-0.158623637	0.765750295	0.047096080	0.378238598	-0.225576937	-0.522166780
490	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
493	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
503	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
505	0.374881038	0.101360411	0.450136109	0.038428525	0.122339112	0.123582320	-0.094511980
506	0.603357678	-0.426457262	-0.847546387	0.631844075	-0.370129110	-0.404501156	-0.892523905
507	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
508	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
509	0.590913484	-0.158623637	0.765750295	0.047096080	0.378238598	-0.225576937	-0.522166780
510	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
512	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
513	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
515	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
516	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
517	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
518	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
519	0.383177167	-0.077195339	-0.625395011	0.428260521	-0.376572694	0.004299507	-0.341416730
521	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
522	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
523	1.021345792	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
524	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
525	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
526	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
527	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
528	0.590913484	-0.158623637	0.765750295	0.047096080	0.378238598	-0.225576937	-0.522166780
532	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
533	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
539	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
546	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
559	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
561	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
564	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
565	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
566	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
567	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
568	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
569	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
570	-0.621067750	0.299317267	-1.178583131	-0.224410317	1.877303130	0.320121473	0.594275942
571	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
572	-0.595419224	-0.192867230	-1.724114560	1.363563241	-1.017869258	-0.506034407	-1.624229035
573	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708

574	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
575	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
576	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
577	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
580	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
582	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
583	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
585	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
589	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
590	-1.728694834	-3.801995869	0.386375756	-0.855101298	-0.717908965	0.502232461	0.866274591
591	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
593	-0.598214923	0.635494243	-1.089361013	-1.815579193	0.779126386	-0.458645295	0.046292911
594	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
595	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
596	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
597	-0.326301539	0.214230639	-0.952603410	0.692328327	-0.703664559	0.157933214	-0.431715708
666	-0.802062100	-0.945955780	0.569254099	-0.213313544	-0.209500889	0.391982442	0.247852475
676	0.383177167	-0.077195339	-0.625395011	0.428260521	-0.376572694	0.004299507	-0.341416730
687	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
688	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
689	-0.304846561	0.964588351	-0.546004519	-2.488411765	-0.903343482	-0.597138998	-0.144437766
690	-0.456354989	0.519777373	-0.328411199	-0.854798259	-0.586422515	-0.462124593	-0.699154838
691	-0.424303563	0.257087100	-0.134242673	0.526241302	-0.309487653	0.055893486	-0.582315400
692	-1.728694834	-3.801995869	0.386375756	-0.855101298	-0.717908965	0.502232461	0.866274591
717	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
875	-0.304846561	0.964588351	-0.546004519	-2.488411765	-0.903343482	-0.597138998	-0.144437766
902	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
903	0.872475363	-0.019359394	-0.076035237	-0.039390839	-0.055924412	0.259466464	0.299989422
985	-0.057183854	0.621328508	-0.181092261	0.021093413	-0.389459861	0.821900834	0.760797619
986	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
993	-0.338745733	0.482064265	0.660693271	0.107580332	0.044703149	0.336857433	-0.061358583
995	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
996	0.603357678	-0.426457262	-0.847546387	0.631844075	-0.370129110	-0.404501156	-0.892523905
998	-0.390252106	-0.368793402	-0.225034449	-1.034607786	0.395991231	-0.220809550	-0.006530039
999	0.374881038	0.101360411	0.450136109	0.038428525	0.122339112	0.123582320	-0.094511980
1007	-0.620307611	0.342800022	1.502478803	0.194067252	0.478866159	-0.148185968	-0.883514785
1008	-0.595419224	-0.192867230	-1.724114560	1.363563241	-1.017869258	-0.506034407	-1.624229035
1009	-0.467474250	0.313851882	-0.446090314	1.077675522	-0.661089995	-1.690421549	0.985144443
1010	-1.162057029	-1.997431549	-0.668869402	0.254230972	-0.867889111	-0.001900973	-0.378977222
1011	-1.728694834	-3.801995869	0.386375756	-0.855101298	-0.717908965	0.502232461	0.866274591
1012	-0.475770379	0.492407633	0.629440807	0.687843525	-0.162178189	-1.571138736	1.232049193
1013	1.802134579	-0.660047295	0.029021786	-0.099875091	0.277611037	-0.302967905	-0.160818775
1145	-0.822729473	-0.423389029	-0.270915064	0.350346412	0.320292222	-0.816479340	0.560991233

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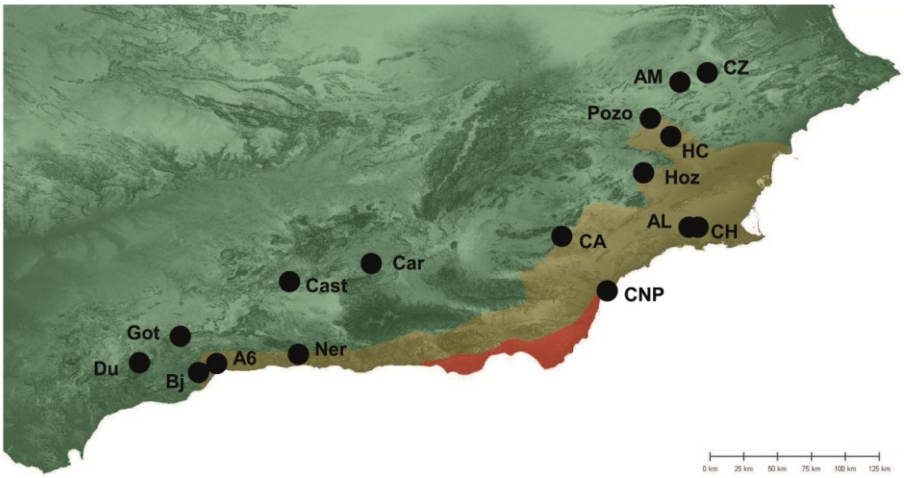
Abbreviations

A6	Abrigo 6 del Complejó del Humo/La Araña, Málaga
A6 EPI	Epipaleolithic assemblage of A6
A6 NEO	Early Neolithic assemblage of A6
AL	Almería *or* Cueva del Algarrobo, Mazarrón, Murcia
AM	Abrigo del Monje, Jumilla, Murcia
Bj	Cueva Bajondillo, Torremolinas, Málaga
CA	Cueva Ambrosio, Las Cuevas de Ambrosio, Almería
Car	Cueva de la Carigüela, Piñar, Granada
Cast	Los Castillejos, Montefrío, Granada
CH	Cueva Higuera, Isla Plana, Murcia
CNP	Cabecicos Negros(-El Pajaraco), Vera, Almería
CZ	Cueva de los Zagales, Jumilla, Murcia
Du	El Duende, Ronda, Málaga
E	East, eastern
E NEO	Early Neolithic
EPI	Epipaleolithic
frag(s).	fragment(s)
Got	Cueva de las Goteras, Molina, Málaga
GR	Granada
HC	Hondo de Cagitán, Mula, Murcia
Hoz	Barranco de la Hoz, Lorca, Murcia
L	length
MA	Málaga
MU	Murcia
N	North, northern
NA	not available
NEO	(Early) Neolithic
Ner	Cueva de Nerja, Maro, Málaga
n.s.	not specified
Ø	mean value
OA	open-air site
S	South, southern
SD	standard deviation
strata	stratigraphy
T	thickness
typ.	typology/typological classification
VU(s)	vessel unit(s)
W	West, western
WE	weight
WI	width
w/o	without

ANALYZED ASSEMBLAGES			stage	14C-ages	stratigraphy	typology	studied		site type
							lithics	VUs	
A6 EPI	MA	Abrigo 6, Málaga	EPI	(x)	x		491		cave
A6 NEO	MA	Abrigo 6, Málaga	NEO	(x)	x	x	601	9	cave
AL	MU	Cueva del Algarrobo, Murcia	EPI		x	x?	513		abri
AM	MU	Abrigo del Monje, Murcia	EPI			x	91		abri
CA	AL	Cueva Ambrosio, Almería	EPI		x	x	1613		abri
Car	GR	Cueva de la Carigüela, Granada	NEO	x	x	x	483	307	cave
CH	MU	Cueva de la Higuera, Murcia	EPI		x?	x	257		cave
CNP	AL	Cabecicos Negros, Almería	NEO			x	246	674	OA
CZ	MU	Cueva de los Zagales, Murcia	EPI			x	395		cave
Got	MA	Cueva de las Goteras, Málaga	NEO			x?		7	cave
HC	MU	Hondo de Cagitán, Murcia	NEO			x?		6	OA
Hoz	MU	Barranco de la Hoz, Murcia	EPI			x	219		abri



(cf. **3.1.2.5. Evaluated sites and archaeological characterization**).