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Cobbles, tools, and plants: techno-functional variability within lithic industries of complex societies in Central Coast, Peru (~1800-400 BP)

Antonio Pérez^{a,1}, Santiago Uceda[†], Eric Boëda^a, Edwin Silva^b, Lucénida Carrión^c,
Rolando Romero^d, Marcos Ramos^e, Pilar Babot^f

^a UMR 7041 ArScAn-Équipe AnTET, Université Paris Nanterre 200 Avenue de la République, 92001 Nanterre Cedex, France.

^b Universidad Nacional Mayor de San Marcos, Cercado de Lima 15081, Peru.

^c División de Arqueología, Parque de las Leyendas “Felipe Benavides Barreda”, Las Leyendas 580, 15008 Lima, Peru.

^d Universidad Tecnológica del Perú, Chiclayo 14001, Lima, Peru.

^e Universidade Federal do Rio de Janeiro, PPGArq-Museu Nacional. Quinta da Boa Vista, São Cristóvão. Rio de Janeiro, CEP: 20940-040, Brazil.

^f Instituto Superior de Estudios Sociales, CONICET; Instituto de Arqueología y Museo, Universidad Nacional de Tucumán. San Martín 1545, CP 4.000 San Miguel de Tucumán, Argentina.

Abstract

This article concerns the technological and archaeobotanical analysis of nine lithic assemblages from monumental sites in the Maranga Archaeological Complex (Central Coast, Peru), dated between about 1800 and 400 yr BP. This period of occupation corresponds mainly to the development of Lima and Ychsma complex societies that were prior to and contemporary with the Inca Empire respectively. In order to study the degree of technical and functional variability between Maranga lithic industries, the different *schèmes opératoires* executed were identified, as well as the characteristics of the raw materials procurement. The eight techno-types present amongst 497 tools, along with the analysis of plant micro-remains preserved in the transformative Techno-Functional Units, allowed us to obtain direct evidence of tool uses. Analytical procedures included the construction of a reference collection of useful local flora, the sampling of the transformative surfaces of the tools, and the taxonomic and anatomical identification of the recovered plant components. After the integration of the results of these analyses with the information coming from the archaeological contexts, diachronic changes in the production systems are proposed, especially the preference for an alternating debitage system in the Late Intermediate Period (~ 1050-470 BP). Towards the Late Horizon (~ 470-400 BP), there was probably an instrumental standardization associated with the processing of the fruits of *Caesalpinia spinosa*, a plant used in the production of gums and tanins.

Keywords: Techno-functional approach; lithic industries in complex societies; Peruvian Central Coast; plant micro-remain analysis; *Caesalpinia spinosa*

1. Introduction

The Maranga Archaeological Complex (MAC) is a diverse set of monumental archeological sites located in the urban heart of Lima, Peru (Fig. 1, 2), which sits in the lower valley of the Rimac River. The MAC has a vast archaeological record, dating

¹ Corresponding author

E-mail addresses : antonioperezbalarezo@hotmail.com (A. Pérez), boeda.eric@gmail.com (E. Boëda), qarwarasu@gmail.com (E. Silva), lucenida.carrion@leyendas.gob.pe (L. Carrión), rrpestadistico@gmail.com (R. Romero), argonauta128@gmail.com (M. Ramos), pilarbabot@csnat.unt.edu.ar (P. Babot).

from the Early Intermediate Period (~ 1800-1400 BP) to the Late Horizon (~ 470-400 BP). Within the MAC, artifacts from complex societies in this region, representing cultures both previous and contemporary to the Inca state, have been found (Carrión and Narváez, 2014).

Despite the material wealth of this complex, the lithic industry has not been an object of much archaeological interest. This is, in part, because “archaeologists have generally overlooked lithic artifacts from Andean complex societies” (Downey, 2010, p. 79), due to the presence of other evidence, such as monumental architecture, textiles, ceramics, and metals, among others. In addition, these industries are generally considered expedient and unsophisticated, without further evolution over time, so they are judged to be of little diagnostic value in techno-cultural studies (SM 1: Archaeological and archaeobotanical background).

The use of technological analysis to study the variability and technical evolution of complex societies in the Central Andes is still quite underutilized, and where it has been applied the objects being studied have not been examined with any overlapping methodologies (Bencic, 2016, 2015, 2001, 1999; Burger, 2007; Costin et al., 1989; Cruz, 2014; DeLeonardis, 2005; Downey, 2010, 2009; Fortin, 2015; Fortin and Nash, 2015; Gero, 1991, 1989, 1983a, 1983b; Giesso, 2010, 2003a, 2003b, 2000; Hu, 2016; Lavallée, 2013; Lavallée and Julien, 1983; León, 2007; Read and Russell, 1996; Russell, 1988; Seddon, 1994; Silva, 2016, 2014; Stone, 1983; Vining, 2005; Yataco, 2008). Although the objectives of these investigations are diverse, the vast majority have focused on the study of artisan specialization. Meanwhile, typological studies are scarce, with the most significant efforts having been published in the 1960s and 1970s (Brown, 1926; Donnan and Moseley, 1968; Hyslop, 1976; Rivera, 1978; Taschini, 1968). In both approaches there is a lack of integration between aspects of production and the functioning/function of the tools.

Within the framework of this problem, archaeobotanical studies at the macroscopic level have demonstrated a clear relationship between artisanal production and the processing of different plant resources since the Early Intermediate Period in the MAC (Bellido, 2014). However, the role of knapped lithic production in this context remains unknown. In this sense, our hypothesis is that there is a close functional relationship between knapped lithic tools and plant use, and that, therefore, lithic production is conceived from the selection stage predominantly for the processing of plant resources.

Therefore, our dual approach combining technological and archaeobotanical analyses is the first such application to an Andean lithic industry, and is presented as a useful technique to understand cultural change based on the internal structure of these lithic tools.

2. The Maranga Archaeological Complex (MAC)

The sites that provided the complex lithic objects of this study are part of the MAC, located in the territory belonging to the theme park *Parque de las Leyendas – Felipe Benavides Barreda* (PATPAL). With a total area of approximately 3 km², the PATPAL is located on the Central Coast of Peru in the lower valley of the Rimac River on its southern bank, 3.5 km from the Pacific Ocean (Fig. 1). This area is dominated by a relatively flat relief, varying between 48 and 68 m.a.s.l., and is ecologically defined by the *Desert-Subtropical Formation* (d-ST) (ONERN, 1986), generally characterized by a dispersed xerophytic vegetation.

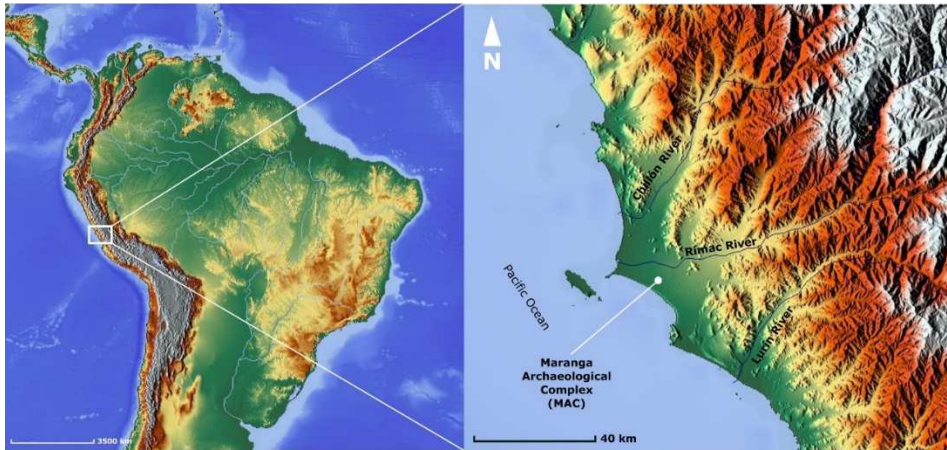


Fig. 1. Location of the Archaeological Complex Maranga (MAC), in the lower part of the Rimac river valley, left bank (Modified from maps-for-free.com).

The nine MAC sites considered for this investigation were: the seven “public buildings” of Huaca El Rosal, Huaca Middendorf, Huaca 33, Huaca 34, Huaca 43, Huaca San Miguel, and Huaca 58B, and the two defensive walls: Wall 46A and Wall 55E (Fig. 2). These are the main sites that, at present, have provided lithic artifacts from within the complex (Carrión and Narváez, 2014).



Fig. 2. Left: Location map of the nine selected sites. Dashed white line: perimeter of the MAC in the PATPAL. Yellow: the sites from which the lithic sets come (Source: Modified from Google Earth Pro satellite image). Right: General photographs of three of the archaeological sites (Source: Parque de las Leyendas, 2014).

3. Materials and methods

3.1. Sample composition

Nine lithic sets were selected, each associated with a different archaeological site, constituting a population of 1257 artifacts that included knapped material and macro-tools (i.e. tools worked on large supports) (Table 1). This paper presents only the analytical results concerning knapped artifacts (n=1108). On the other hand, it should be noted that these artifacts come from both primary and secondary contexts. In the case of

MAC, secondary contexts correspond to architectural fillings. For the functional analysis, only 39 artifacts recovered in primary contexts, identified as activity areas where lithic and ceramic material were found in association, were selected. Because the materials coming from the architectural fillings could predate the building of the structures within which they were incorporated, and because their origins are unknown, they were not considered for technological or functional analysis. The relative chronology of both primary- and secondary-context lithic assemblages was assigned by taking into account the stylistic information provided by the associated ceramics, as well as the construction moments for primary context buildings.

Historically, the main archaeological purpose in studying MAC archaeological sites was the reconstruction of architectural stages and general chronology of those monumental sites (Carrión and Narváez, 2014). Activity areas inside the buildings remain unstudied, this work being one of the first to discuss mobile items. As such, we have proposed general characterizations of the activity contexts of provenance of lithic artifacts as can be seen in Tables 1 and 2.

3.2. Technological analysis

As part of a broad technological methodology (Pérez, 2018), the total artifactual population (n=1108) was subject to macroscopic petrographic, taphonomic, technological production, and techno-functional analyses.

The work began with the macroscopic identification of the large rock families present in each collection. Then, the microscopic analysis of thin section allowed us to determine the specific types of raw material. As for the taphonomic analysis, a detailed observation of the surface of the lithic artifacts was performed, either by naked eye or via binocular microscope. Some of the variables described in Levi Sala (1986), Borrazo (2004) and Weitzel (2012) were taken into account for the recording of the taphonomic observations.

Subsequently, the technological analysis focused on the determination of the initialization and production methods used for the exploitation of the cores and flakes, using a diacritical analysis of the pieces and following a structural classification of, affordance, debitage, shaping, and confection (also called “retouch”) systems (Boëda, 2013; Boëda and Ramos, 2017). These four terms refer to different modes of production. Affordance refers to the selection of techno-functional criteria naturally present in the initial block and which will remain in the finished product since they participate in the functionalization of the piece. Debitage denotes the fractioning of a volume of matter through a panoply of methods into different units of techno-functional criteria and volumes. Shaping refers to the configuration that is invested from the beginning in order to obtain the techno-functional criteria missing in the initial volume. Confection refers to the operation of transformation of supports into tools (Boëda et al., 1990; Boëda, 2013; Boëda & Ramos, 2017).

The tools (n = 497) were subject to techno-functional analysis (Boëda, 1997, 1991, 2013; Lepot, 1993) in order to determine the techno-functional intentions that structure these artifacts. This analysis should not be understood as an integration between technological and traceological observations. The term "functional" is used in the sense of the artifact's structural organization according to its function. Thus, this analysis focused, first, on determining the techno-functional consequences of each technical operation, and second, on determining the *schèmes opératoires* applied to produce such techno-functional consequences.

Techno-functional consequences refer to the effects produced by the mentioned technical operations. The implications are technical at the level of structural configuration (surface types evidenced by each negative of removal), and functional, at

the level of configuration of the transformative part (i.e. cutting edge, cutting wedge, cutting wedge angle, rake and flank face).

After observing these elements, we proceeded to identify hypothetical Techno-Functional Units (UTF): the transformative techno-functional unit (UTFt) or the active portion of the tool plus the edge; the transmitting techno-functional unit (UTFtr) or the intermediate portion transmitting the force from the handle to the UTFt; and the prehensive techno-functional unit (UTFp), i.e. the held portion. Generally, UTFtr and UTFp are difficult to separate, so here they were identified as UTFp. According to the UTF configuration of each tool, the artifacts were grouped into techno-types. A techno-type is defined by pieces with the same number and characteristics of UTFt, and the same position and number of UTFp. Within these techno-types, there are sub-types which correspond to internal variations. In the objects studied, this variation corresponds to the delineation of the cutting edges. The determination of techno-types allows for the identification of groups of artifacts that share the same structural composition and that potentially fulfilled the same functions and functioning. Using this knowledge, the difference in proportions of these techno-types between the studied sites combined with the results of micro-remain analysis contributes to a functional perception of the Maranga toolkits.

Frequency analyses were carried out and a sampling simulation test was applied to evaluate the similarity or difference in the representation of the different techno-types in the studied sites and in different time periods.

3.3. Micro-remain analysis

In order to obtain direct functional information, one piece was selected from each techno-type identified in each of the sites, establishing a sample of 39 artifacts for micro-remain analysis (Table 2). Due to the greater variety of techno-types in the assemblages corresponding to the Early Intermediate Period, this era has a relatively greater representation than the other periods of occupation. All of these artifacts come from primary contexts, associated with walls and ceramic fragmentation.

Table 1. Lithic assemblages studied in the technological analysis and relative chronological association

| N° | Site | Provenance | Context of provenance | Relative chronology | Period (<i>sensu</i> Rowe, 1962) | No. of artifacts | | | | | | | | Total artifacts per lithic assemblage |
|--------------|------------------|--|-----------------------------|---------------------|--|------------------|--------|--------|--------|---------|--------|-------------|---------------------|---------------------------------------|
| | | | | | | Knapped | | | | | | Macro-tools | | |
| | | | | | | Cores | | Flakes | | Tools | | | Total Knapped tools | |
| n | % | n | % | n | % | | | | | | | | | |
| 1 | Huaca El Rosal | UE8, 9 and 10. Occupation floors associated with wall | Indeterminate activity area | ~1800-1400 BP | Early Intermediate Period | 85 | 24.29 | 6 | 2.30 | 79 | 15.90 | 170 | 21 | 191 |
| 2 | Huaca Middendorf | Layers A and B | Building fill | ~1800-1250 BP | Early Intermediate Period - early Middle Horizon | 8 | 2.29 | 7 | 2.68 | 18 | 3.62 | 33 | 6 | 39 |
| 3 | Huaca 33 | UE30 and 31. Occupation floors | Indeterminate activity area | ~1800-1400 BP | Early Intermediate Period | 73 | 20.86 | 53 | 20.31 | 22 | 4.43 | 148 | 33 | 181 |
| 4 | Huaca 58B | Occupation floor associated with a <i>adobitos</i> wall | Indeterminate activity area | ~1800-1400 BP | Early Intermediate Period | 43 | 12.29 | 25 | 9.58 | 10 2 | 20.52 | 170 | 3 | 173 |
| 5 | Huaca 34 | Occupation floor associated with ceramic fragmentation | Indeterminate activity area | ~1050-470 BP | Late Intermediate Period | 26 | 7.43 | 86 | 32.95 | 11 4 | 22.94 | 226 | 12 | 238 |
| 6 | Huaca 43 | Occupation floor associated with ceramic fragmentation | Indeterminate activity area | ~1050-470 BP | Late Intermediate Period | 20 | 5.71 | 16 | 6.13 | 13 | 2.62 | 49 | 4 | 53 |
| 7 | Wall 46A | Tamped floor-seal | Indeterminate activity area | ~1050-470 BP | Late Intermediate Period | 14 | 4.00 | 8 | 3.07 | 10 | 2.01 | 32 | 2 | 34 |
| 8 | Wall 55E | Building fill covering wall | Building fill | ~470-400 BP | Late Horizon | 8 | 2.29 | 5 | 1.92 | 14 | 2.82 | 27 | 1 | 28 |
| 9 | Huaca San Miguel | EU 2 and 7: Occupation floor associated with wall | Indeterminate activity area | ~470-400 BP | Late Horizon | 73 | 20.86 | 55 | 21.07 | 12 5 | 25.15 | 253 | 67 | 320 |
| Total | | | | | | 350 | 100.00 | 261 | 100.00 | 497 | 100.00 | 1108 | 149 | 1257 |

Table 2. Corpus of artifacts analyzed by micro-remains analysis.

| Period (<i>sensu</i> Rowe, 1962) | Site | Provenience | Techno- type 1 | Techno- type 2 | Techno- type 3 | Techno- type 4 | Techno- type 5 | Techno- type 6 | Techno- type 7 | Techno- type 8 | No. of pieces | % |
|--|------------------|--|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------------------|-------|
| Early Intermediate Period | Huaca El Rosal | UE8, 9, and 10 – Occupation floors associated with wall | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 20.5 |
| | Huaca 33 (H33) | UE30 and 31 – Occupation floors | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 6 | 15.4 |
| | Huaca 58B | Occupation floor associated with an <i>adobitos</i> wall | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 6 | 15.4 |
| Early Intermediate Period - early Middle Horizon | Huaca Middendorf | Layers A and B: Building fill | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 5 | 12.8 |
| Late Intermediate Period | Huaca 34 | Occupation floor associated with ceramic fragmentation | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 4 | 10.3 |
| | Huaca 43 | Occupation floor associated with ceramic fragmentation | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 5.1 |
| | Wall 46A | Tamped floor-seal | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2.6 |
| Late Horizon | Wall 55E | Building fill covering wall | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 5.1 |
| | Huaca San Miguel | EU 2 and 7: Occupation floor associated with wall | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 5 | 12.8 |
| Total | | | 7 | 8 | 6 | 8 | 5 | 2 | 2 | 1 | 39 | 100.0 |

The analysis was carried out according to the “multiple analysis of micro-remains” (Coil et al., 2003), which considers the recovery and study of the total set of micro-remains rather than a specific type. This study focused especially on starch grains (SG); however, silicophytoliths (Si), calcium phytoliths (PCa), cellulose rings (C), microcarbons (Mic), diatoms (Di), spherulites (Sph), and silicified tissues (Pte) were also considered in terms of presence and absence.

In the case of our artifact sample, we used a “low impact protocol” composed of two major stages: (1) preparation of a herbarium and histological reference collection from modern plant material (Babot et al., 2016) and (2) recovery, analysis, and identification of the micro-remains preserved in the UTFt of the artefacts (Babot, 2009, 2003; Henry et al., 2009; ICSN, 2011; Madella et al., 2005). At the end of these two stages, the presence of the identified taxa was evaluated, depending on each archaeological period and in relation to the instrumental variability. This evaluation sought to determine the “ubiquity” (Popper, 1988) of these taxa, or the number of times they appeared in the samples (SM 2: Methodology used in the preparation of reference collection and analysis of micro-remain in archaeological residues).

4. Results

4.1. Results of technological and techno-functional analysis

4.1.1. Procurement, management and taphonomy of raw materials

The microscopic analysis of thin sections allowed us to define a particular type of andesite, microporphyritic andesite, as the main raw material for artifactual manufacturing in the MAC (SM 3: Macro and micro petromineralogical analysis). Microporphyritic andesite is ubiquitous in the nine sets analyzed, in the form of ellipsoid cobbles between 50 and 150 mm long, 40 and 120 mm wide, and between 15 and 80 mm thick. Some experimental tests with this type of rock have allowed us to corroborate its adequate quality for knapping, especially due to its aphanitic texture and compact structure. On a relative quality scale of the rock used for knapping in MAC, microporphyritic andesite is the best followed by medium and coarse grain andesites.

At the petromineralogical level, the knapped lithic assemblage of Huaca El Rosal is made up exclusively of local microporphyritic andesite. The management of the andesite corresponds to a predominant selection of oblate ellipsoid cobbles, without fracture planes and with polished neocortex. It was possible to discern a technical adequacy between cores and flakes. Technical adequacy refers to the relationship between the techno-types of removals (inferred through diacritical analysis of the cores) and the flakes actually found at the site. At the taphonomic level, slightly abraded pieces predominate in Huaca El Rosal ($n = 113$, 59%). Likewise, the complete pieces predominate ($n = 117$, 93%), while among the fragmented pieces ($n = 14$, 7%) *snap* fractures are the most frequent, which are probably related to intentional direct percussion.

The data is not very different in the assemblage of Huaca Middendorf, which is also composed entirely of microporphyritic andesite. The variability here comes from a partial technical adequacy between cores and flakes. At the taphonomic level, the slightly abraded pieces also predominate ($n = 25$, 64%) and only two pieces have a *snap* fracture.

On the other hand, in Huaca 33, the variability is expressed in the exploited raw materials. On this site, microporphidic andesite ($n = 123$, 83%), tonalite ($n = 13$, 3%) and fine-grained quartzite ($n = 12$, 2%) were recorded. These rock types are found to form the same types of natural alluvial and coastal deposits as microporphyritic andesite. In general, the same proportions of microporphyritic andesite occur in Huaca

34 (n = 116, 69%), Huaca San Miguel (n = 159, 63%) and Huaca 58B (n = 111, 65%), increasing in Wall 46A (n = 30, 94%). On the contrary, at these last three sites, cobbles seem to have a unique alluvial origin, due to the presence of a slight smoothness on their surfaces, typical of cobbles that can currently be recovered on the river banks of the Rimac.

Similar proportions of microporphyrritic andesite were recorded at Huaca 43 (n = 37, 75%) and Wall 55E (n = 25, 94%), with the only exception of an exploitation of microporphyrritic andesite cores and diorite in the first, without counting on knapped tools on the last.

4.1.2. Debitage: Core initialization and production methods

The 350 cores analyzed allowed us to identify four initialization methods and three production methods in the nine sites studied (Fig. 3).

- The first initialization method (Mi1) corresponds to the opening of a striking platform surface over the selected volume.
- The second method (Mi2) consists in the selection of the lower face of a cobble cortical flake as a striking platform surface.
- The third method (Mi3) corresponds exclusively to the selection of a convex striking platform, a flat flake-release surface, and a thickness (generally between 16 and 25 mm) that allowed for bipolar production.
- The fourth method (Mi4) consists of the peripheral configuration of the flake-release surface and the establishment of an initial striking platform through unipolar removals.

After the initialization phase, the *schèmes opératoires* are organized into relatively short series of removals, following any of three production methods: unipolar, bipolar, and alternate (Fig. 3).

- Mp1 – Unipolar debitage. Linear and non-linear chronology. The removals are made into series in each plane of the volume, successively from left to right or vice-versa, and in an intercropped way, following the guide rib created by the last negative and the adjacent surface. Four variants have been identified: Mp1a, Mp1b, Mp1c, and Mp1d. The technique used is always direct hard percussion.
- Mp2 – Bipolar debitage, produces simple or *split* type removals. The technique used is always direct hard percussion.
- Mp3 – Alternate debitage, produces alternating removals. The technique used is always direct hard percussion.

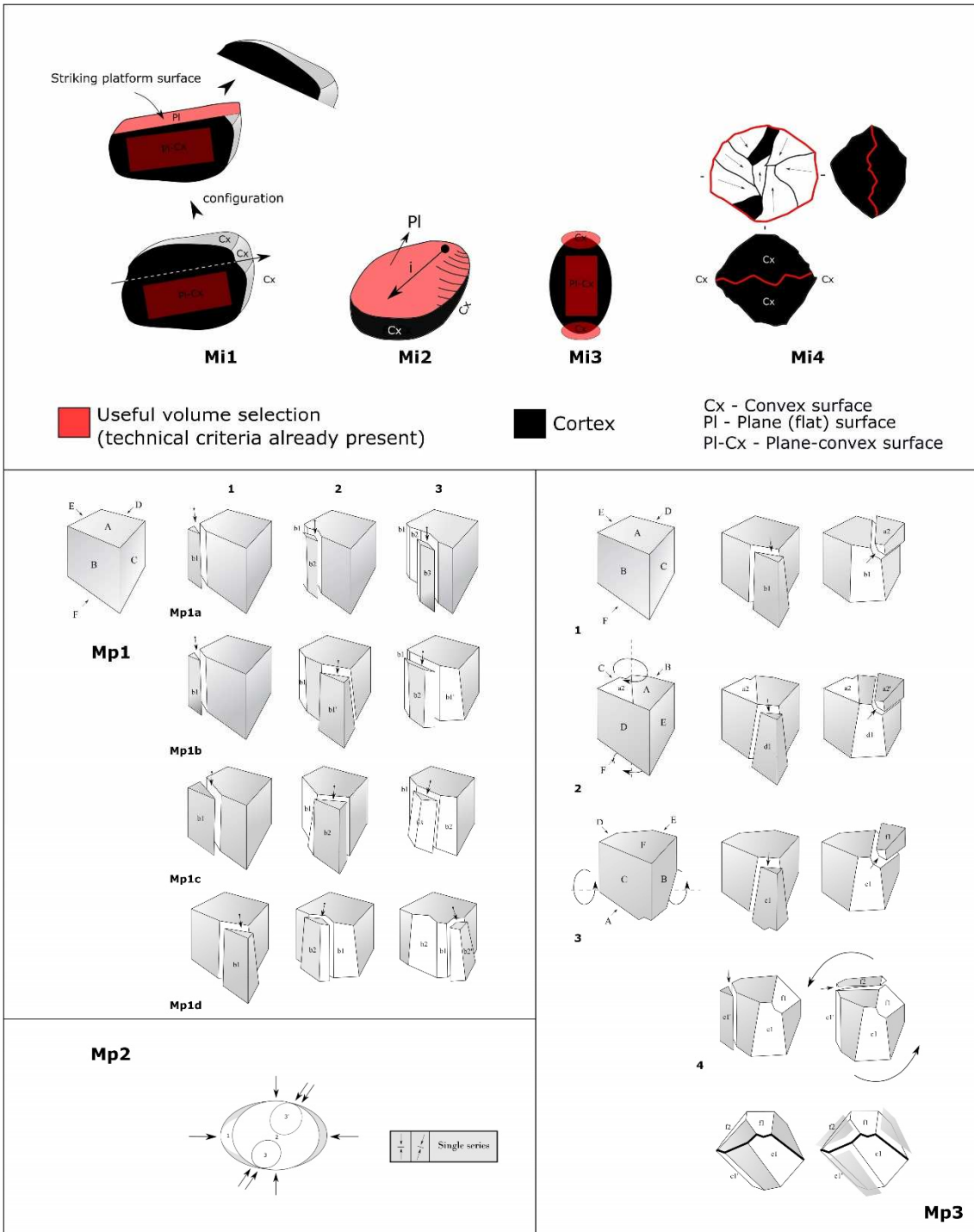


Fig. 3. Core initialization (Mi) and production methods (Mp) used in the Maranga Archaeological Complex.

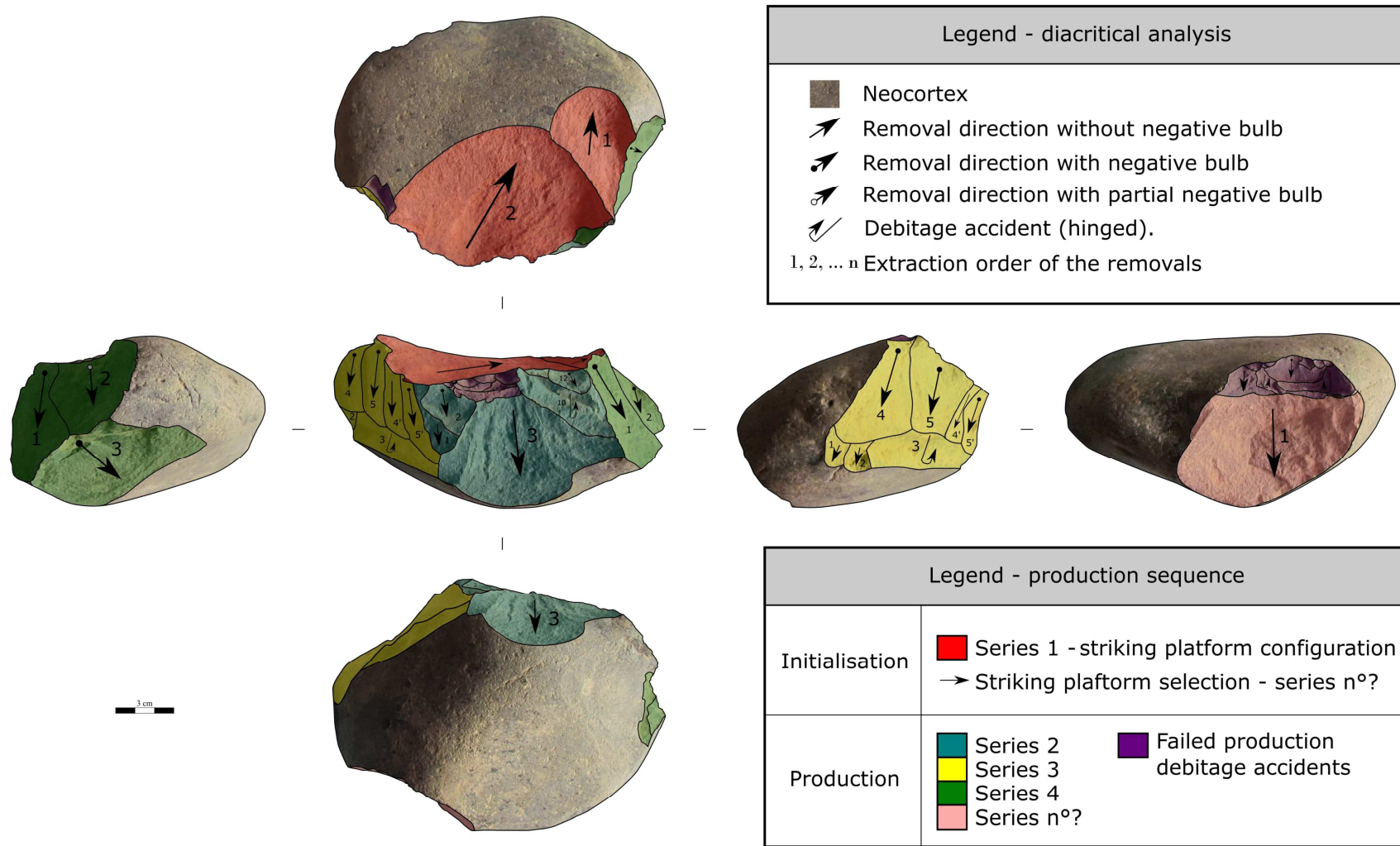


Fig. 4. Core reduction system type C1 (cobble support): example from Huaca San Miguel.

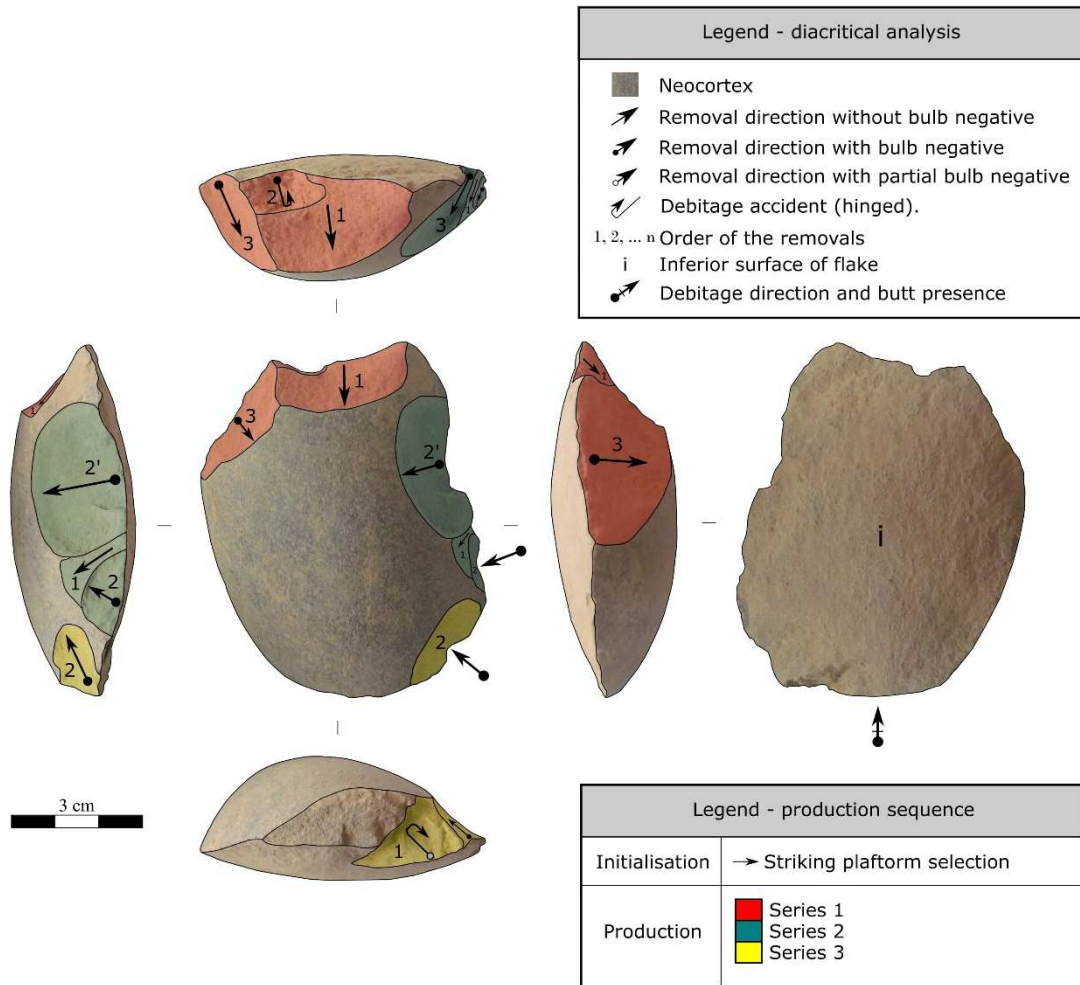


Fig. 5. Core reduction system type C1 (flake support): example from Huaca El Rosal.

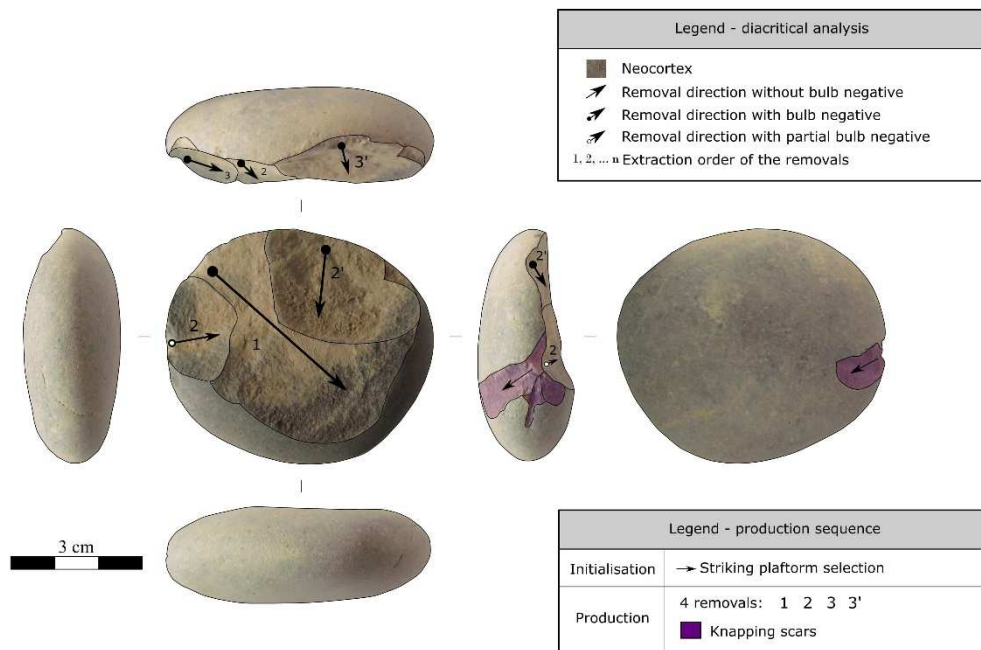


Fig. 6. Core reduction system type F3 (multiple bipolar): example from Huaca El Rosal.

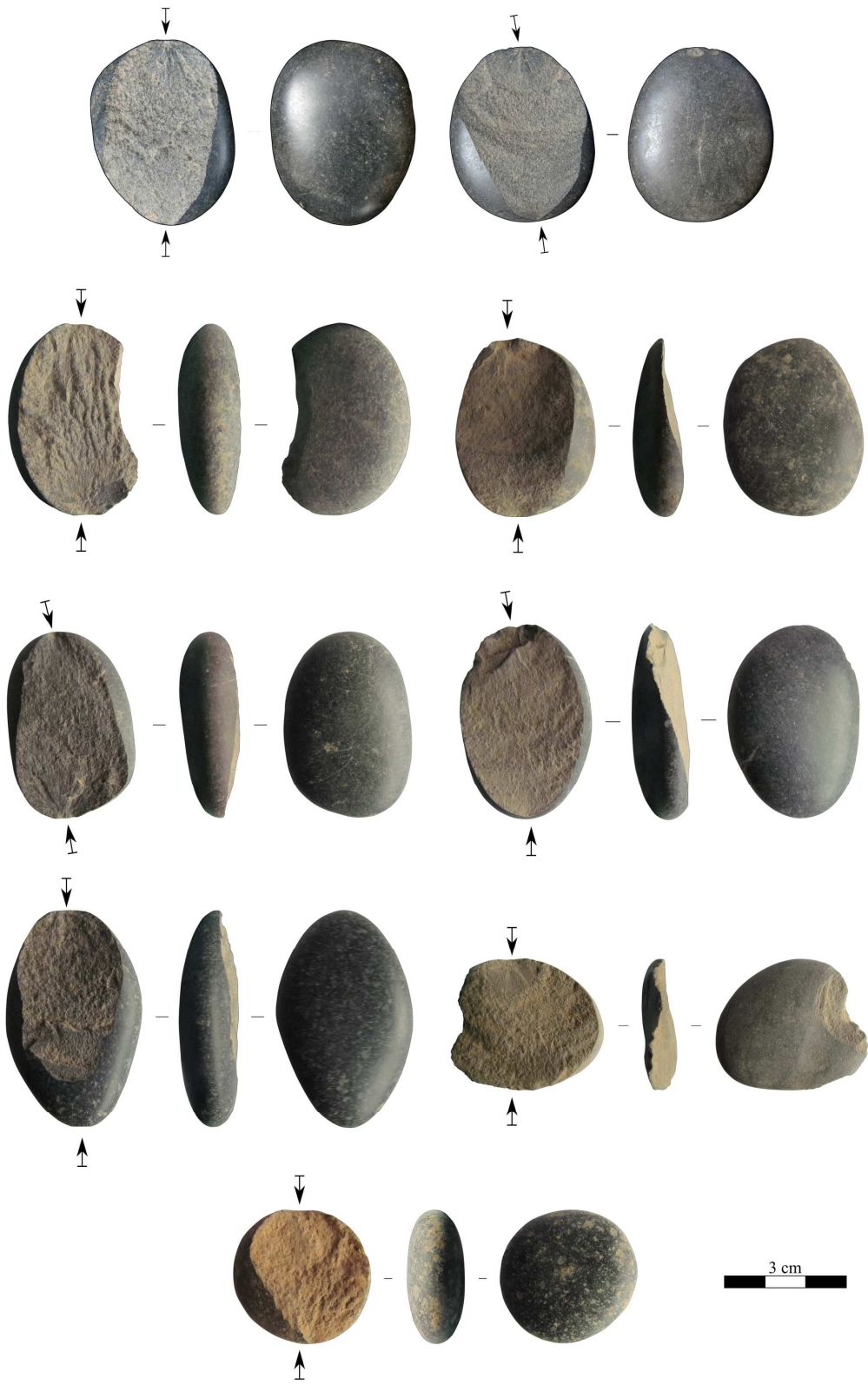


Fig. 7. Core reduction system type F3 (simple bipolar): examples from Huaca 34

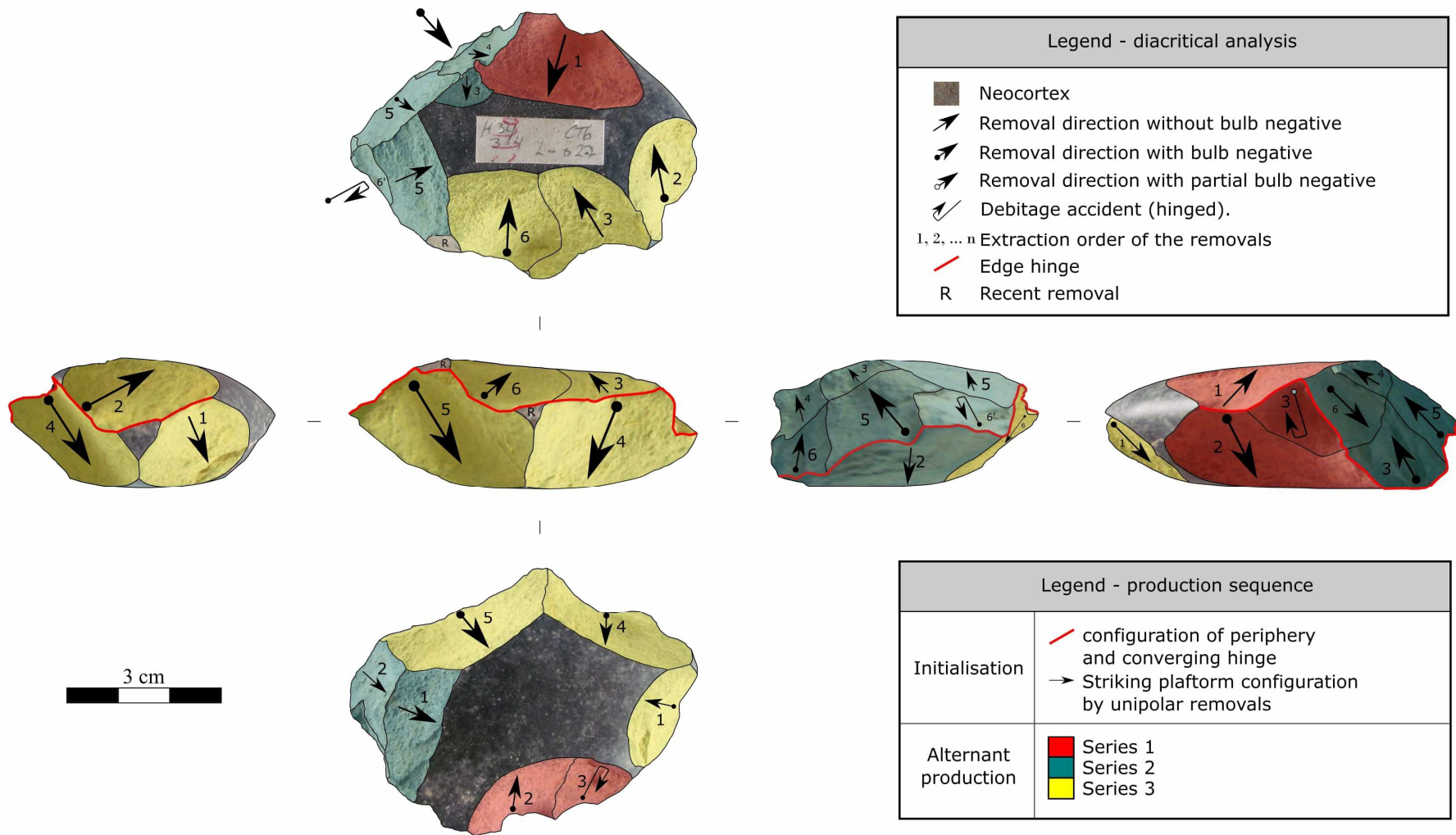


Fig. 8. Core reduction system type D1 (alternating production of quadrangular flakes): example from Huaca 34.

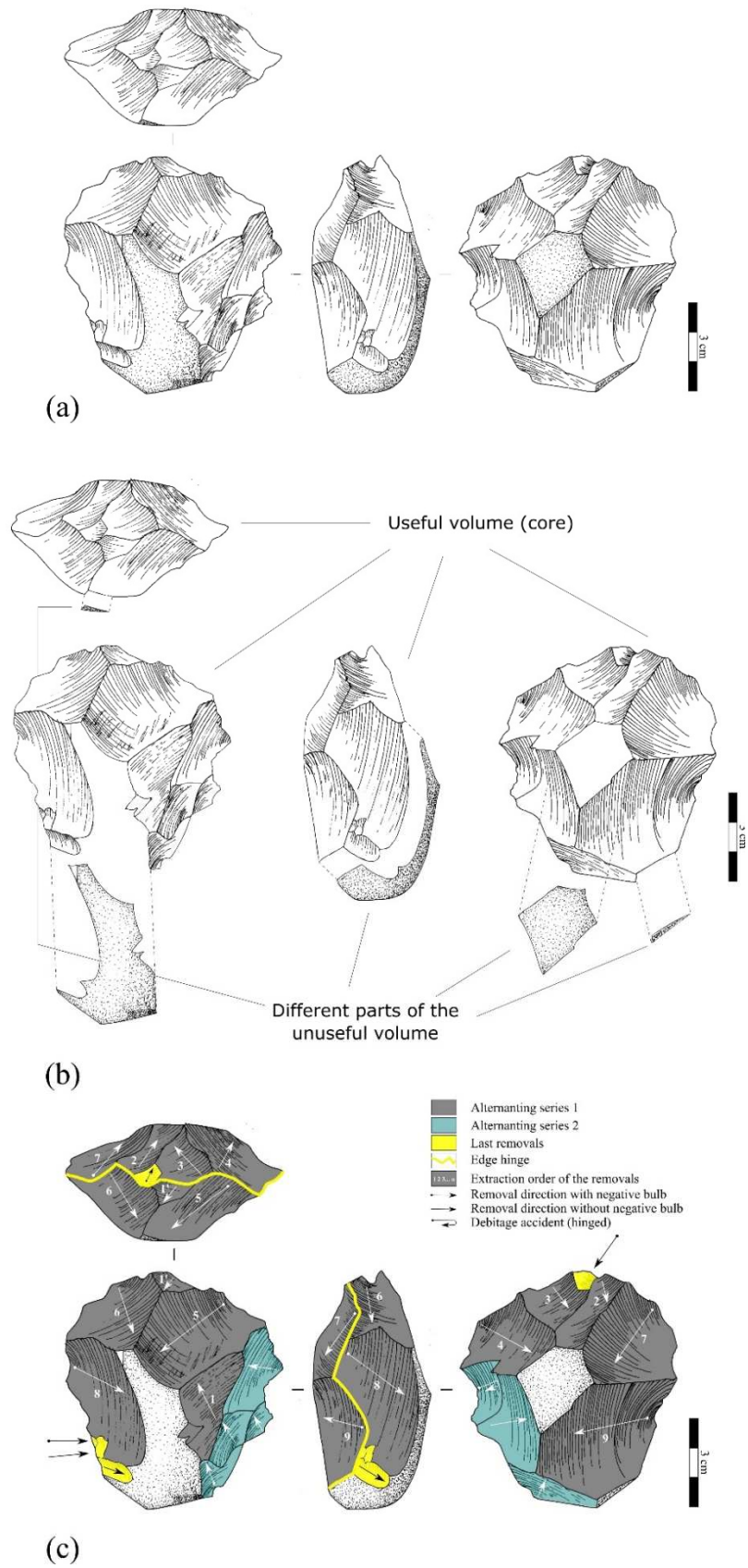


Fig. 9. Core reduction system type D1 (alternating production of quadrangular flakes), example from Huaca San Miguel: (a) traditional drawing, (b) structural analysis, (c) technological analysis. (Modified from Silva, 2014).

4.1.3. Debitage systems

The technical correspondence between the initialization and production methods allowed us to recognize thedebitage systems used in the MAC: C1 (Fig. 4 and 5), F3 (Fig. 6 and 7) and D1 (Fig. 8 and 9).

In Huaca El Rosal, C1 (on flakes and cobbles) and F3 (bipolar) systems were identified. C1 was identified across three different production methods (Mp1a-Mp1c). Likewise, two techno-types of flakes were recognized, corresponding to cortical and semi-cortical flakes. In Huaca Middendorf, the only recognizeddebitage system is C1, with two production methods (Mp1a and Mp1d). A single flake techno-type is present, which corresponds to 7 cortical flakes.

The production methods are diversified in Huaca 33, as C1, D1 (alternating production of quadrangular flakes), and F3 are recorded. C1 includes two production methods (Mp1a and Mp1c). Eight flakes techno-types are present, partially linked to the production methods.

The Huaca 58B site shares the same production characteristics as Huaca 33, with the exception of a smaller number of flake techno-types ($n = 3$). Huaca 34 has the same criteria, although here the flakes do not correspond to the first phases of exploitation of the cores, but rather to a fulldebitage.

In Huaca 43, thedebitage systems are D1 and F3, with 4 techno-types of flakes corresponding to the initial and intermediate stages of production. In Wall 46A, only the C1 system is present, with two production methods (Mp1a and Mp1c). The flakes present correspond to retouch operations and not to the production stage. Similar characteristics are presented in Huaca San Miguel, where production was carried out exclusively using the C1 system, with a single production method (Mp1a).

However, it should be noted that at all sites in the MAC there is a correlation between the size of the cobbles selected and thedebitage system used. For systems C1 (on flakes) and D1, cobbles and flakes between 55 to 65 mm long, 50 to 70 mm wide, and 25 to 30 mm thick were selected. For C1 system (on cobbles), cobbles between 100 to 120 mm long, 140 to 150 mm wide, and 70 to 80 mm thick were used. Finally, in the case of the F3 system, smaller cobbles were used, between 35 to 55 mm long, 30 to 40 mm wide and 15 to 25 mm thick.

Regarding the production objectives of the recognized systems, quadrangular flakes of flat-convex section predominate, between 30 to 80 mm long, 25 to 120 mm width, and 5 to 30 mm thick. These flakes do not present any evidence of shaping or confection. These flakes did not undergo any further configuration into potentially useful tools.

4.1.4. Affordance, Shaping and tool Confection

Prior to the shaping, cobble blanks of microporphyrritic andesite with ellipsoid section were selected, generally between 60 to 80 mm long, 60 to 90 mm width, and between 30 to 50 mm thick. Only techno-type 3 (*ut infra*) is outside these size ranges, since smaller pebbles were selected for its preparation, with between 30 to 40 mm long, 20 to 25 mm width, and between 7 to 15 mm thick.

The techno-functional criteria of the future tools come from this selection time. These criteria reveal an almost completely concentrated affordance in the UTFp.

In general, shaping *schèmes* involved two or three partial removals on both sides of the cobble, in order to configure an asymmetric cutting dihedral composed of a flat bottom surface and a convex top surface. This was followed by a confection stage corresponding to the unifacial retouching of these dihedrals, forming abrupt angles (between 70° and 80°).

In all the tools analyzed (n = 497), 528 UTFt were identified, with denticulate, convex, concave, pointed, and rectilinear delineation. Among these shapes, denticulate delineation was predominant (n = 291, 58.55%). The UTFp identified (n = 502) have a great technical homogeneity, mostly corresponding to the cortical part of the worked cobbles, with an ellipsoid section composed of two rounded edges in a position opposite to the UTFt. The edges of this ellipsoid section were parallel, divergent, or convergent, although divergent edges predominated. In some cases (n = 102, 20.31%), the UTFp were subject to configuration, always through short removals by unifacial shaping.

By grouping the observed UTFt and UTFp, eight techno-types were determined (Fig. 10), of which the first six have only one UTFt, while the last two (techno-types 7 and 8), have two or more UTFt. It should also be noted that techno-types 7 and 8 were configured on thick flat-convex flakes using the C1 debitage system.

After the techno-type frequency was considered across the studied sites (SM 4: Frequency of techno-types by archaeological site), a predominance of techno-types 1 to 4 became evident, while techno-types 5 to 8 are present in low numbers. In addition, no techno-type was present across all sites, although techno-type 4 occurs at all sites with the exception of Wall 55E.

| Techno-types | Structural description | | Schematic illustration |
|--------------|--|---|------------------------|
| 1 | 2 sub-volumes + converging or parallel edges + 1 denticulate UTFt / sawtooth edge + 1 convex afforded UTFp Bifacial shaping UTFt angles: 70 °, 60 °, 50 ° | | |
| 2 | 3 sub-volumes + parallel edges + 1 denticulate UTFt + 1 confectioned UTFp Bifacial shaping UTFt angles: 75°, 60°, 65° | | |
| 3 | 2 sub-volumes + converging edges + 1 convex afforded UTFp Unifacial shaping | (3a) + 1 concave UTFt UTFt angles: 50° | |
| | | (3b) + 1 pointed UTFt (<i>bec</i>) angles: 75°, 80° | |
| 4 | 2 sub-volumes + converging edges + 1 rectilinear UTFt + 1 convex afforded UTFp Unifacial shaping UTFt angles: 60°, 65°, 75° | | |
| 5 | 2 sub-volumes + converging edges + 1 UTFt denticulate + 1 convex afforded UTFp Bifacial shaping UTFt angles: 75° | | |
| 6 | Modular support + 1 denticulate UTFt + 1 confectioned UTFp Bifacial shaping UTFt angles: 75° | | |
| 7 | Modular support + 1 UTFp opposed to denticulate UTFt + 1 UTFp opposed to a potential concave UTFt Unifacial shaping Denticulate UTFt angles: 70°, 75° Concave UTFt angles: 70° | | |
| 8 | Modular support + 2 UTFp opposed + 2 denticulate UTFt + 2 rectilinear UTFt Unifacial shaping Denticulate UTFt angles: 70° Rectilinear UTFt angles: 75°, 80° | | |

Observed UTFt
 Hypothetical UTFt
 Observed UTFp
 Hypothetical UTFp
 Proposed prehensile zone

Fig. 10. Description of techno-types in the Maranga Archaeological Complex.

In the stage of data exploration, we obtained 497 records referring to the sites and techno-types present in them. This classification was found with a non-normal behavior. Table 3 shows that this classification does not meet the assumption of the minimum expected frequencies of 5. Therefore, in order to conclude on the relationship between sites and techno-types, the bootstrap resampling method was conducted on a simulation based on 5000 samples (Table 4). The results reaffirmed the existing relationship between sites and techno-types, as observed with an association based on a Cramér's V value of 0.667. With these results, Fig. 11 shows a correspondence analysis made from the four sites with the most pieces. Huaca San Miguel has the greatest presence in relation with techno-type 2, Huaca 34 with techno-type 4, while Huaca el Rosal and the Huaca 58B are associated with techno-type 1.

Table 3. Test of relationship between sites and techno-types before resampling.

| | Chi-squared test | | |
|------------------------------|----------------------|-------------------------|-------------------------------------|
| | value | degrees of freedom (df) | asymptotic significance (bilateral) |
| Pearson's chi-squared test | 221.339 ^a | 56 | .000 |
| Likelihood ratio | 230.114 | 56 | .000 |
| Linear-by-Linear Association | .066 | 1 | .798 |
| Number of Valid Cases | 497 | | |

a. 51 cells (70.8%) have expected a count less than 5. The minimum expected count is .02

Table 4. Degree of association between sites and techno-types after simulation.

| | Sampling simulation for symmetric measurements | | | | |
|-----------------------------------|--|------|------------|----------|----------|
| | sampling simulation ^a | | | | |
| Nominal-by-nominal | Value | Bias | Dev. error | Inferior | Superior |
| Phi correlation coefficient (phi) | .667 | .045 | .040 | . | . |
| Cramér's V | .252 | .026 | .018 | . | . |
| Contingency coefficient | .555 | .024 | .021 | . | . |
| Number of Valid Cases | 497 | 0 | 0 | . | . |

a. Unless otherwise indicated, sample simulation results are based on 5000 sample simulation samples.

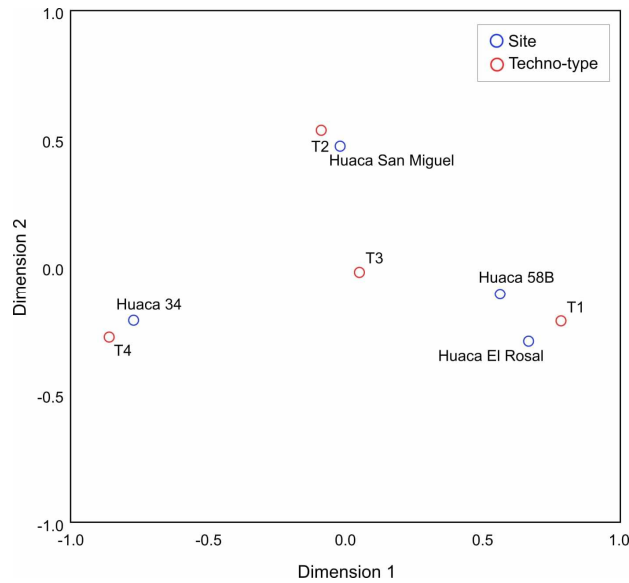


Fig. 11. Diagram of correspondence between sites and techno-types.

Amongst the identified techno-types, techno-type 8 is represented by a single piece (Fig. 12), recovered in Huaca El Rosal. The diacritical analysis of the piece allowed us to recognize that its production involved organized removals to shape the lateral and central surfaces of the flake support from an unmodified flat surface. The confection stage involved the modification of four isolated areas in order to establish four different UTFt. It is a tool matrix. Each of the UTFt presents evidence of reshaping and resharpening, as shown by large reflected removals.

As an example of the techno-functional analysis carried out in all the pieces, Fig. 13 is presented, where there is an instrumental coexistence between the three main principles of affordance, debitage via bipolar production, and shaping.

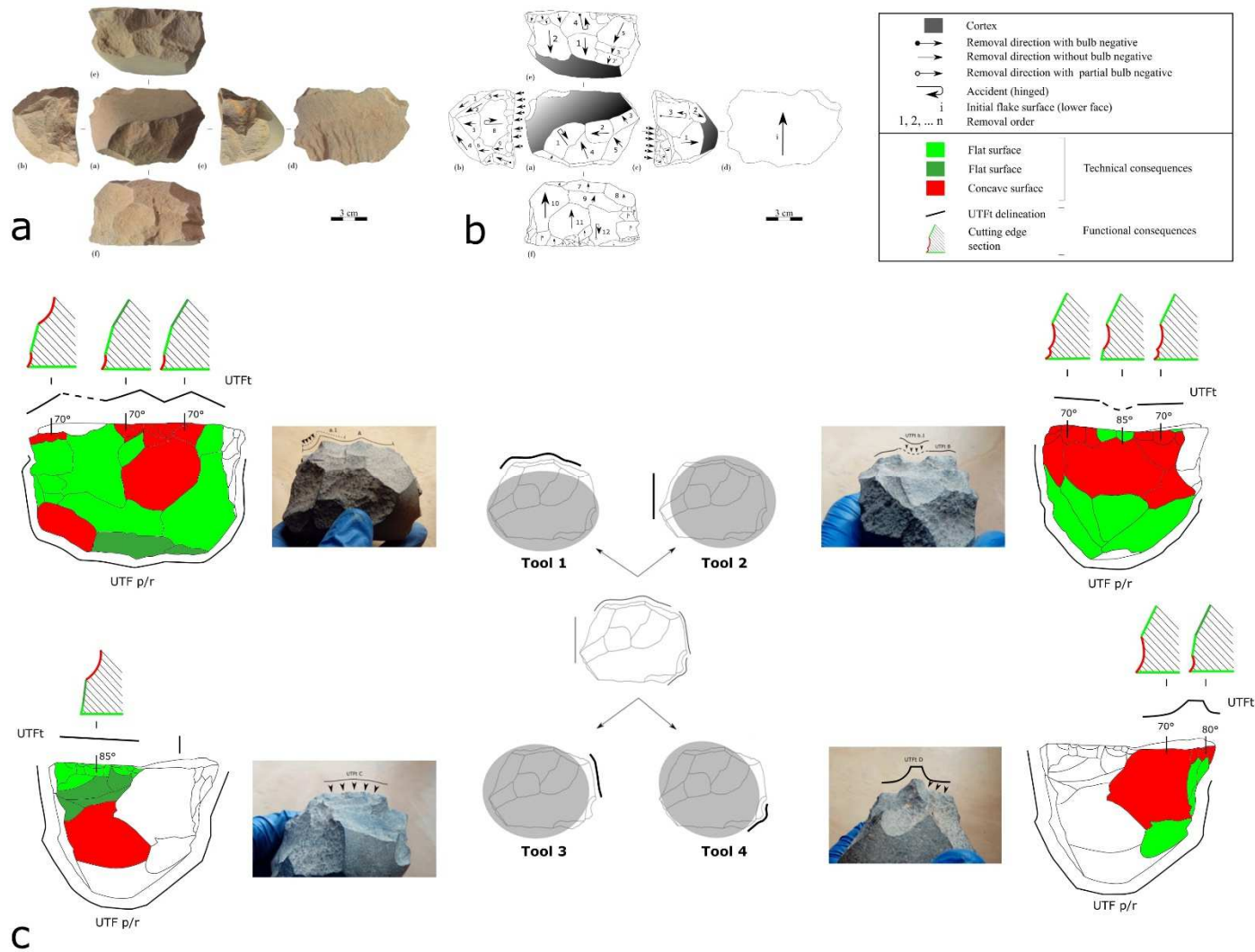
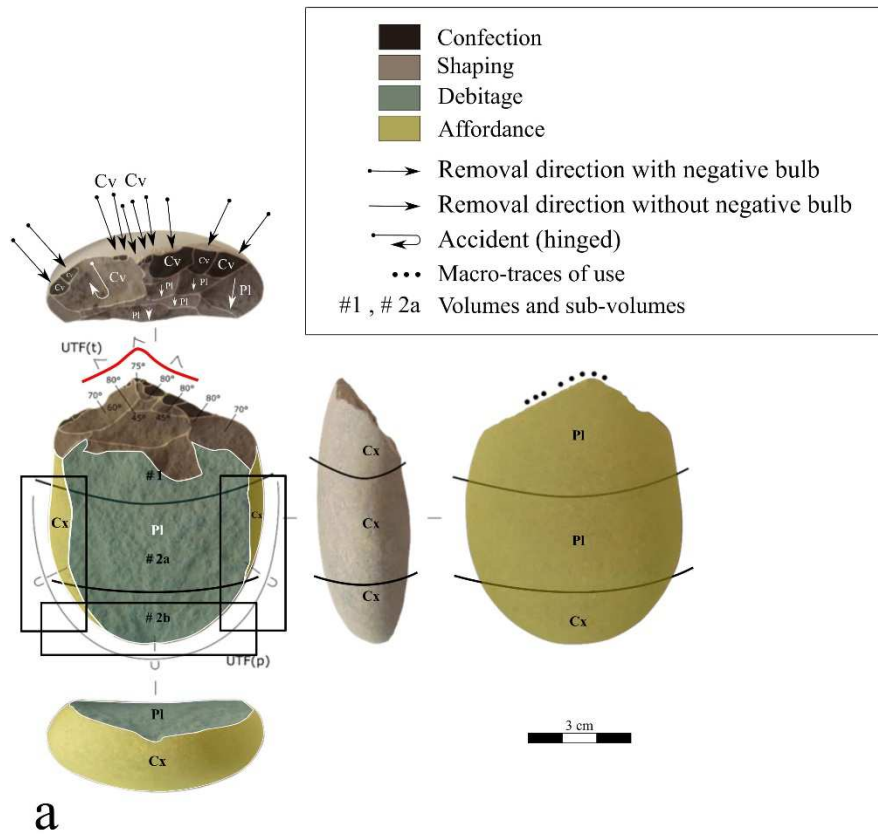
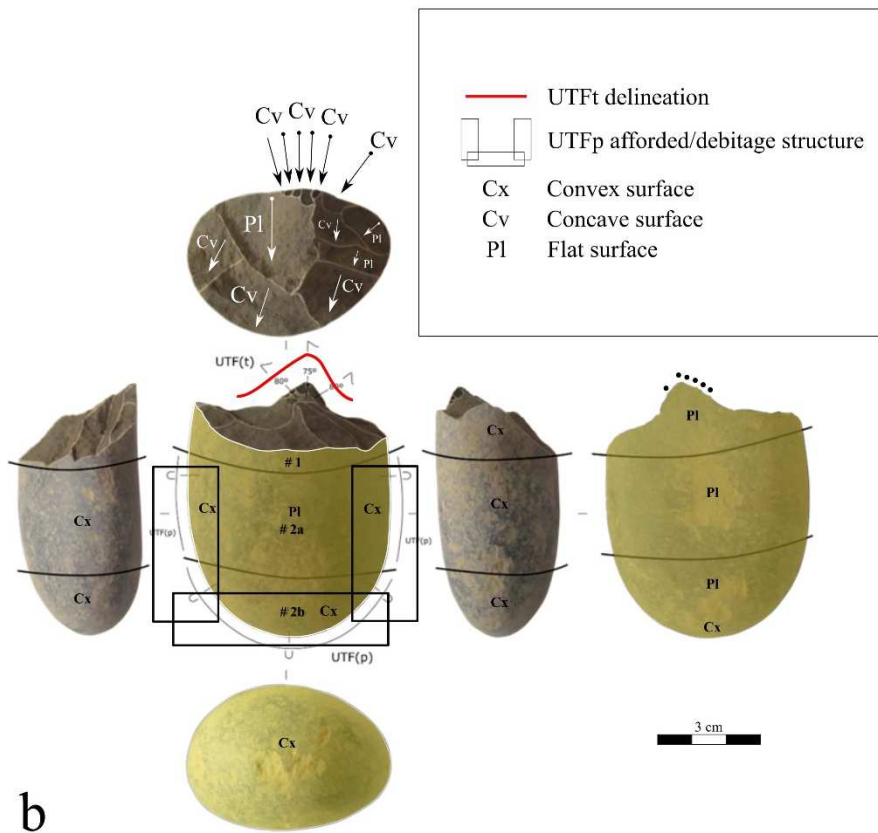


Fig. 12. Techno-type 8, Huaca El Rosal: (a) Photograph of the piece, (b) diacritical analysis, (c) techno-functional analysis.



a



b

Fig. 13. Techno-functional analysis of two tools that correspond to techno-type 3b (*becs*). (a) Instrumental coexistence of affordance, debitage and shaping. (b) Instrumental coexistence of affordance and shaping.

4.2. Results of the plant micro-remain analysis

In the 39 artifacts analyzed, five morphotypes of starch grains, two morphotypes of silica phytoliths, and one related to silicified plant tissues were identified. The total distribution of plant micro-remains and the corresponding taxonomic assignation is shown in Table 4 (SM 5: Description of morphotypes).

Table 4. Total plant micro-remains and taxonomic assignation in the artifactual sample.

| Taxonomic assignation | | | | Type and amount of micro-remain | | | | | | | | TOTAL | Frequency (%)* | Ubiquity* |
|-----------------------|---------------|--|---|---------------------------------|-----|-----|----|-----|-----|----|----|-------|----------------|-------------|
| Order | Family | Genre / Species | Common name | SG | Sip | PCa | Ti | Mic | Sph | CR | Di | | | |
| Fabales | Fabaceae | <i>Caesalpinia spinosa</i> (Molina) Kuntze | Tara | 73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 33.0 | 0.33 (N=13) |
| | | <i>Prosopis</i> sp. | Carob (Algarrobo) | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 5.1 |
| Poales | Poaceae | <i>Zea mays</i> L. | Maize (Maíz) | 28 | 58 | 0 | 9 | 0 | 0 | 0 | 0 | 95 | 17.9 | 0.18 (N=7) |
| | | Indeterminate | - | 6 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 5.1 | 0.05 (N=2) |
| Cucurbitales | Cucurbitaceae | <i>Cucurbita</i> sp. | Wax gourd (Calabaza blanca, chiclayo, lacayote) | 13 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 7.7 | 0.08 (N=3) |
| N.I. (Not identified) | | | | 32 | 71 | 10 | 84 | 17 | 16 | 20 | 18 | 278 | - | |
| TOTAL | | | | 177 | 140 | 10 | 93 | 17 | 16 | 20 | 18 | 491 | - | |

* Percentage is calculated as the proportion of the artifacts analyzed that have plant micro-remains of the taxa. Ubiquity is calculated by dividing the number of artifacts in which the taxon is recorded by the total number of artifacts in the sample group, i.e. n=39.

6.2.1. Content of micro-remains at the assemblage level

The microfossil fertility was established as a variable character in the different artifact analyzed, ranging from less than 5 to more than 25 plant micro-remains counted per artifact (SM 6: Contents of plant micro-remains by techno-type in each assemblage analyzed). From those, diagnostic microfossils allowed for the identification of four plant taxa in the artifactual residues. Figure 14 shows the correspondence relationship between techno-types and taxa (SM 7: Taxa frequency by techno-type).

Concerning Huaca El Rosal, a greater amount of SG was observed, although the amount of Sip is equally important. Specifically, the SG of *Caesalpinia spinosa* was predominantly found in techno-types 1 and 2, the SG of *Zea mays* was found in low proportion in techno-types 2 and 5, and the SG of *Cucurbita* sp. have been recorded in significant quantities in techno-types 3 and 4. With respect to Sip, only *Zea mays* could be identified in techno-type 5. Sph was not present in any analyzed artifact, so fecal contamination is ruled out. The results of the plant micro-remains analysis of the UTFt identified from the techno-type 8 are presented in Fig. 15.

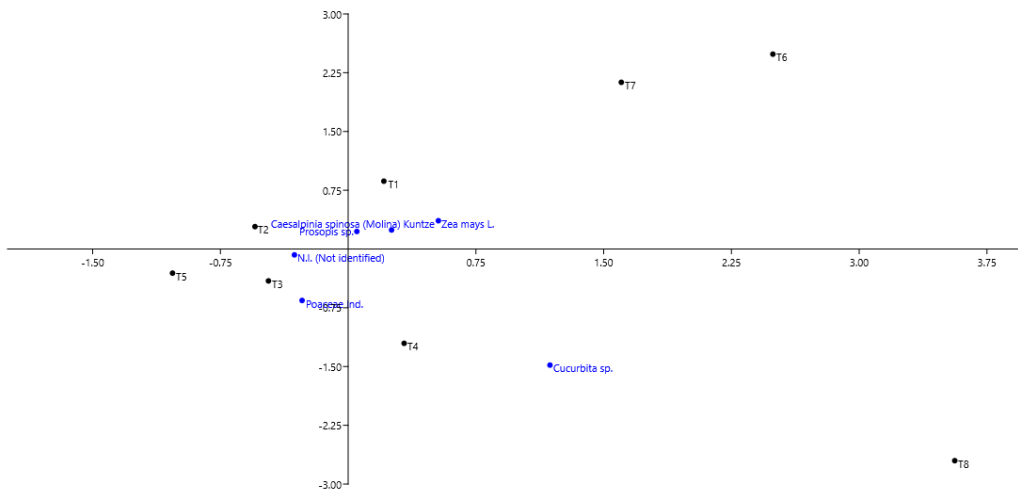


Fig. 14. Correspondence analysis between techno-types and identified plant taxa.

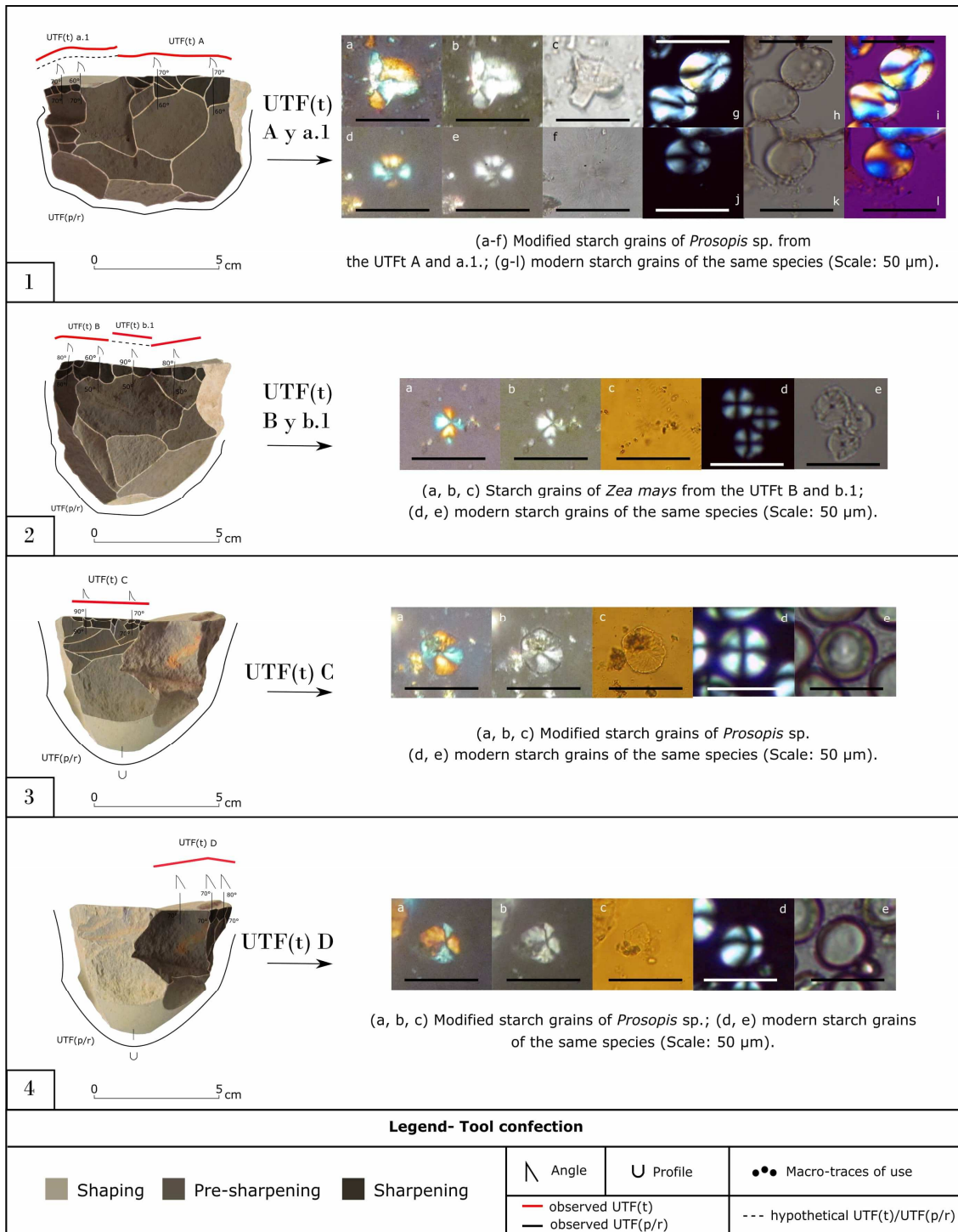


Fig. 15. Huaca el Rosal, Techno-type 8, plant micro-remains analysis by UTFt. The legend for the tool confection also applies to the following figures 16, 17, and 18.

Meanwhile, the assemblage from Huaca Middendorf has a greater amount of Sip, although the amount of SG is significant. Sph was not present in any analyzed artifact. In this assemblage, the SG of *Caesalpinia spinosa* predominate in the techno-types 1, 2, and 3. The SG of *Cucurbita* sp. are found in techno-type 4. On the other hand, the Sip and Ti of *Zea mays*, are present also in techno-type 4.

The assemblage from Huaca 33 has a greater amount of SG, followed by Sip. In this assemblage, the SG of *Caesalpinia spinosa* are predominant, and they are present in

all techno-types except for 1 and 4. Only in two techno-types (2 and 3), *Zea mays* Sips are associated with the SG of *Caesalpinia spinosa*. The example is techno-type 7 (Fig. 16).

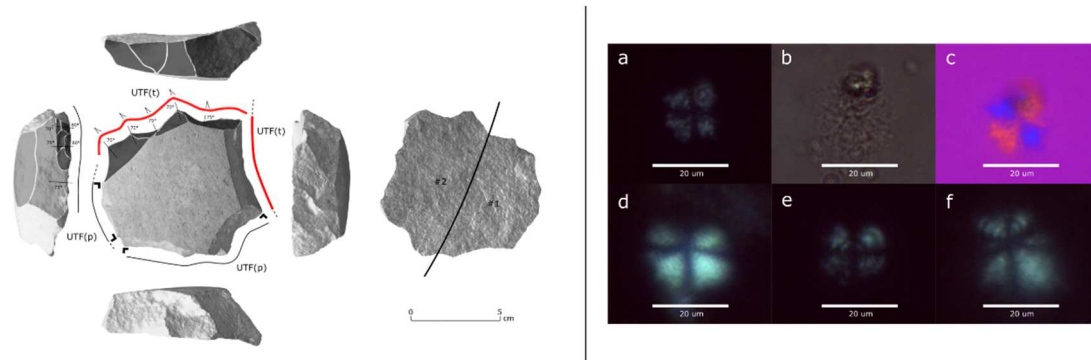


Fig. 16. Huaca 33, techno-type 7, plant micro-remains recovered from both UTFt; taxonomic assignment (a-c): SG of *Caesalpinia spinosa*. (d-f) Modern SG of the same species. The white color of the tool corresponds to a modification of the original, in order to better observe the removal negatives.

The Huaca 58B assemblage has a predominance of SG, followed far behind by the Ti, Sip, and CR. In this assemblage, the SG of *Caesalpinia spinosa* are present in techno-types 1, 2, and 3. In Huaca 34, the distribution is similar to Huaca 58B, with the exception that only techno-type 1 has SG of *Caesalpinia spinosa*, in addition to Sip of Poaceae. On the other hand, techno-type 3 registers SG of *Prosopis* sp. In Huaca 43, there is a greater amount of Sip. It was only possible to identify SG of *Caesalpinia spinosa* in techno-type 4 (Fig. 20).

On the other hand, the Wall 46A assemblage, represented only by techno-type 4, has 14 SG, all probably belonging to modified (fermented) *Zea mays* (Fig. 17).

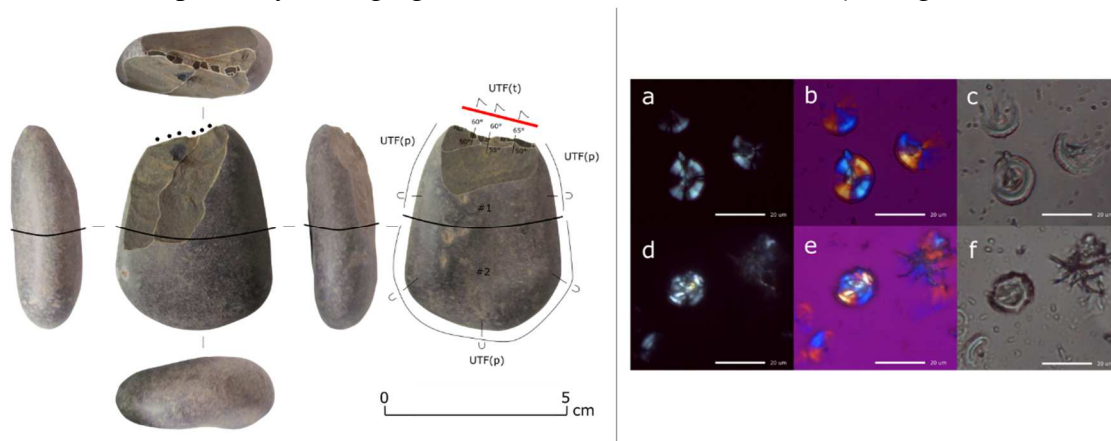


Fig. 17. Wall 46A, Techno-type 4, (a-f) probable modified SG from *Zea mays*, recovered in the single UTFt.

Likewise, the Wall 55E assemblage has a strong proportion of Sip (n = 31), all assignable to *Zea mays*, registered in both techno-type 1 and 2 (Fig. 18).

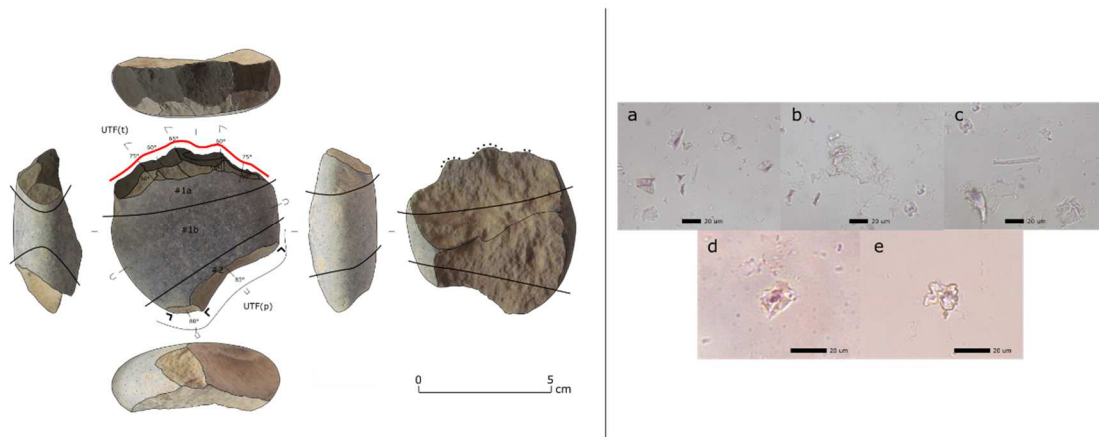


Fig. 18. Muralla 55E, Techno-type 2, plant micro-remains recovered in the single UTFt, possibly of *Zea mays* (“maize”): (a, b) rondel, flat rondel and killed rondel; (d) tetra-lobate (crosses) and rondel silica short cell, (b, e) tetra and poli-lobate silica short cells, (c) hair cell mesophyll.

Finally, the assemblage corresponding to Huaca San Miguel has a greater number of Ti ($n = 17$), followed by Sip ($n = 12$), GA ($n = 10$), Esf ($n = 11$) and CR ($n = 3$). Di and Mic are not present in any analyzed artifact. The SG of *Caesalpinia spinosa* and the Sip of Poaceae predominate.

The percentage and ubiquity analysis establishes a greater presence in the case of *Caesalpinia spinosa* (33% and 0.33, respectively), followed by *Zea mays* (17.9%, 0.18). Although *Caesalpinia spinosa* occurs in all the techno-types analyzed, its presence predominates in the techno-types 1 and 3, with different UTFt.

Discussion and Conclusions

From a diachronic perspective, it can be noted that during the earliest periods (Early Intermediate Period and initial Middle Horizon), Maranga artisans selected ellipsoid cobbles of very fine-grained andesite (microporphyrritic andesite) from the alluvial deposits around the Rimac River and from the nearby Pacific coast. However, towards the final periods of occupation (Late Intermediate Period and Late Horizon), there is a diversification of raw materials, and a change in the use of sources.

The natural presentation of the raw material offers the necessary technical criteria to materialize the techno-functional intentions. In addition, the selection operated, in all cases, towards the collection of hard and solid rocks, among which microporphyrritic andesite stands out for its conchoidal fracture and excellent knapping quality.

The industries analyzed are governed in a very marked way by the conceptions of affordance (concentrated in the UTFp), debitage (production of flakes of flat-convex section) and shaping (confection of UTFt). These assemblages are a clear example of the phenomenon of false homothety, that is, an apparent homogeneity of UTFp forms and volumes (Boëda, 2013, p. 92). The utility of quadrangular flakes produced by the identified debitage systems is still unclear, with the exception of the use of flat-convex and thick cortical flakes from the C1 system for techno-types 7 and 8.

With respect to the debitage systems used, it can be seen that systems C1 (unipolar), D1 (alternating production of quadrangular flakes) and F3 (bipolar) are present in all periods of MAC cultural sequence, and in almost all of the sites. Possibly, the absence of systems D1 and F3 in Walls 46A and 55E can be explained by their particular functionality as defensive structures, rather than putative processing areas. Given a site's general functionality, we might expect that artifacts recovered from these sites are related to that purpose or perhaps with tasks occurred during its construction. However, no data allows us to conclude this. Moreover, the strong presence of D1-type cores in sites such as Huaca 34 and Huaca 43, allows us to state that this concept of production has its peak in the Late Intermediate Period (~1050-470 BP).

Regarding the techno-functional relationship without considering the archaeological periods, the statistical analyzes performed allow us to preliminarily indicate that in Maranga, techno-types 1 and 3 are more related to *Caesalpinia spinosa* processing, techno-type 2 to *Prosopis* sp., techno-types 1, 2, 4 and 6 to *Zea mays* L., and techno-types 3 and 4 to *Cucurbita* sp. Taking into account the diachronic dimension, during the Early Intermediate Period and the beginning of the Middle Horizon, the use of seven techno-types for the processing of a single resource is recorded, *Caesalpinia spinosa* (commonly called the tara plant): techno-types 1, 2, 3, 5, 6, 7, and 8. In the Late Intermediate Period, techno-type 1 was still used, but a new one was also used – techno-type 4. In the Late Horizon, only techno-types 2, 5, 6, 7 and 8 were used to process this plant resource. The *tara* is an ornamental tree or shrub that grows wild normally between 800 and 2800 meters above sea level and also does so under cultivation (De la Cruz, 2004). In the cases studied, the *tara* record corresponds to the processing of pods and/or seeds where dehydrated, minimally birefringent, and fractured starches indicate a crushed or ground process (Babot, 2003). This becomes relevant because it is related to the two useful parts of the plant.

Modern uses of crushed or pulverized *tara* include integration into food processing chains, traditional medicines, and artisanal products (Cordero, 2015; Melo et

al., 2013). Normally, the pods are picked by hand to aid the drying process before they are transformed. Furthermore, *tara* gum is a yellowish white powder with no smell and no taste, fully soluble in hot water and partially soluble in cold water. This gum is composed of polysaccharides, mainly high molecular weight galactomannans, which is an additive or thickener and food stabilizer in the modern industry. It is obtained by reducing the seeds to flours. The presence of tannins in the pods has been exploited at least since colonial times in the elaboration of a black dye. They are also used in leather tanning. The artisanal process in both cases involves crushing the pods. Another component of the fruit is gallic acid, an active antimicrobial substance used in traditional medicine (De la Cruz, 2004). The infusion of mature pods is also used to heal wounds and reduce fever. Due to both the binding capacity of *tara* gum and the presence of tannins, these fruits constitute modern additives in the paint industry, which suggests a potential similar use in pre-Hispanic occupations.

There is also a (albeit smaller) recurrence of *Prosopis* sp. and *Zea mays* amongst the residues, corresponding at least in one case (Wall 46A) to the presence of starch. This starch shows damage compatible with the fermentation of the grain, in particular the occurrence of radial fissures and the presence of grains with a remaining annular thickening (Gardiman, 2014), a situation that indicates the maize *chicha* spill (Table 5). The evidence of *Prosopis* sp. could come from the processing of the pod for a variety of possible uses, with starches of this genre showing damage related to dehydration and mashing, such as cracks, loss of relief and shine, and structure damage evidenced in the partial loss of birefringence (Babot, 2003). On the other hand, the presence of graminoid silica phytoliths (Poaceae) is cautiously assignable here to the contribution of the natural vegetation cover at the site, both contemporary and ancient, mainly *Stipa* sp.

Of the microscopically identified families, Fabaceae, Cucurbitaceae, and Poaceae were also registered as plant macro-remain in the MAC (Bellido, 2014). Both the macro- and the micro-remains from the residues in the lithic artifacts indicate that the plants were being processed, consumed, used, and discarded inside these monumental buildings, further indicating the activities that were carried out in them during the construction stages themselves or after them. These activities include the preparation and consumption of fermented foods and beverages. Also, these remains suggest the eventual use of these areas for medicinal preparations or the extraction of tannins and gums from the *tara*, and possibly the elaboration of other products from these substances. These products could be used for artisanal purposes, as in the case of tannins for leather tanning and the elaboration of black dyes, or for constructive ends in the case of gums as binder in pigment mixtures for wall paintings or plasters. They could also have been used in the food itself, in the case of gum as a thickening or stabilizing additive.

Various recurrent plant macro-remains come from Huacas 34, 43, and San Miguel (Manrique, 2012, 2011). Most of the identified taxa correspond to a variety of cultivated foods that include fruits, grains, legumes, vegetables, roots, rhizomes, tubers, and condiments. Within the condiments we have mainly *Arachis hypogaea*, *Capsicum* sp., *Canna indica* and *Cucurbita* sp. Wild foods have also been identified: fruits such as pacaes (*Inga* sp.), lúcumas (*Pouteria lucuma*), and algarrobo (*Prosopis juliflora*); algae such as *Condracanthus chamissoi*, among others. Similarly, plant remains that would be used in construction and craft work such as woods, reeds (*Gynerium sagittatum*, *Phragmites australis*), juncos (*Cyperus* sp.), totoras (*Typha* sp.), calabazas (*Lagenaria*

siceraria) and cotton (*Gossypium barbadense*) compose the archaeobotanical ensembles of MAC (Bellido, 2014).

In relation to the results of this work, we highlight that all the taxa recovered as micro-remains in the lithic tools were also recovered as plant macro-remains at the MAC sites. In particular, *Caesalpinia* sp. macro- and micro-remains were found in the same building, that is Huaca San Miguel (Bellido, 2014).

The registration of these taxa is consistent with the information provided by the chroniclers of the Indies who indicated that the *algarrobos* and the *tara* were among the trees that made up the riparian forests in the coastal zone upon the arrival of the Spanish (Rostworowski, 2005), and that they constituted a local resource, like the maize that was cultivated under irrigation in the area (Rostworowski, 1978).

It becomes evident, then, that as time went by, Maranga's inhabitants continued to process the same main resource (*Caesalpinia spinosa*), but with less variability in techno-types and, consequently, with greater standardization in techno-types, particularly techno-types 2, 5, and 8. In other words, it is likely that an instrumental standardization occurred in the MAC towards c. XV A.D.

Finally, the techno-functional and plant micro-remain analyses taken together have allowed us to question previous approaches that, only from a partial typological or technological perspective, categorized these assemblages as expedient, archaic, poorly elaborated, and without greater evolution (Taschini, 1968). Our research, however, has made evident the significant techno-functional variability in the MAC's archaeological sequence. The results show that the lithic artifacts studied respond to a thorough selection of technical criteria, that is a volumetric and functional configuration specific to certain processes, and, therefore, were manufactured following a logical and highly effective project.

Additionally, toward c. XV AD political or social constraints –as cultural preferences— could condition the manufacturing of lithic tools by driving into a technological standardization, at the same time that plant processing become more diverse. This makes sense when considering that the MAC area was under the influence of the Inca State during the Late Horizon.

This study has proposed one of the first approaches to mobile items present inside the monumental sites of the Peruvian Central Coast. Beyond specifying some of the artifact classes and plants that were being used, as well as changes in usage trends over the course of more than a dozen centuries in the MAC sites, this research raises new questions about the cultural processes and preferences that conditioned the technological choices we have recorded and the need to explore in detail the activity areas and the materials inside the monumental buildings.

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