Crafting Pastime

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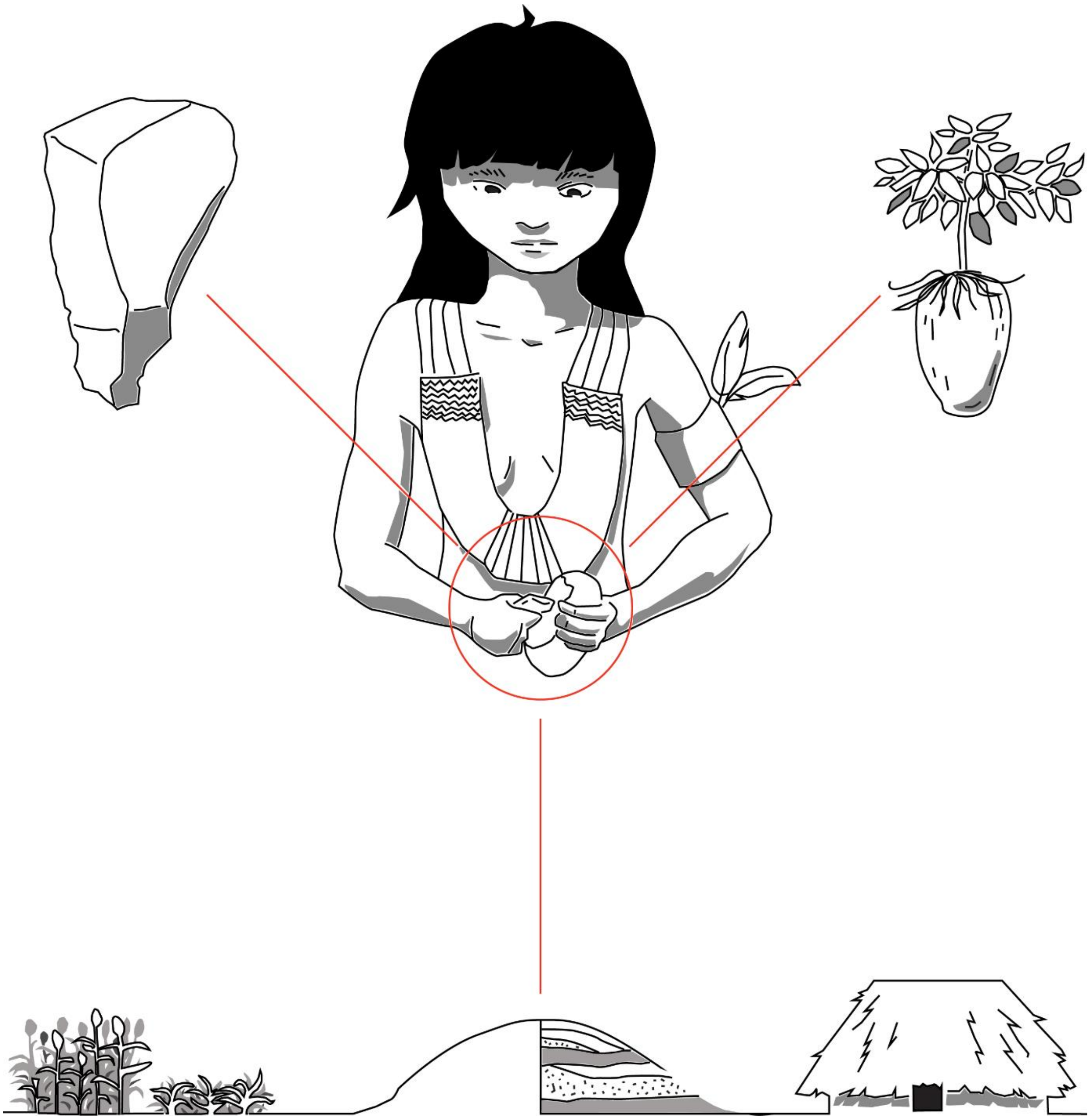

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Cover image: Original artwork by Finn O. van der Leden

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Archaeology and Heritage of Indigenous America

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Table of Contents

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1. Introduction

This thesis focuses on the domestic activities at the Late Ceramic Age site of El Carril (North-western Dominican Republic), through a pilot study of the flakes of mostly sedimentary rock and their potential use as tools. The site of El Carril has been dated to between cal. AD 900 and 1450 (Hofman and Hoogland 2015, 2017, 2018; Hofman *et al.* 2018). Various excavation campaigns have been carried out at El Carril between 2016 and 2019 as part of the broader research agenda of the ERC-Synergy NEXUS1492 project: *New World Encounters in a Globalizing World.* This thesis contributes to our understanding of the site of El Carril by demonstrating the value of starch grain and use wear analysis on flakes of mostly sedimentary rock in research on domestic and craft activities at El Carril.

1.1 Introduction

The NEXUS1492 project is a trans-disciplinary and collaborative research project between researchers of Leiden University, the Free University of Amsterdam, the University of Konstanz, and Caribbean local specialists and stakeholders. This research is funded by the European Research Council (Hofman and Hoogland 2015, 2017, 2018). This project studies the contact period between the Indigenous peoples of the Americas and the first Spanish colonists from an Indigenous perspective. Multiple excavations have been carried out, some of which are still ongoing, in Cuba, the Dominican Republic, Haiti, Jamaica, the Lesser Antilles and the northern region of South America, to study the daily activities of the Indigenous peoples before, during and after the Spanish conquest, record cultural traditions which are still in use today and to recognize and valorise the region's Indigenous heritage. Since the start of this project, over 350 Indigenous sites have been discovered, of which El Carril is one of them (Hofman and Hoogland 2015, 2017, 2018; Hofman *et al.* 2018).

El Carril was inhabited by Indigenous peoples between the 9th and 15th centuries (Hofman and Hoogland 2015, 2017, 2018; Hofman *et al.* 2018). Culturally, the area was said to be inhabited by the so-called Macoriges and "Taino", the latter of which is a term that is currently heavily debated (Curet 2014; Herrera Malatesta 2018; Hofman 1993; Keegan 2013; Keegan and Hofman 2017; Rodriguez Ramos 2010). The Indigenous peoples of Hispaniola during this period are known for their socio-political complexity, sedentary villages, and wide variety of pottery styles, as well as for their horticulture (Keegan and Hofman 2017, 221-321; Ulloa Hung 2014; Wilson 2007, 96; Veloz Maggiolo 1972).

Early excavations at El Carril in the 1950's and 1970's discovered mounds which were suggested to be related to agricultural activities (Veloz Maggiolo 1972). Later, in 2019, several NEXUS1492 studies into the mounds of El Carril expanded this interpretation by demonstrating that some of the mounds were not only related to agricultural activities, but also to burials, house construction, domestic, and craft activities (Hofman and Hoogland 2017, 2018, 2019;; Pagán-Jiménez *et al.* 2020; Van Dijk 2019, 121).

Domestic and craft activities at El Carril are represented by a toolkit composed of a wide variety of tools. Celts including adzes and axes are used for wood working, whereas knives, scrapers, and flakes for scraping and cutting wood, hide, flesh or other raw materials. When adzes and axes made of green stone were recovered during excavation at El Carril, they are kept separate to other finds and marked as "special" finds. This is because these artefacts can be directly related to domestic craft activities such as wood working of house poles and bowls through their obvious shape, and are expected to have a high potential for discovering use wear traces.

However, the El Carril assemblage also includes lithic flakes of igneous, sedimentary or metamorphic rock material, without a clear typology, with irregular shapes that cannot be observationally related to any clear form of tool. At first, these lithic flakes were suggested to be a part of waste material; such as a by-product of knapping cores (Marreiros *et al.* 2015, 46), or caused by natural processes and were therefore not separated as tools. After recovering numerous flakes, the idea arose that they may have been used as scrapers. It is possible the flakes were a part of the Indigenous inhabitants of El Carril's toolkit for their daily activities or for special domestic and craft activities. Therefore, the lithic flakes of this research are referred to 'flakes of mostly sedimentary rocks'.

So far, not much is known about such 'lithic flakes without a clear typology'. Previous research on domestic and craft activities in the Caribbean has focused only on lithics with a standard typo-morphological relation between form and function, as well as those containing a suitable working edge (Briels 2004; Lammers-Keijsers 2007; Falci 2015; Breukel 2019). Studies into these lithic materials applied the low power microscopy method of use wear analysis for tracing use wear related to motion and contact material. The domestic activities were explained by terms as 'chopping wood' or 'scraping siliceous or non-siliceous plant materials', but this approach lacks the identification of exactly which plants were modified with these tools (Briels 2004; Lammers-Keijsers 2007; Falci 2015; Breukel 2019). Other studies of lithic flakes in the Caribbean identify lithics as expedient tools as part of the wider toolkit (Knippenberg 2007), or as indicating the presence of exchange (Rodríguez Ramos *et al.* 2013), but these studies did not analyse the use wear of the lithics for further identification of the domestic and craft activities they were used for (Knippenberg 2007). Therefore, to resolve this discrepancy, this thesis applies a combined starch grain-use wear approach to investigate a sample of lithic flakes from El Carril and their potential uses. The combination of these two methods can elucidate the potential uses of these flakes as tools and demonstrate the array of possible domestic and craft activities carried out by the Indigenous peoples of El Carril.

1.2 Research objective

The main objective of this study is to gain a better insight into the domestic and craft activities of the Indigenous Peoples of El Carril by studying irregularly shaped flakes of mostly sedimentary rocks. By combining use-wear and starch grain analytical methods, the potential uses of these lithics may be revealed. This will lead to a better understanding of the toolkit used in domestic activities.

1.3 Research questions

Based on the lack of research on these flakes, the following research question was formulated:

Which domestic activities involved these flakes of mostly sedimentary rocks at El Carril?

This can be broken down into the following corollary sub-questions:

- What do we know about the domestic activities (subsistence or craft) carried out at El Carril based on the excavation data?
- What are lithic flakes used for in wider Caribbean contexts?
- Are there traces of use visible, and if so, what kind of use wear can be identified?
- Are there any starch grains present, and if so, what kind of starches can be identified?
- What material are these lithics made from?

1.4 Materials and Methods

1.4.1 Materials

In total 35 flakes of mostly sedimentary rocks, from the 2017 and 2018 field seasons, have been researched in a pilot study utilizing a combined starch grain-use wear approach. These flakes of mostly sedimentary rocks are mostly discovered in mounds. The selection was based on the flaked specimens that could have been used as tools according to their shape, size and macroscopically visible traces of use wear.

1.4.2 Methods

For the combined starch grain-use wear approach, the following methods were used: 1) dry scraping and 2) ultrasonic bath method for extracting residues for analysis of potential starch content, and 3) low power microscopy and 4) high power microscopy for detecting possible use wear on lithics.

Through the combination of these four methods a preliminary insight into the domestic activities should be visible. The results will be compared with lithic flakes with a defined morphology related to function from other sites in the Caribbean in order to infer if the El Carril flakes of mostly sedimentary rocks were used as expedient tools or were not used at all.

The combination of the starch grains and use wear analysis in this approach will help to illustrate some of the domestic activities carried out at El Carril. By applying the starch grain analysis, recovered starches can be directly correlated to culinary practices and use of plants (Mickleburgh and Pagán-Jiménez 2012; Pagán-Jiménez and Oliver 2008; Pagán-Jiménez 2011; Piperno and Dillehay 2008). With the application of use wear analysis, observed use wear traces can be related to contact with other materials and the human motions that caused the traces (Lammers-Keijsers 2007; Tringham *et al.* 1974; Van Gijn 1990). The combination of both results will provide information about the motion carried out, such as scraping, or cutting for example, as well as contact with soft or hard materials. The recovered and identified starches may be correlated to the contact materials. This combined approach will provide a more refined insight into domestic activities carried out by Indigenous Peoples of El Carril.

1.5 Thesis outline

In Chapter 2 the site of El Carril will be described in more detail, as well as the history of excavations at the site. The first excavations carried out in the 1950's and 1970's will be described, followed by the excavations of the ERC-Synergy NEXUS1492 project. The discovery and investigation of the mounds at the site is also described, and the relation of these features to agricultural, domestic, house building and burial activities (Van Dijk 2019, 122).

Chapter 3 will give an overview of lithic flakes in the Caribbean. Previous studies in the Caribbean where the combination of starch grain analysis and use wear analysis have been utilised will also be discussed, as well as the broader context of these methods.

Following this, Chapter 4 will describe the materials and methods used in this thesis. The first part of this chapter will describe in depth the artefacts studied, with a further description of the materials given. This latter description is based on research by BA-student Rosa Verheij and MA-student Denice Borsten with NEXUS1492 PhD Alice Knaff as supervisor from the Free University of Amsterdam, who conducted investigations into the genesis of these lithics.

The second part of this chapter will discuss the combination of the starch grain-use wear method. The methods will be explained further to provide a better understanding of the terms used of the generated results. In addition, this chapter provides a detailed description and explanation of the methodology to allow for replication.

Chapter 5 presents the results of the analyses. First the results from the investigations conducted by the students of the Free University of Amsterdam will be described to assign know what kind of stones the lithics consist of. Then the starch grains discovered from the lithics by the dry scraping and ultrasonic bath method are described. This is followed by the results of the low and high-power microscopy methods of use wear analysis.

Chapter 6 forms the discussion, with the data collected and summarised here. The domestic activities of El Carril, the flakes of mostly sedimentary rocks in a Caribbean context, the rock genesis, the results of the starch grains and use wear combined will be discussed.

In Chapter 7 the results of the combined approach used in this pilot study will be placed in wider context, with future directions for the use of the starch grain-use wear approach discussed.

2. El Carril

This chapter provides background information of the archaeological site of El Carril, which is currently still being excavated as part of the broader research agenda of the ERC-Synergy NEXUS1492 project: *New World Encounters in a Globalizing World.* Fieldwork reports from the past excavations, theses and articles are used as main source of information for the discussed paragraphs about the locality, mound features, and functions of El Carril.

El Carril was first researched by Emile de Boyrie Moya in the 1950's, where he identified 40 mounds. Later, in the 1970's the site was researched for a second time by Marcio Veloz Maggiolo and his colleagues where they identified more than 125 mounds by using aerial photography. From 2013 onwards, El Carril became part of the ERC-Synergy project NEXUS1492: New World Encounters in a Globalizing World. The research into the discovered mounds continued and new research questions were formulated, including this pilot study, looking into the domestic and craft activities of El Carril.

2.1 Locality

The archaeological site of El Carril is located in the north western part of the Dominican Republic (see fig. 2.1). This country forms together with Haiti the islands of Haytí, nowadays known as Hispaniola. The island is the second largest island of the Caribbean Sea after Cuba and belongs to the Greater Antilles with Cuba, Jamaica and Puerto Rico. Together they compromise over 194.000 square kilometres of landmass, which is over 15 times larger than the size of the Lesser Antilles combined (Wilson 2007, 9).

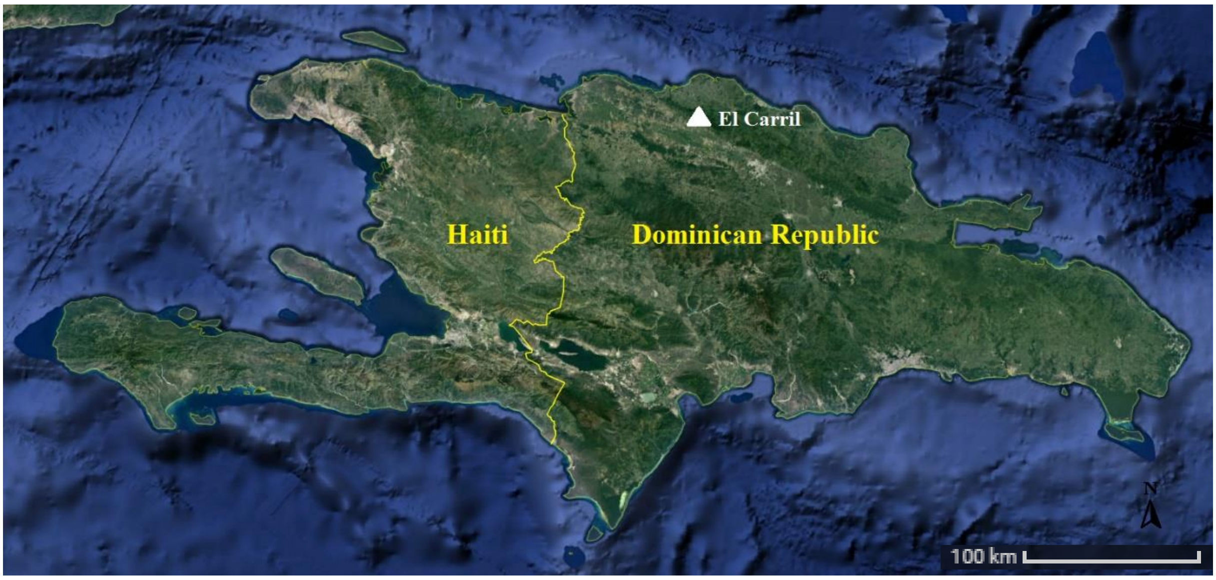

***Figure 2.1**: Location of El Carril in the Dominican Republic, on the island of Hispaniola (Modified from Google Earth Pro 2015).*

The environment of the Dominican Republic is diverse. The country is located between the Atlantic Ocean in the north western part of the island and the Caribbean Sea in the south western part of the island. The coastline of the Dominican Republic consists of beaches and mangroves. The Dominican Republic also has two mountain ranges, the Cordillera Septentrional and the Cordillera Central. The Cordillera Septentrional is located in the north western part of the Dominican Republic, where the area is hilly with high mountains. The Cordillera Central is located in the central part of the island where the area is lower with swamps. Between both mountain chains is the Cibao Valley. The largest river of the Dominican Republic is the Yaque River, which flows through the Cibao Valley (Hofmand and Hoogland 2018, 202).

The site of El Carril can be found in the southern hillslopes of the Cordillera Septentrional, in the municipality of Laguna Salada, the province of Valverde (see fig. 2.2). The site is located 18km from the coast, and is approximately 300 meters above sea level. To the south of the site, the Cibao valley can be seen until the Cordillera Central in the central part of the island. The site is located around a modern cemetery, which lies between two small settlements: El Carril de Abajo in the east and El Carril de Arriba to the west. These two settlements are connected to each other by a road, the Calle Ismael Peralta. The vegetation at the site is dense, typical for a semiarid climate, with different species of grasses, bushes and trees.

Figure 2.2: *Location of the sites El Carril and El Flaco in the north-western Dominican Republic. In here the Cordillera Septentrional and the Cibao Valley are also marked in yellow. In white are the modern city names visible (Modified from Maphill 2011).*

2.2 Mounds

Mounds have been identified at the site of El Carril since the first prospects of the site in the 1950s by Emile de Boyrie Moya. He discovered 40 mounds and described these according to their size and texture (Veloz Maggiolo 1972). A second round of investigation in the 1970s by Marcio Veloz Maggiolo, Elpidio Ortega, Plinio Pina and Bernardo Vega revealed more than 125 mounds (Veloz Maggiolo 1972). This time the area was researched by survey and using aerial photography. An area of 53.000 m^2 had been documented and mapped through aerial photography. All 125 mounds were located on the map using a black dot. Both investigations focused on the identification and location of the mounds.

The construction of mounds is a worldwide phenomenon. Peoples intentionally shaped their landscape by creating mounds. These mounds differ in structure, function and purposes per culture and are frequent topics for debate (De Mooij 2018; Sonneman 2016; Van Dijk 2019). Previous studies in the north-western Dominican Republic concerning mounds have typically focused on the spatial organisation of the mounds, as will be discussed below.

Contemporary to the site of El Carril is the nearby located archaeological site of El Flaco (see fig. 2), also part of the ERC-Synergy project NEXUS1492: *New World Encounters in a Globalizing World.* The mounds of El Flaco were part of the research conducted by Emma de Mooij in 2018 as a key feature in gaining a better understanding of the spatial and temporal developments of El Flaco (De Mooij 2018). The stratigraphy of the mounds contained multiple layers of different fills, such as thick layers of burnt trash or redeposited bedrock, featuring the daily sweep of cleaning the areas around houses and kitchen areas. Her research showed that mounds are not homogenous, both in their internal function and in the structure between mounts, suggesting that they could have multiple functions through time (De Mooij 2018; 127).

Further investigations into the mounds of El Carril began in 2013 as part of the NEXUS1492 project (Hofman and Hoogland 2015; 4). Research into the mounds was carried out using modern techniques such as drones. In 2016 Sonneman used drones for his research to understand the spatial organization within archaeological sites in the north-western Dominican Republic. He made a Digital Elevation Model using a GoPro 3+ attached to a drone, allowing him to make 200-500 photos of the site (Sonneman *et al.* 2016; 4). This resulted in the documentation of 42 mounds bordering 78 flat areas. The number of mounds is different than that counted in the 1970s by Marcio Veloz Maggiolo and his colleagues as the 2016 drone survey was carried out during rainy season, which results in problems in differentiating between mounds and areas covered by shrub (Sonneman *et al.* 2016; 10). However, the results on the spatial organisation of El Carril by Sonneman were promising enough to carry out further excavations at El Carril.

In 2018 Kaz van Dijk carried out further research into the mounds of El Carril. His aim was not only to investigate the spatial organisation of the mounds, as had been previously attempted by Maggiolo (1972) and Sonneman *et al.* (2016), but also to investigate the function of the mounds and if they were related to each other. He surveyed the site twice by foot using the maps created by Veloz Maggiolo (1972) and Sonnemann *et al.* (2016) for measuring the known mounds. Of each mound cores were taken for describing the texture of the mounds, differentiating between natural or artificial created mounds. This task was accomplished with the help of students from the NEXUS1492 fieldschool. By doing so he was able to create maps about the location of the mounds, but also new maps about the texture. His research resulted in the absolute minimum number of 107 human made mounds at El Carril (see fig. 2.3). The function of the mounds was related to domestic, house building, agricultural and burial activities. This will be further exemplified in the next section (Van Dijk 2018).

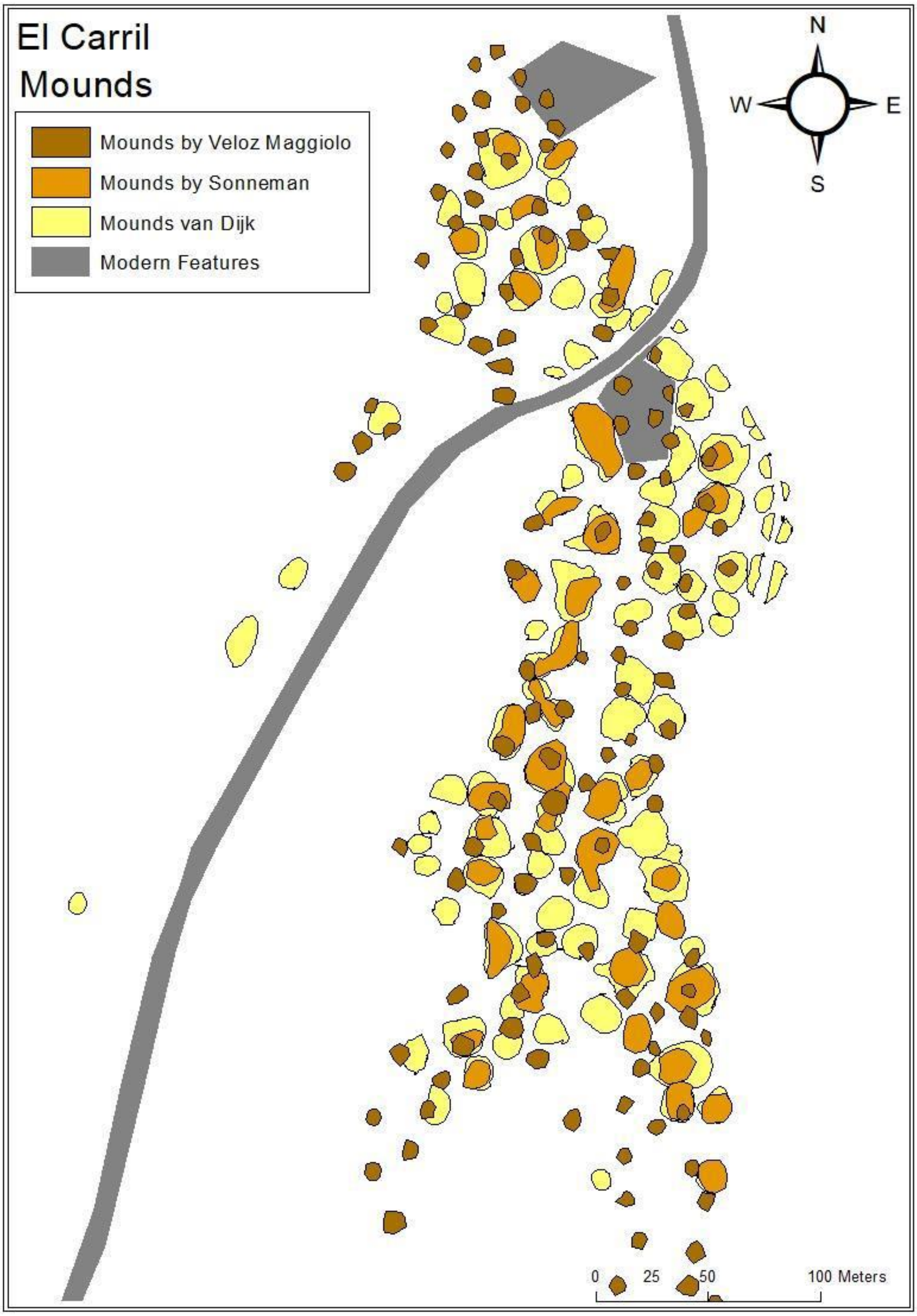

Figure 2.3: *All mounds documented by Veloz Maggiolo, Sonneman and Van Dijk in El Carril (By Kaz van Dijk 2018, 62).*

2.2.1 The multifunctional uses of mounds

The function of the discovered mounds at El Carril will likely be related to the broader site function. Currently, mounds are the most studied aspect of the site of El Carril, with initial research yielding promising results. Future research can give more pronounced information, but for this thesis the results of the mounds are useful in establishing a background to the site and to the context of the lithics..

As discussed above, the function of mounds is not always related to one single purpose. In fact, most recent studies into mounds in the north-western Dominican Republic as seen in El Flaco by De Mooij (2018) and with El Carril by Van Dijk (2019) showed that one single mound can have multiple functions which also differs from time. According to the results from the cores taken by Kaz van Dijk in 2018, mounds are related to domestic, burial and agricultural activities. The materials found in the cores of the mounds includes ceramics, lithic, coal, coral, shell and a diversity of animal bones. All these findings are indicators of various domestic activities such as cooking and cleaning (Van Dijk 2019, 34).

Indigenous peoples shaped their environment by creating flattened areas which they then built their houses on. The cleaning of this area in preparation for construction, as well as daily domestic cleaning, likely created some of these mounds (Van Dijk 2019, 63). Layers of ash were also recorded, while some layers contained more special finds such as beads, celts of green rock, axes, and bones of larger animals (Hofman and Hoogland 2018, 22). The mounds seem to be associated with better preservation of organic materials (Hofman and Hoogland 2018, 22). The mounds created are also connected with a defensive/protective function, as seen with the mounds in El Flaco (Hofman and Hoogland 2016, 19). This could be related to the strategic location of El Carril near to a shallow pass through the Cordillera Septentrional (Sonneman *et al.* 2016, 14).

Next to ceramics or shells, human remains have also been found in the mounds. Since the excavation of El Carril in 2017, ten complete burials have been found of children and adults. Fragmented human bones (skulls, long bones, teeth) have been found scattered all over the site. Most of the findings were located in the northern part of the site in units: 7, 11, 16, 18, 9, 22, 23, 36, 38, 42, 45, 47, 48, 50, 51, 52 and 53 (see fig. 2.4), in close vicinity of the current cemetery. The isolated bones found in the mounds may indicate burial activities or celebration of the ancestors, similar to burying the death beneath the floor of the houses known of contemporary Indigenous sites in the region (Hofman and Hoogland 2017, 2018, 2019; Van Dijk 2019).

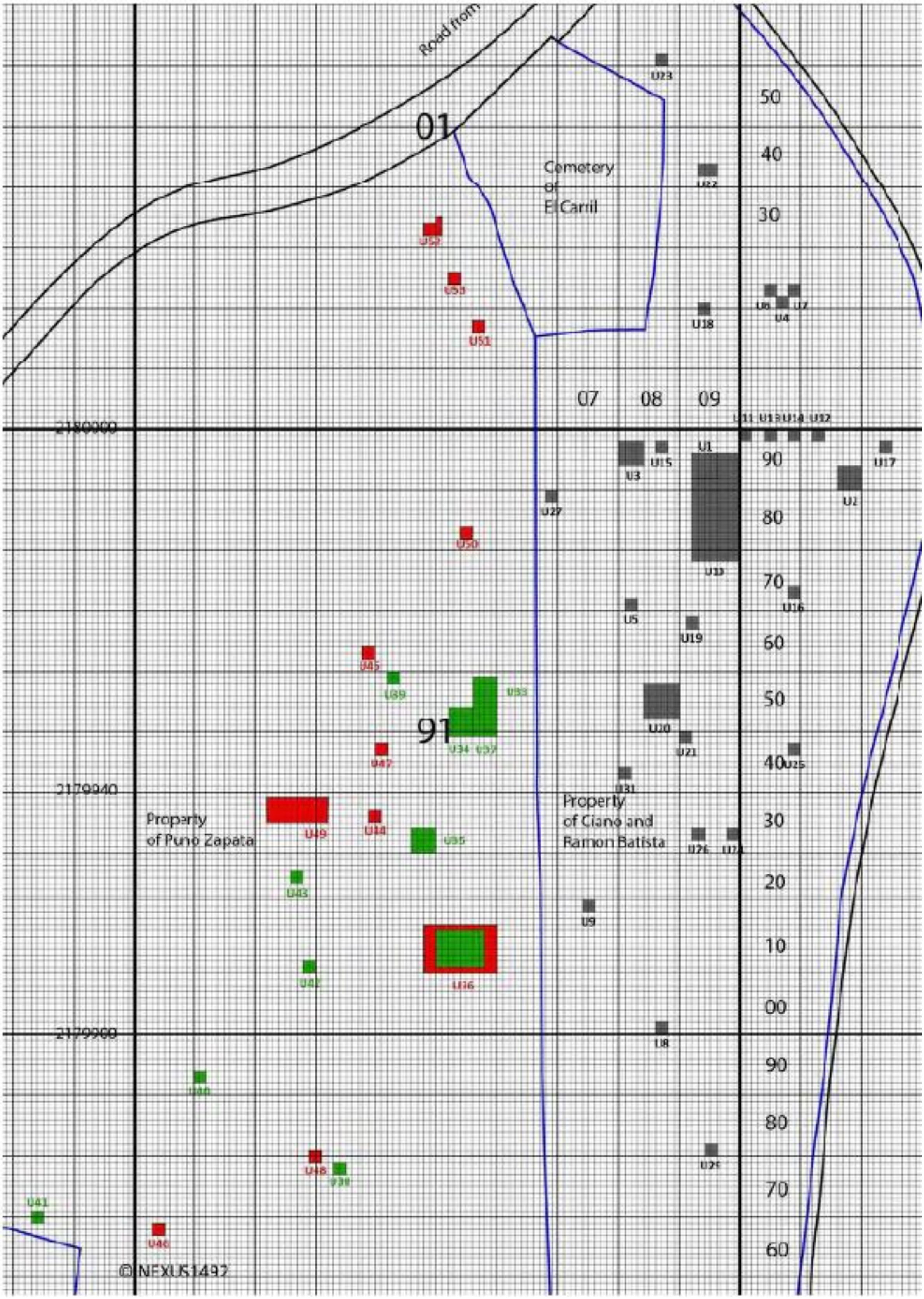

Figure 2.4: *Overview of excavated units. In red and green the units excavated in 2018, in gray units excavated in 2016 and 2017 (After Hofman and Hoogland 2018, 20).*

2.2.2 Agricultural purposes of the mounds

In one of the first reports written about El Carril by Velioz-Maggiolo in 1977, he mentions agricultural processes. The first inhabitants of El Carril adapted to their environment (Velioz-Maggiolo *et al.* 1977, 61). The agricultural systems used by the Indigenous people of El Carril is still unknown and under-researched, with little information on the use of systems such as terraces and irrigation (Hofman and Hoogland 2018, 25). We do know from observations by Fernández de Oviedo in 1851 that Indigenous people used the slash and burn technique for preparing their land, especially in forested areas.

A system called "montones" was used. These are roundish and artificial mounds, typically 3metre wide and 70cm high, consisting of loose and fertile soils. Areas were sometimes covered with thousands of them, but mostly they were arranged stretching in rows (Pagán-Jiménez *et al.* 2020, 3). Something more common and still being used today, is the use of orchards or home gardens. These are gardens which are related to close vicinity within the indigenous villages (Pagán-Jiménez *et al.* 2020, 3).

To know and learn more about these home gardens, with a particular focus on the mounds, a new combination of research methods has been applied to the mounds of El Carril. Pagán-Jiménez et al conducted research questioning the integration of plants into multi-layered household mounds (Pagán-Jiménez *et al.* 2020, 2). They combined phytolith analysis with basic geochemical and stratigraphic analysis. Before this research was carried out, a small experimental research project had been performed by Niels de Koning during the El Carril field school in 2018. He researched if there was a correlation between the archaeological phytoliths found and the vegetation we assign it to. The results turned out to be very clear, to name an example, in a palm forest the phytoliths that predominate are those of the palm (Hofman and Hoogland 2018, 45). This contributed to the research carried out by Pagán-Jiménez.

The work of Pagán-Jiménez et al showed that the stratigraphy of the mounds is related to the soil fertility of the mound (2020), with this supported by other findings (Van Dijk 2019, Hofman *et al.* 2016; Mooij 2018). The mounds excavated by Velioz Maggiolo and his colleagues were shown to consist of multiple layers (see fig. 2.5), which when combined increased the fertility of the mounds. The layers at the lowest part of the mound consist of different stones mixed with black humid soil at the bottom. On top of this layer was a layer of limestone brought from another region. This layer was covered with a layer of ash from hearths or burning waste. Next on top was a layer of 10 cm with sediment mixed with seashells (Van Dijk 2019, Hofman *et al.* 2016; Mooij 2018).

Each layer had a purpose. The layer with limestone kept the lowest layers with black soil humid by preventing water from moving through the mound too quickly. The ash layer and the top layer which is mixed with seashells, are to increase the fertilization (Van Dijk 2019, Hofman *et al.* 2016; Mooij 2018). Ceramics and other inorganic materials were also encountered in the mounds. These were believed to be used as votive offerings (Hofman *et al.* 2016, 22). The mix of these layers with the earth and natural deposits combined made mounds fertile and sustaining for plants to grow in (Fieldwork report 2018; Pagán-Jiménez *et al.* 2020).

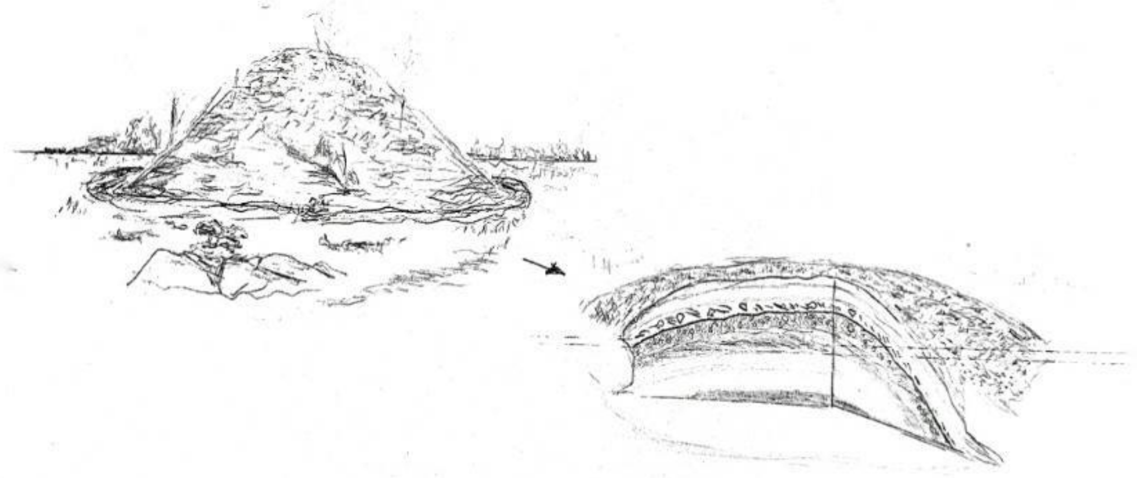

Figure 2.5: *An example of a mound and the stratigraphy within. Drawing by Betül Türkyilmaz.*

According to the results of the interdisciplinary research performed by Pagán-Jiménez et al (2020), it is too early to confirm agricultural processes for the use of mounds. Indigenous peoples choose the environment to live in if the landscape had similar conditions to the landscape they used to know. In the 600 years before the arrival of Columbus, little changes occurred to the floral environment of El Carril. Phytoliths of the plant species *Sabal domingensis* were present in the samples taken, a palm species currently growing in El Carril. Phytoliths of the Marantaceae, Cannaceae and Costaceae families were also encountered in the samples. These are plants with attractive leaves for wrapping foods, but are also indicators of development and conditions of understory vegetation of lower montane moist subtropical forests. However, what can be based upon the results of the combination of phytolith analysis with basic geochemical and stratigraphic analysis, is that that the Indigenous peoples probably knew how to nourish the mounds for the enrichment of the soils for plant production processes (Pagán-Jiménez *et al.* 2020).

2.5 Summary of the El Carril research history

To summarize the mentioned research topics in this chapter: the site of El Carril was first discovered by Emile de Boyrie Moya in the 1950s, and was later in the 1970s investigated for a second time by Marcio Veloz Maggiolo and his colleagues. Since 2011 El Carril is still being excavated as part of the

ERC-Synergy project NEXUS1492: *New World Encounters in a Globalizing World.* During these excavations the discovery of mounds gained much attention by the researchers. In the beginning for the spatial organisation, with later investigations focusing on the function of the mounds in relation to the broader site. Researched performed by Kaz van Dijk into the function of the mounds showed that the mounds were related to domestic, burial, house building and agricultural activities. The connection with agricultural activities was further researched by Pagán-Jiménez et al (2020) to learn about the vegetation of El Carril. Mounds were shown to be very fertile due to the way the layers of the mounds were formed. The Indigenous peoples of El Carril likely knew how to nourish the plants growing in the mounds, and may have intentionally constructed the mounds to support their plants.

The next chapter will focus on placing the lithic assemblage of El Carril within the broader context of other Caribbean archaeological sites. The lithic assemblage of these described sites had been researched with the combination of the use wear and starch grain analysis, which is similar to the research methodology used in this research.

3. The multiple functions of flaked tools in the Caribbean context

In the current chapter, the lithic assemblages of the Caribbean will be discussed. First, a general overview of lithic artefacts through time in the Caribbean area will be presented, from the earliest inhabitants to the Indigenous peoples living in the ceramic period. This section will be followed by research wherein use wear and starch grain analysis have been combined, particularly where these show a detailed understanding of the technological choices of the Indigenous peoples. The focus will mostly be on sites in the Caribbean, but with case studies of similar methodologies from a worldwide context also integrated.

3.1 Time line

The societies of the Indigenous peoples of the Caribbean used to be categorised in four different time epochs, the Lithic Age (4000-2000 BC), the Archaic Age (2000-500 BC), the Ceramic Age (500 BC – AD 1500) and the Historic Age until present. These time periods were based upon technological terms by Irving Rouse (1992). Research from the last two decades showed that the use of this time frame is outdated (Keegan and Hofman 2017; Hofman and Antczak 2019). In this chapter the outdated time frame of Rouse will be used for creating a general perspective for the use of lithic artefacts. A problematisation of the Rouse schema will also be included, expanding on why these previously used epochs are no longer adequate.

3.1.1. Lithic Age

The earliest inhabitants of the Dominican Republic, as well as the oldest archaeological sites known, are radiocarbon-dated to the fifth millennium BC (Keegan and Hofman 2017; Wilson 2007). The time period linked with these first inhabitants is the Lithic Age and starts around 5000 BC (Keegan and Hofman 2017; Wilson 2007). Indigenous peoples lived in small, mobile ‘bands’ and stayed in caves or rock shelters. (Keegan and Hofman 2017; 28). Sites of the Lithic Age have not received much archaeological interest yet, with only a few sites known from this period in Cuba and Hispaniola (Keegan 1994; Keegan and Hofman 2017).The main artefacts that were found on these limited archaeological sites were stone tools, primarily flaked-stone blades from prismatic cores (Keegan 1994, 264). These tools have been used to manufacture other tools and were used for wood working and hunting of large game (Keegan 1994, 264). Surprisingly, no remains from large game have been found in the Caribbean so far. Manatees, giant sloths, large flightless owls and sea turtles are the only fauna which are remarkable larger in size then small game as rodents. The flaked-stone blades contained suitable characteristics for hunting these larger animals (Keegan and Hofman 2017; 23). The Lithic Age was characterized the use of flake-stoned blades for hunting, wood working and toolmaking. This changed in the next era.

3.1.2. Archaic Age

Around 2000 BC, known as the Archaic Age, the flaked-stone blades were replaced by ground stone tools and shell technologies (Keegan and Hofman 2017, 37). This period is marked with the use of stone and shell tools, absence of pottery and the abundance of marine molluscs (Keegan 1994, 266). The toolkit of archaic sites in Hispaniola contained larges blades used for end scrapers, backed knives and spearheads, made with a macroblade technology (Keegan 1994, 268). Mortars, stone and coral balls, hand grinders and single- and double-bitted axes were also part of the toolkit (Keegan 1994, 268). The Indigenous peoples shifted from hunting larger animals to smaller animals including terrestrial animals. This might be influenced by overhunting, causing the extinction of the larger species as ground sloths and large flightless owls. The Indigenous peoples were highly mobile, following seasonal rounds and cultivated plants (Keegan and Hofman 2017; 42).

3.1.3. Early Ceramic Age

In the last centuries BC, dated between 800 BC and 200 BC, multiple, new and diverse patterns of migration occurred. Indigenous peoples living in the Orinoco Basin colonised the Lesser Antilles via Trinidad, into the eastern part of Hispaniola. These peoples were named the Saladoid, after their distinctive white-on-red pottery found on the Saladero site in Venezuela (Fitzpatrick 2015; Keegan and Hofman 2017; Wilson 2007). According to the framework made by Irving Rouse, this period starting from 500 BC until AD 500 was called the Ceramic Age, referring to the appearance of ceramics (Wilson 2007, 59).

3.1.4. Late Ceramic Age

The Late Ceramic Period starts from the AD 6th century onwards. This period is demarcated from the Early Ceramic age on the basis of a wave of changes on economic, socio-political, cultural and demographic grounds (Fitzpatrick 2015, 315). This was visible in the archaeological record by an increase in sites, which is considered to reflect population growth and regionalization (Fitzpatrick 2015, 315). The northern Caribbean underwent a change in pottery styles to thin, undecorated red-ware pottery by the fast movement of the Ostionoid peoples, originated from Archaic ceramic traditions (Fitzpatrick 2015, 311). The Lesser Antilles saw a cultural diversion in pottery styles (Fitzpatrick 2015, 317). Indigenous societies exploited terrestrial animals such as snakes, lizards, guinea pigs and opossums, to name a few examples (Fitzpatrick 2015, 320). Deceased peoples were mainly buried in a flexed position in burials or cemeteries whereby the inclusion of grave goods is less abundant (Fitzpatrick 2015, 322).

3.1.5. Dearchaizing the Archaic

The previous paragraphs separated archaeological evidence in a time frame made by Irving Rouse. The Lithic Age, Archaic and Ceramic Age are separated time areas based upon subsistence strategies and material culture signatures as described above. The flaked-stone tools were common in the Lithic Age, the ground stone assemblage and shell tools in the Archaic Age, and the use of ceramics for the Ceramic Age. From a Western point of view, the Archaic Age is characterised as developmental "stage". It follows up the Lithic Age with a more specialised tool kit and sophisticated way of living, but compared to Ceramic Age, the peoples living in the Archaic Age were "simple", with a nomadic style of living. Recent research from the last two decades shows that the Archaic Age might have begun earlier than 2000 BC and Archaic communities continued during the Ceramic Age (Hofman *et al.* 2011; Hofman and Antczak 2019).

The traditional used time frame for the Archaic Age in the Caribbean is not up to date when recent research is taken into considering. One of the recent researches to mention is the work of Pagán-Jiménez and his colleagues (2005). They showed that the consumption of beans, maize, manioc and sweet potato can be traced back to 4000 BC by researching starch grains from lithic grinding stones from two Archaic site in Puerto Rico. These are starches from plants which are domestic in the mainland of the Neotropics and for the first time have been identified in the insular of the Caribbean. The knowledge of knowing how to process these plants passed through by generation on generation, probably from the first immigrants of the mainland who travelled to the Caribbean around at least 4000 BC (Pagán-Jiménez *et al.* 2005, 25). Another example of which the 'earliest' moment of the Archaic Age can be traced back to is the findings of the Banwari Trace Site in Trinidad (Keegan and Hofman 2017, 36). Radiocarbon dates of archaic sites with shell middens were dated to 5700 BC, which is overlaps significantly with the Lithic Age according to the time frame by Irving Rouse (Keegan and Hofman 2017, 36). Research into the exchange of flint from Long Island, Antigua showed that Archaic Age communities continued to exist during the Early Ceramic Age (Hofman *et al.* 2011, Knippenberg 2007). During the Archaic Age, the quarries of flint were available for the Indigenous communities who travelled yearly to the site, however later during the Ceramic Age, the flint of Long Island could only be gained through exchange with the Archaic Age communities who monopolised the quarries of Long Island (Hofman *et al.* 2011, Knippenberg 2007). This exchange shows that Archaic Age communities were still present during 800 BC and 200 BC (Hofman *et al.* 2011, 124).

Therefore, researchers have recently started working with an 'open mind set' and asking new questions as: 'How did the Archaic Age population interact with the incoming "other" known as the "Early Ceramic" or "Early Saladoid" peoples?' (Hofman and Antczak 2019, 41). This has also started the discussion to if there is truly a sharp line dividing human/environment interaction. Future researches should consider these questions and archaeological evidence of the Archaic Age to construct bridges between the traditional time frames used and the recently added data.

3.2 Previous research of flaked artefacts in the Caribbean

In the early Caribbean archaeology, the identification of flaked artefact function was based on a typo-morphological relation between form, and function. Recently, interest in classifying flaked artefact assemblages by using use wear analysis in combination with other methodologies or raw materials has increased, showing that standard typologies are not always relevant for the materials researched. As will be explained below, multiple new insights were gained through the use of combining different methods and techniques for researching the activities carried out with lithic tools by the Indigenous peoples.

3.2.1. Plum Piece, Saba

The archaeological site of Plum Piece in Saba is an inland site, located 400 meters above sea level in a dense, tropical forest (see fig. 3.1). The site dates back to approximately 3300 B.P. in the Archaic age (Briels 2004, 2). From this period, mainly coastal sites are known, making Plum Piece as an inland site interesting for researchers to learn about the function of this site. Dense midden deposits were found in the site, consisting mainly of bones from birds or crab from migrating species. Not many fish bones or mollusks had been found, suggesting that this restricted variety of exploited food is an indication of seasonal occupation at the site of Plum Piece. Activities carried out at this site are related to plant and woodworking (Hofman and Hoogland, 2003; Hofman and Hoogland, 2006).

Supporting the indication of seasonal occupation at the site of Plum Piece, Briels (2004) conducted a research into the flint assemblage of Plum Piece through use wear analysis. The inland site contained large quantities of flint without a clear typology. Previous research into pre-ceramic flint in the Caribbean tried to relate flints to function, but their methodologies did not contain use wear analysis and results were mainly based on related assemblages from Archaic pre-ceramic complexes from the Lesser Antilles (Hofman and Hoogland 2003, 12). For this reason, Briels conducted an use wear analysis for the Archaic Age flint assemblage of Plum Piece. In this way the flint artefacts could be related to function and give a better understanding of the activities carried out by the Indigenous people of Plum Piece (Briels 2004, 1).

Briels results showed that most of the flint artefacts from Plum Piece were used for the processing of siliceous plant materials by using a perpendicular motion (Briels 2004; Hofman *et al.* 2008). By scraping, whittling and planing the plant materials were shaped in their desired form the create basketry, thread and rope, containers or spoons which were in use for domestic activities. This result is not surprising as people of the Archaic Age were dependent on plants for making other tools and objects, as they did not use pottery yet. These objects are made from perishable materials which are rarely discovered during excavations, but are known to have been used based on ethnographic research (Briels 2004, 74). It was not possible to distinguish what kind of plant species had underwent the scraping by using flints, only that half of the researched lithics contained polish with fine punctuations (Briels 2004, 78). Different plant species leave different traces according to with what kind of motion and material they have been used with (Briels 2004; Hofman *et al.* 2008). Briels was only able to mention that the use wear traces were caused by working with an obtuse angle, something familiar for scraping hard materials (Briels 2004; Hofman *et al.* 2008).

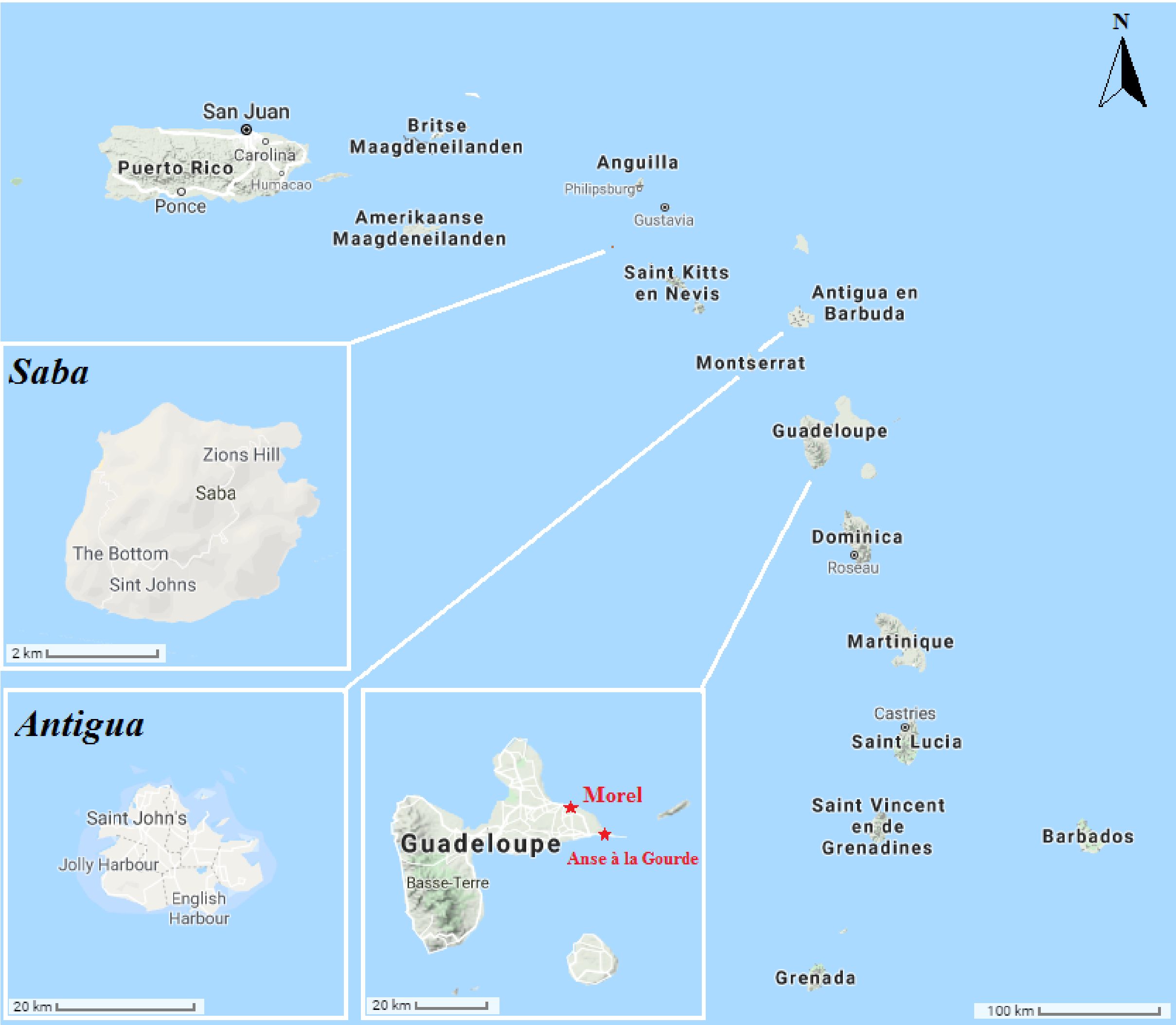

Figure 3.1: *A map showing the different Caribbean locations discussed: Saba, Antiqua and Morel and Anse à la Gourde in Guadeloupe. (Modified from Maphill 2011).*

Also remarkable to mention is that according to her results, 76 % of the researched flint of Plum Piece did not originate from Saba (Briels 2004, 30). These pieces were imported or exchanged from Long Island, Antigua. Most of the over the 700 researched flakes can be characterised as unretouched whole flakes of irregular sizes, mostly without cortex. Some flakes are long and have a blade-like appearance. No evidence had been found for blade production at the site, but the large amount of waste material of small flakes and worn out flint cores point to an expedient flake technology (Briels 2004, Hofman and Hoogland 2003, Hofman and Hoogland 2006). These small flakes are probably only used for small-scale activities as cutting, scraping, planning, whittling and incising, not for hollowing out tree trunks (Briels 2006, 78). Also, not many researched flint artefacts contained traces of wear, which forms another indicator for seasonal occupation at the site (Briels 2006, 79).

Residue analysis has been performed on the Plum Piece assemblage after the research of Briels (2004), in order to refine insights into the specific tool uses (Nieuwenhuis 2008, 125). On all samples starch grains and phytoliths were found, of which the finding of starch grains on two artefacts was leading. These starches were identified as *Prestoea montana*, a palm species (Nieuwenhuis 2008, 129). For this research it had only been possible to compare the starches with known starches from experimentally processed palm leaves. Therefore, only the use of palm leaves, for example for the fibres for roofing or the manufacture for other products, could be confirmed (Nieuwenhuis 2008, 134).

3.2.2. Anse à la Gourde and Morel, Guadeloupe.

Another innovative example of use wear analysis in a Caribbean context is the work of Lammers-Keijsers (2007). She applied use wear analysis to shell artefacts of two sites in Guadeloupe, Anse à la Gourde and Morel (see fig. 3.1), to examine the role of shell artefacts in the technological systems in these two sites (Lammers-Keijsers 2007, 11). Shell is a raw material which is very abundant in the Caribbean, while other raw materials as flint and hard stone are less abundant. By examining the role of artefacts made from shell, flint and hard stone, the understanding of the differences between these artefact classes and their related functions can be made. Previous researchers in the past century in the Caribbean applied use wear analysis to only flint artefacts, making Lammers-Keijsers one of the first to apply this analysis to shell artefacts. She also combined high power and low power microscopy approaches for examining the artefacts, while other researchers typically only utilise one of the approaches (Lammers-Keijers 2007, 11)

According to her results, all studied raw materials were used as tools (Lammers-Keijsers 2007, 139). There is not necessarily a preference between certain types of raw materials as shell, flint or hard stone (or the other studied raw materials) for certain type of domestic and craft activities. But some physical properties as weight and abrasiveness of hard stones are required for activities as grinding, pounding and rubbing (Lammers-Keijsers 2007, 139). Shell turned out to be a good replacement for the local stone pebbles and rocks of Guadeloupe because those local raw materials are calcareous and therefore do not contain preferred physical properties for usage as tool. Flint is indispensable for the durability and sharp cutting edges (Lammers-Keijsers 2007, 139).

Both sites contained flint flakes. The flint flakes from Anse à la Gourde were imported from Long Island, Antigua (Van Gijn 2008, 107). These flakes were used in a transversal and longitudinal motion, wherein scraping is a transversal motion and cutting a longitudinal motion. Use wear suggested that they were used mostly on plant material, and sometimes on wood (Van Gijn *et al.* 2008, 108). The condition of the finds assemblage of Morel was less able to be used for use wear analysis due to the bad state of conservation (Van Gijn 2008, 112). The available use wear was comparable to the use wear of Anse à la Gourde, suggesting that the flint flakes of Morel were also used for plant and woodworking (Van Gijn 2008, 112).

One of the goals of the research of Lammers-Keijers (2007) was for identifying preferences between different type of raw materials for the production of ornaments and tools (Lammers-Keijsers 2007, 139). She acknowledged this information by using the use wear analysis and concluded that different raw materials can be used for the same type of activity (Lammers-Keijsers 2007, 139) Combining her methodology with the use of starch grain analysis would allow for a more in-depth understanding into the different raw materials used in different activities, as well as allowing for the overlap of using one tool for multiple activities to be tested.

4. Materials & Methods

This chapter will give an overview of the materials researched for this pilot study and the methodologies used. The first part of this chapter will review the materials researched, while the second part will focus on the methodologies used during fieldwork, as well as the laboratory protocol for the combined starch grain-use wear analysis. Both types of analyses in the lab will be explained separately, to begin with starch grain extraction, separation, identification, and interpretation of culinary practices, and then use wear analysis, which includes cleaning, drawing, identification and interpretation of traces of use wear. The starch grain analysis was carried out before the use wear analysis, to prevent the analysis being biased from modern contamination acquired during the handling for use wear analysis.

3.3 Previous research of flaked artefacts in a worldwide context

The following section will shed light on the combination of use wear and starch grain analysis on lithic artefacts in a worldwide context. To refer to all the research within this field is beyond the scope of this thesis, therefore six main case studies will be mentioned in order to show the possibilities of the starch grain-use wear analysis method on lithics (Fullagar and Jones 2004; Hayes *et al.* 2014; Torrence and Fullagar 1998). Three case studies include sites from Australia, Tasmania, Papua New Guinea, and East Timor (Fullagar and Jones 2004; Hayes *et al.* 2014; Torrence and Fullagar 1998), and three case studies from sites from the Peiligang culture (Li *et al.* 2018; Li *et al.* 2020; Liu *et al.* 2020). These particular studies have been selected as they are comparable to the research goals of this research.

From an open air site in Papua New Guinea, obsidian artefacts have been studied to identify post-depositional contamination (Torrence and Fullagar 1998, 1232). The artefacts were selected as potential use wear traces are easily to detect on obsidian, and the possible starch grains encountered can be related to common food staples, such as yams and taros from the surrounding area (Torrence and Fullagar 1998, 1232). Blind tests and the soil samples were studied as well. The research of Torrence and Fullagar (1998) showed that discovered starch grains on the obsidian artefacts are related to tool use and not through contamination by discarding used artefacts in waste (Torrence and Fullagar 1998, 1236).

In the Enclosed Chamber from Rocky Cape South in Tasmania, a diversity of flakes with no clear shape were researched for site function (Fullagar and Jones 2004, 79). The site had effectively been ‘closed off’ for 6 millennia for post depositional processes and therefore the artefacts were in great organic preservation (Fullagar and Jones 2004, 79). Artefacts from this site are therefore considered to contain almost no contamination. Use wear and starches recovered from these artefacts were related to processing of plant materials and identified as expedient tools (Fullagar and Jones 2004, 90). These results contributed to interpretation of this site as a temporary dwelling. It is interesting to note that the combination of use wear and starch grain analysis is not limited to fine grained raw materials such as chert, but can also be applied to coarse grained raw materials such as quartzites and silcretes (Fullagar and Jones 2004, 92).

Flaked material form the site Madjedbebe in Northern Australia and Jerimalai in East Timor were studied with the combined use wear and starch grains analysis, because ‘larger’ artefacts and formal tool classes were absent in both sites (Hayes *et al.* 2014, 77). The research of Hayes and his colleagues contributed useful information to the interpretation of both sites, and showed that even ‘waste’ material can lead to supporting information (Hayes *et al.* 2014, 89).

In China the combination of the starch grain-use wear approach had been applied on grinding stones (Li *et al.* 2018; Li *et al.* 2020; Liu *et al.* 2020). Research carried out with this combination was on two archaeological sites in the Middle Yellow River Valley in China of which the results challenged the traditional archaeological view of the function of the six researched grinding stones (Liu *et al.* 2020, 817). The two sites are dated back to the earliest Neolithic settlement in the Middle Yellow River Valley and are part of the Peiligang culture, around 7000-5000 BC. Traditional archaeological views hold on to the function of grinding stones only being used for the grinding of rice and millet, but researching these grinding stones with the combination of use wear and starch grain analyses challenged this view. The results showed that the analysed grinding stones predominantly ground acorns, followed by millet and beans (Liu *et al.* 2020, 30). The traditional view of the Peiligang culture wherein the grinding stones were used as indicator for intensive agriculture based on cereals, changed to a wide-spectrum subsistence economy, wherein for these two sites the focus was on the exploitation of acorns, at least with the analysed grinding stones. The combination of the two analyses provided new details which are of importance for further research of Neolithic sites in China by challenging the traditional views (Liu *et al.* 2020, 817, 831).

In 2018, research was carried out on grinding stones from the site of Jiahu located in the central plain of China, dated around 9000-7500 BC (Li *et al.* 2018, 1). The combination of the starch grain-use wear analyses confirmed the production of cereal flour during the early Neolithic period for the use of different types of foods, possibly such as noodles and breads (Li *et al.* 2018, 5). Next to traces of producing cereals, traces of wood-like materials had also been identified on two of the seventeen researched grinding stones (Li *et al.* 2018, 5). These traces could not be related to slabs for producing flour, and were therefor identified as another product processed by the use of grinding stones (Li *et al.* 2018, 5). This interpretation of using grinding stones for other materials than producing cereal flour, nuanced the previously mentioned interpretation by Liu and her colleagues wherein grinding stones are not solely used for the production of agricultural products. This research contributed to the challenging traditional archaeological views.

Recent research in 2020 carried out by Li and his colleagues on grinding stones of Tanghu in the central plain of China, dated around 9000-7000 BP, contributed as well to multiple functions of grinding stones (Li *et al.* 2020, 1). The combination of the starch grain-use wear analyses applied showed not only evidence of processing cereals, but also evidence of processing bones on one of the seventeen researched grinding stones, showing that grinding stones were involved for other daily tasks (Li *et al.* 2020, 8). They even went further in the identification of the use of the grinding stones, and related this to other sites from the Peiligang Culture. The two sites located in the Middle Yellow River Valley, Jiahu and Tanghu all show similarities in use of the grinding stones for the production of agricultural products. As well as a distinction can be made in the distinctive characteristics (Li *et al.* 2020, 8). Which means that the functions related with grinding stones are yet not all discovered.

4.1 Materials

4.1.1. Selection

For this pilot study 35 lithics have been researched, of which 32 lithics are recovered during the fieldwork of summer 2018 and 3 lithics of the fieldwork of 2017. The sampling strategy for the current research was defined in collaboration with my supervisor Prof. dr. Corinne Hofman based on the flaked specimens that could have been used as tools for a variety of tasks. Herein flakes are defined as: 'detached pieces that separates from the objective piece as it is being worked' (Andrefsky 2005, 12).

The size and shape of the flake, as well as the presence of macroscopically visible polish and retouch were criteria for the sample selection. The lithics are derived from unit 36, 37, 38, 39, 43, 45, 47, 50, 51, 52, and 53 from the excavated units of 2018, as well from unit 10, 19 and 21 from 2017 (see fig. 4.1). Except for the lithic discovered from unit 10 and 36, all other units were excavated in mounds.

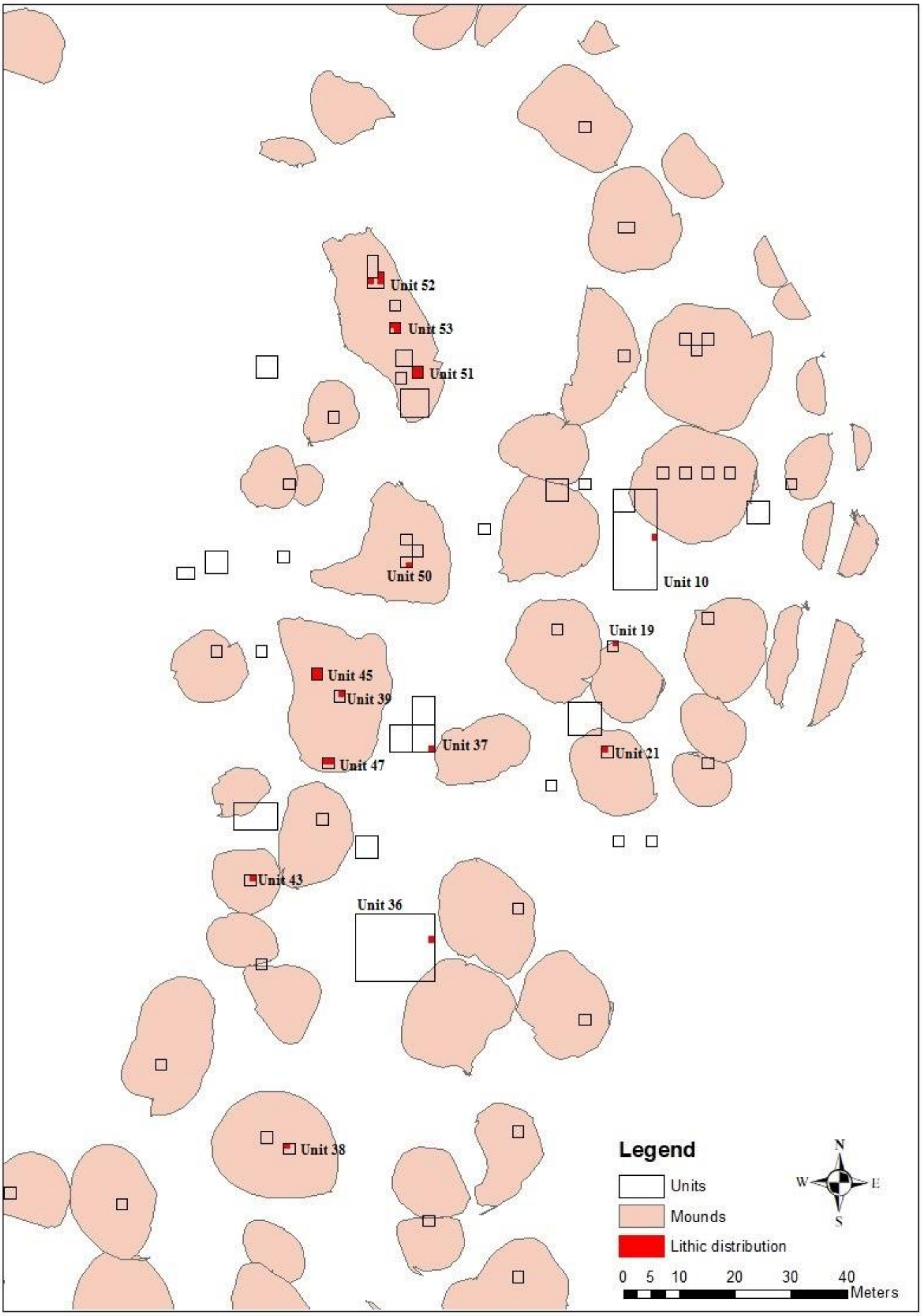

Figure 4.1: *Map showing the distribution of the sampled lithic flakes. All lithic flakes are derived from units which were excavated in mounds, except for unit 10 and 36 which are flatten areas. Map made by Simone Casale.*

4.1.2 Renaming

All 35 lithics were given an extra identity number in accordance with the already existing numbering of the accession list. For example, an artefact with find number 3439 according to the numbering system used for the NEXUS1492 project in El Carril, is renamed as 09CA-R/U/DS for this research. The '09CA' stands for sample number 9 of the 35 sampled lithics from the site El Carril, with 'CA' the initialism for El Carril. The combination of 'R/U/DS' is referring to the research methods carried out. The 'R' stands for 'residue', the 'U' for ultrasonic bath and 'DS' for the dry scraping method. The residue of 16 lithics from the 35 lithics studied have been subjected to starch grain analysis, therefore only sample 01CA-R/U until 16CA-R/U/DS have the addition 'R/U'. Sample 09CA-R/U/DS until 16CA-R/U/DS are the only 8 lithics also analyzed with the dry scraping method. All samples from 01CA-R/U until 35CA were analyzed for use wear. A complete list with the labelling of the 35 lithics can be found in Appendix A.

4.1.3. Rock genesis

All 35 lithics have been researched by BA-student Rosa Verheij and MA-student Denice Borsten with NEXUS1492 PhD Alice Knaff as supervisor from the Free University of Amsterdam for identification of the rock genesis. They analysed the 35 lithics for weathering of the surface and grain size. The results of their study will be described in Chapter 5.1. A complete overview of their research is attached in appendix D.

The classification of the rock genesis is based of composition and texture of the raw materials. Three main families of rocks exist, namely sedimentary, igneous and metamorphic rocks (Andrefsky 2005, 46). The difference between these three families is based upon the process of how the rocks were created. Sedimentary rocks are created by the cementation of sediments on the surface (Andrefsky 2005, 46). Igneous rocks are formed from molten rock which solidifies below the surface of the Earth (Andrefsky 2005, 46). Metamorphic rocks are created by pressure and high temperatures below the surface of the Earth from sedimentary or igneous rocks (Andrefsky 2005, 46). These three families can be further divided by the identification of minerals found and texture (Andrefsky 2005, 46). The results from the research by the students of the Free University of Amsterdam utilised the minerals and textures of the lithics to identify the rock type

4.2 Field Methodology

The 35 lithics were retrieved during excavations at El Carril in 2017 and 2018. At the site of El Carril general excavation methods were used defined by the NEXUS1492 project. The units were set out with a unique system, which enables the finding of the exact location of each unit, even after closing it again. This system, the so-called 'zone-sector-square' system, works with the x and y coordinates of the Universal Transverse Mercator (UTM) coordinate system. The corners of the squares were located at each whole meter by using a Robotic Total Station. Every unit consisted of multiple squares depending on the research question asked. Each square is 1 x 1 meters. In one sector fit 10 x 10 squares and in one zone 10 x 10 sectors, which is equal to 1000 x 1000 squares. The numbering of the squares is 0 to 9 and is determined by the x and y coordinates. For example, if a square is number 25, this x of this coordinated ended on 2 and the y on 5. This number will be 35 after ten squares to the north and will be 26 when one square to the east. Each unit was excavated per square in 10 centimetre intervals, which is called a layer. For excavating multiple tools were used, such as trowels, shovels, and pickaxes. Sieves with 4 mm mesh were used for sieving or 2 mm for specifically sieving burials. Findings included ceramics, animal and human bones, lithics, shell, coral, land and sea snails and charcoal. All the findings were placed in bags per category, per square and layer. However, *Codakia orbicularis* (American Tiger Lucina) and *Lucina pectinata* (Thick American Lucina), seashells, lithics and special ceramics which might have been used for cooking were each placed in separate, clean, new bags to avoid contamination because these findings could contain plant residues. All of these single packed findings received their own find number.

The recovered lithics can be divided into flakes, adzes, celts, grinding stones, pebbles, green adzes, and mortars. These were counted and weighed per layer, square and unit, and subsequently kept stored in the plastic bags. The weight of the plastic bags was deducted from the total weight. The movement of the plastic bags containing the lithics caused them to lose some of the covering dirt inside the bags. After making notifications of these measurements, the lithics were stored per unit in a larger bag, which was placed in a plastic box. The plastic boxes are stored in the room where all other findings of the excavations are being held.

The 35 selected lithics were not stored in the Dominican Republic, but transported to the Faculty of Archaeology in the University of Leiden in the Netherlands for further analyses, with great care for preventing damage.

4.3 A combined starch grain-use wear approach

A combined starch grain – use wear approach was chosen for this research. With this combination the possibility exists to relate the results from two typically separate analyses. The starch grain analysis can provide an insight in human-plant interactions of the past, and the use wear analysis can give clues about the contact material and motion used of the studied artefacts. If starch is recovered from a lithic which contains use wear, and the starches are not contaminated, then one can learn more about the possible function of this lithic. Previous studies in the Caribbean such as Briels (2004) and Lammers-Keijsers (2007) which focused on use wear analysis, only mention residue analysis shortly. Nieuwenhuis combined the use wear analysis with the residue analysis (Nieuwenhuis 2008, 129).

This research will combine both methods which will be described in the next sections. Each section will provide background information to the applied method, as well as the specific methodology followed. As discussed above, starch grain analysis was conducted first, to prevent modern contamination or damage to the residues through the handling required in use wear analysis. The starch grain analysis was done under guidance of Andy Ciofalo, PhD candidate in the NEXUS1492 project and the use wear analysis was supervised by Dr. Tom Breukel.

4.3.1. Background Information for Starch Grain Analysis

Worldwide, starch grain analysis has become an important tool for archaeological research. Due to limited organic preservation, starch analysis in the Neotropics, including the Caribbean, is crucial for understanding human-plant interactions (Pagán-Jiménez *et al.* 2005, 8). Through the identification of archaeological starch grains to certain plant taxonomic levels (family-, genus, species, or a variety within), it is possible to gain insights into those starchy plants used by humans in the past. Even more informative, the type of culinary practice damage (if present) on a starch grain in combination with the archaeological contexts in which an artefact was recovered, could provide information about certain cooking processes or manufacturing techniques. Therefore, this sub-chapter will give general information about the methodology of recovering and interpreting starch analysis in archaeology.

4.3.1.1 The formation of starch

Plant production of starch starts with the process of photosynthesis. In the chloroplasts (the green plastids which give the plant colour), the energy of sunlight is converted into a solid form of potential energy. The energy of sunlight causes a series of reactions within the chloroplasts where water (H_2O) is split into hydrogen (H) and oxygen (O), and then recombined with the free hydrogen (H) and absorbed carbon dioxide (CO_2) to form glucose (Gott *et al.* 2006; Pagán-Jiménez 2011; Shannon *et al.* 2009). This sugar is a basic 'building block' for all substances that the plant needs for the process of photosynthesis. These substance are: fat, protein, and complex carbohydrates, the latter of which starch and cellulose are part of. A part of the sugar building blocks are transported to amyloplasts (starch plastids) which is a specialised unit for long-term storage of reserve or storage starch (Gott *et al.* 2006, 35).

Starch is a form of energy storage which, in case of need, the plant is able to utilise, converting the stored starch back into sugar and transferring this to the required parts in the plant. During the day when the rate of photosynthesis is high, transitory, temporary, or transient starch granules are formed within the chloroplasts as well. Overnight these transient starch granules are reconverted to sugar to transform into storage starch or as energy for other locations of the plant (Gott *et al.* 2006, Shannon *et al.* 2009). These transient starch granules are small, about 1 to 4 µ in length, and identification is highly unlikely, because transient starch does not contain diagnostic features relatable to species (Gott *et al.* 2006, Pagán-Jiménez 2015; Shannon *et al.* 2009).

4.3.1.2 Starch storage locations

By knowing the starch storage locations, the possibility arises to trace what kind of plant parts have been used in the past. Not all plant parts contain the same amount of reserve starch in starch storage locations. Namely: tubers, rhizomes, underground stems, roots, and seeds contain a higher concentration of starch storage locations, while minor starch storage locations are found in plant fibres. This difference gives an insight into how starch from plants could have entered the archaeological record, for example through consumption or from parts of plants which have been used as tools, and from wild as well as cultivated plant parts (Gott *et al.* 2006, Shannon *et al.* 2009).

4.3.1.3 The morphology of a starch grain

As plants differ in size and shape, so do starch grains as well. The morphology of a starch grain is mostly species-specific (Gott *et al.* 2006, 40). The size and shape of starch grains also depend on the organ of the plant from which it derives, and time. No two starches are exactly the same, some plant species even have different distinct forms of starch, and others have highly diagnostic features to assign starch to a certain plant species (Gott *et al.* 2006, 40). Overall, starch is recognizable under the microscope and can be distinguished from pollen, phytoliths, plant fossils and other (in)organic substances by considering some of their general optical properties, such as the extinction cross produced when starches are seen under polarised light (Gott *et al.* 2006, 40).

The following features are also characteristics of starch: hilum, fissures, lamellae, extinction crosses, facets and borders (see fig. 4.2). The **hilum** is the starting point from which the granule grows during the process of photosynthesis. This is the core of the granule, mainly located near the middle of the granule, but sometimes located near the edge, which is referred to as ‘eccentric’. The hilum is usually circular, but it could also be triangular in some species. Closely located to the hilum are natural **fissures**. These stem from the hilum. Fissures vary in shape between lineal or stellate. **Lamellae** are growth layers of amylose and amylopectin, which are created in layers and concentrated around the hilum.

The **extinction cross,** sometimes referred to as a Maltese cross, is visible by looking through the microscope with cross-polarised light. The ‘arms’ of the extinction cross near the hilum. Extinction cross arms have different visual forms such as, undulating, angular, curved, depressed, or straight. Some starch have **facets**, occasionally these are highly diagnostic features to help identify some plant species. These are indications of compression that occurred during formation of a starch in a starch cluster in the plant. The **borders** of a starch grain can be understood as the edge of the starch. This can be a combination of a single or double clear or dark line (Gott *et al.* 2006, Pagán-Jiménez 2007).

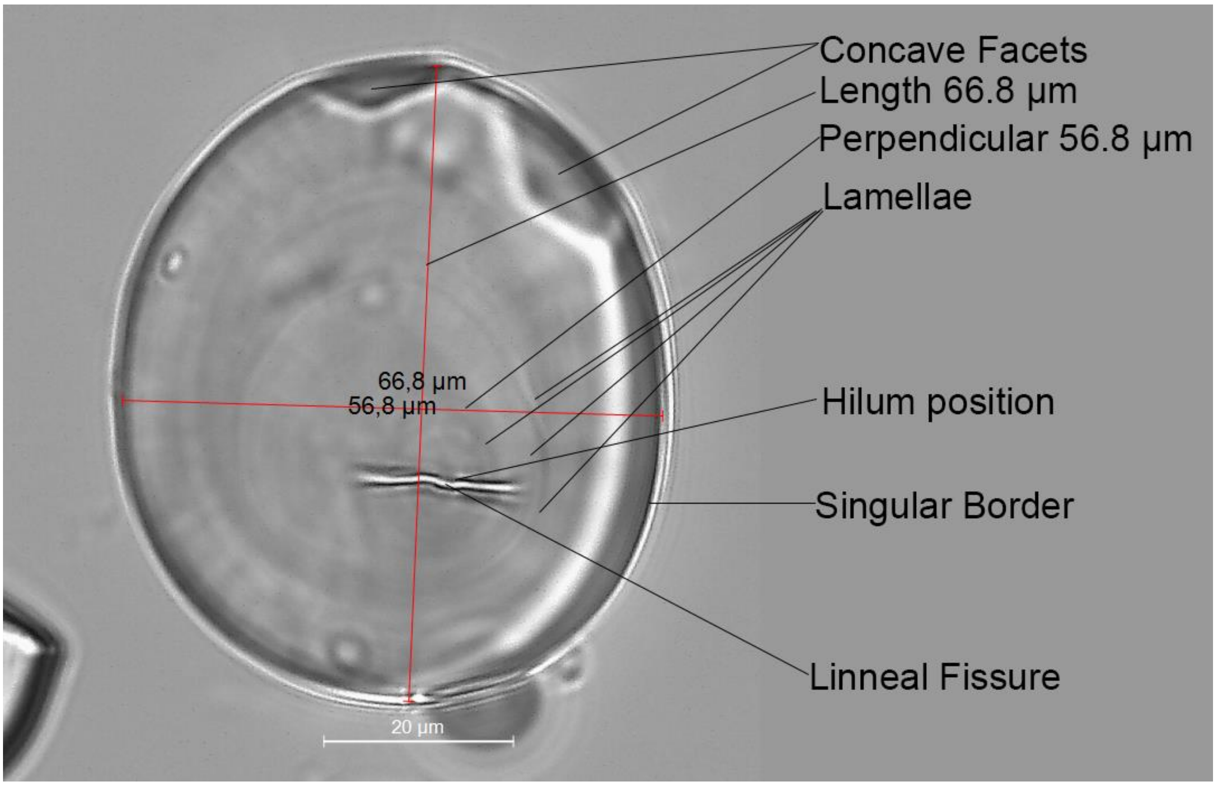

Figure 4.2: *Features of the starch grains. The hilum, fissures, lamellae, facets and border are pointed out. Made by Andy Ciofalo.*

Size and **shape,** also known as morphometrics are characteristics to help taxonomically identify starch. The shape of a starch has a wide variety of common forms, such as: disc-shaped, kidney-shaped, spheres and polyhedral. The storage location of the starch might influence the shape. The size of the starch varies between 1 µm and 140 µm and can be influenced by many environmental factors and the age of the granules. Younger granules tend to be smaller than older ones. Also, the environmental conditions wherein a plant lives influence the size of the starch. During periods of stress, for example during drought when the general nutritional status of plants is limited, the size of the starch is smaller. The plant produces less carbohydrates which affects the production of starch. (Gott *et al*. 2006, 42).

4.3.2. Starch grain analysis

From the 35 assessed lithics, 16 samples were selected with guidance by Prof. dr. Corinne Hofman, which were considered to have the highest possibility to have been used as scrapers or at least look like scrapers. Of these 16 lithics, 7 were first researched with the dry scraping method to see if one specific spot of the lithic could contain more starches than the entire lithic. Afterwards, these 7 lithics with the other 9 lithics will together be examined on starches by using an ultrasonic bath for extracting starches from the entire surface of the artefact. For the scraping process a plastic stirring rod was used which does not leave traces after scraping, preventing the creation of new traces on the lithics.

4.3.2.1 Dry scraping method

The following steps have been taken during the dry scraping method. In between every step or contact with the lithic, my hands were thoroughly washed with water without soap and cleaned with disposable paper towels to avoid contamination. The table I was working on was cleaned in between stages with water and disposable paper towels. The door in laboratory in Leiden I was working in was closed the entire time to prevent potential airborne contamination inside the room. The next steps were taken per artefact, there was always one artefact per time taken out of the plastic bag.

1. Hands and working space thoroughly washed between each sample extraction.
2. New and un-used printing papers were placed on the table to handle each sampled artefact.
3. Each artefact was removed from the plastic bag.
4. Each artefact was handled between fingertips above the new, unused paper and without touching it.
5. Selected spots of the artefact (with possible use-wear macroscopic traces) was scraped with a new, clean, plastic disposable coffee stirring rod.
6. Each artefact was placed back in their original plastic bags.
7. The scraped residues were transferred to a new, plastic 1.5 ml micro centrifuge tube from the paper.
8. Used papers and plastic stirring rods were properly discarded.

4.3.2.2. Ultrasonic bath method

For extracting starch grains from lithics an ultrasonic bath at 42KHz (frequency) was used. This method dislodges any remaining plant residues while preventing the creation of new traces on the lithic, by vibrations of the water, and is therefore ideal for this research. In total 16 lithics have been put in the ultrasonic bath, including the 7 of which the dry scraping method was first performed. The described protocol below was based upon on Pagán-Jiménez (2007) and Pagán-Jiménez *et al.* (2015) and personal communication with Dr. Pagán-Jiménez.

1. **Artefacts were placed in a small, new zip lock bag filled with ultrapure water until the lithic was completely covered in water.**
2. **Soak for 5 mins.**
   Depending on the amount of sediment that had become lose after 5 minutes of soaking, some lithics were put before others in the ultrasonic bath. No record had been made about which lithic was soaked longer in the ultrapure water than others.
3. **Artefacts were placed in the ultrasonic bath for 6 mins.**
   For samples 6CA-R/U, 8CA-R/U and 12CA-R/U, 6 additional minutes were needed in the ultrasonic bath because it looked like not all sediment had come loose of the lithic. For sample 7CA-R/U, 12 additional minutes were needed.

4. **One corner of the bottom of the zip lock bag was cut off.** This was done by scissors which were firstly washed and thereafter heated with a lighter to remove any possible starches on the scissors.
5. **The sample solution was drained into a new, 50 ml centrifuge**
   In the case of samples 3CA-R/U, 4CA-R/U and 11CA-R/U/DS two 50 ml centrifuge tubes were needed for pouring all the sample solution with residue/sediments in. For sample 8CA-R/U, three tubes were used. If necessary, all tubes were filled with ultrapure water to the maximum volume of 50 ml. This had been done in preparation for the next step because all tubes need to have the same volume to have an equal division of balance during centrifugation.
6. **The tubes were placed inside a centrifuge (Multifuge 3. Heraeus) for 5 mins at 3000 rpm**. In total 21 tubes were used for holding the sample solutions. Ten tubes were centrifuged at a time to comply with the capacity of the centrifuge. Centrifuging forces all the sediment to the bottom of the tube, leaving the top with purified water.
7. **The supernatant was decanted in the sink by turning the tube slowly downwards in one single action.** To prevent losing any sediment, the turnover was done at eye level for the best view of the contents in the tube.
8. **The tubes with the extracted residues/sediments were placed to** dry at 25°C over **a radiator for a couple of days.**

After 7 days, the sediment was dried enough to continue with the flotation process described below, based on Pagán-Jiménez (2007) and Pagán-Jiménez *et al.* (2015):

1. The weight and volume of the dried residues/sediments were measured.
2. 0.1 ml of a solution of Caesium Chloride (CsCl) with a specific gravity of 1.8 g/cm^3 was added to each sample in the centrifuge tubes.
   Due to starches generally having a mean specific gravity of 1.5 g/cm^3 the solution will make them float if they are present in the residue/sediment sample. Using a cleaned, glass stirrer residues/sediments were mixed with the CsCl in each tube. The glass stirrer was washed and heated with a lighter to remove any possible starches and prevent contamination between tubes.
3. The tubes were placed in the ultrasonic bath for 2 mins to completely loosen the sediment from the inner side of the tube and to better mix it with the CsCl. This step also aids in releasing starch from conglomerated and/or carbonized residues.
4. The tubes were placed in the centrifuge for 8 mins at 2400 rpm. This flotation process will begin to separate the starches from the small sediment particles and let them float to the top of the solution.

5. The supernatant, where any starches would be contained was transferred from the 50 ml tube to a smaller 1.5 ml tube using new disposable pipettes.
   For each sample a different pipette was used to prevent contamination.
6. Ultrapure water was added to the 1.5 ml tubes to the maximum volume.
7. The tubes were placed in the centrifuge for 6 short centrifugation rounds through rotating the tubes each time. After placing the tubes in the centrifuge, the device is turned on until it reaches 7000 rpm. When the centrifuge reaches 4000 rpm, the device is turned off and the tubes are rotated 180° to face the opposite side. In this way the starches were moved downwards. This avoids losing starch during the following washing steps.
8. A centrifugation of 8 mins at 9000 rpm was carried out.
9. The supernatant was pipetted off and discarded decreasing the liquid volume from 1.5 ml to 1.0 ml and filled up with ultrapure water until 1.5 ml. These 8 mins of centrifugation will cause to place the starch at the lowest part of the tube, but they cannot be forced quickly, therefore only 0.5 ml was removed.
10. The tubes are placed in the centrifuge for 6 short centrifugations instead of 15 mins resting vertically (see step 7).
11. A centrifugation of 8 mins at 9000 rpm was carried out.
12. The supernatant was pipetted off and discarded decreasing the liquid volume from 1.5 ml to 0.5 ml and filled up with ultrapure water until 1.5 ml. These 8 mins of centrifugation will cause to place the starch at the lowest part of the tube, but for this time 1.0 ml was removed.
13. The tubes are placed in the centrifuge for 6 short centrifugations instead of 15 mins resting vertically.
14. A continuous round of 8 mins on 9000 rpm is done when residues/sediments are nicely located near the bottom of the tube of the previous step.
15. The supernatant was pipetted off and discarded decreasing the liquid volume from 1.5 ml to 0.2 ml and filled up with ultrapure water until 1.5 ml. These 8 mins of centrifugation will cause to place the starch at the lowest part of the tube. This time 1.3 ml was removed. The amount of 0.2 ml volume was chosen to continue working with for preparing slides because it can fit comfortably on a slide and under a coverslip without losing any of the sample.

4.3.2.3 Slide preparation

The next step is to prepare the slides. In total 30 slides were prepared, 14 of the dry scraping method and 16 for the ultrasonic bath method. The 30 slides were prepared by two at one time. The liquid inside the tube was mixed with 0.05ml of glycerine with the plastic pipette belonging to the sample number. This makes it possible to rotate starches in the mounting solution by putting light pressure to the glass covers of each slide. All slides were scanned with a Leica DM 2700P microscope with a magnification of 100x with cross-polarizing capacity. Each slide was first put with the slide label towards the bottom of the microscope stage, and afterwards turned around, under the microscope. With moving up and down in a s-shaped movement, the slide was completely scanned trough the microscope. After finishing, the slide was stored horizontally in a cardboard holder in a drawer. These are kept for preservation and in case more observation or future analyses are needed.

4.3.2.4 Microscope photographs

When a starch was encountered, or something what looked similar to a starch, a minimum of 10 pictures were taken with magnifications of 400x or greater. The first four pictures were all taken of the encountered position of the starch, but with different polarisations and fields (dark, colour, bright). The first picture was in colour view without any polarisation to recognize a different starch in the gallery of pictures and is also the only one taken with colour. The second picture and all other following pictures are in grey scale for possible publication. The third picture was taken with dark field and cross polarisation to recognize if visible and present the extinction cross, the fourth picture was with bright field to recognize other features such as facets, lamellae, and fissures. The following three pictures were also made in bright field, but with changing the focus to help view the starch in three dimensions. Continuously, one picture was taken in bright field and copied three times adding a scale bar and the measurements of length and width of the starch. Afterwards, multiple pictures were taken in bright field of the starch while it was manually rotated to view its different sides.

All pictures were afterwards shown to Dr. J. Pagán-Jiménez or Andy Ciofalo to check if the starch in the picture was most likely a starch or a starch-like particle with birefringence similar to starch. These two researchers were also consulted for feedback on plant identifications.

4.3.2.5. Methodological limitations

After finishing the previously described steps for the starch grain analysis, it became clear that for further research some steps should be carried out differently in order to attain a better chance for extracting and recovering starches. During the second step of the ultrasonic bath method, the lithic artefacts were only soaked for 5 mins to loosen the sediment attached to the lithics. According to personal contact with Andy Ciofalo, soaking lithic and shell artefacts for at least 24 hours can give a completely different outcomes in the amount of starches recovered than soaking an artefact for 5 minutes. All lithics should have soaked equally in time, instead of making differences in the visible amount of sediment that had come lose. This also is the case for time spent in the ultrasonic bath. Each sample should have been for the same amount of time in the ultrasonic bath, instead for two samples 6 minutes more as described in step 3.

In section *4.2.2.3. Preparing slides*, the slides were prepared two at a time. This should have been done one at a time to prevent possible cross-contamination. No pipettes have been mixed up during this research, but this is mentioned to consider for further research.

The identification of the starches as written in Chapter 5.3 was singly based on published reference collections in '*De antiguo pueblos y culturas botánicas en El Puerto Rico* indígena' (2007) and '*Almidos Guía de material comparatio modern del Ecuador para lose studios paleoetnobotánicos en el neotrópico'* (2015) both written by Dr. J. R. Pagán-Jiménez, as well as a host of other published sources regarding archaeological starch identification and interpretations of culinary practices (Chinique de Armas *et al.* 2015; Mickleburgh and Pagán-Jiménez 2012; Piperno and Dillehay 2008). For a more secure identification of the starches recovered of the lithics, a small reference collection should be made with 10 starches from a modern starch grain reference collection made by Andy Ciofalo. These 10 starches would have been measured and with these results the discovered starch grains from the 35 lithic samples could have been compared with. This would have led to a more secure identification of the starches identified.

The next chapter will describe the results of the starch grain in part *5.1 Results starch grain analysis.* The identification of the starches was based upon the comparison of at least two published sources as described above. A more secure identification can be given when 10 starches from modern starch samples of reference collections were measured. For this pilot study the comparison with published sources is sufficient.

4.3.3. Use wear analysis

The use wear analysis was carried out after the starch grain analysis was completed. As discussed earlier, the starch grain analysis was conducted first to prevent modern contamination or damage to the residues during handling.

4.3.3.1 Background information for use wear analysis

Use wear analysis is studying the surface of an artefact for modifications which are caused by contact material and motion (Lammers-Keijsers 2007; Van Gijn 1990). This analysis was developed by Semenov in the thirties (Tringham *et al.* 1974, 172). Semenov was the first to conduct experiments on a larger scale by systematic testing of various materials with different actions for making statements about the cause of edge damage (Tringham *et al.* 1974, 172). He relates different types of edge dames to function. At the time of when his work was translated to English 'Prehistoric Technology' in the sixties, Francois Bordes was working on the replication of flint tools (Andrefsky *et al.* 2005, 4). Bordes was an experienced flintknapper and able to relate techniques of reduction sequence and tool refitting by replicating stone tool forms (Andrefsky *et al.* 2005, 4). He shared the opinion that stone tool function is related to morphology, in opposition to the work of Semenov. Their difference between opinions started a debate in the second halve of the last century between 'functionology' from Semenov and 'typology' by Bordes (Tringham *et al.* 1974, 172). In this research both opinions will be reviewed and considered.

In the work of Semenov different techniques had been applied for systematically working and researching the damage of the edges of the stone tools. One of these techniques is the ‘low power method’, where a microscope is used with magnifications up to 100x. With this technique, edge damage such as edge removals, edge rounding, striations and polish can be observed and interpreted. To be more precise about what kind of material caused these edge damages, the ‘high power method’ can be more secure. This method was developed by Keeley in 1980 wherein a microscope with magnifications up to 400x is used (Andrefsky *et al.* 2005; Grace 1996; Keeley 1980; Lammers-Keijsers 2007; Van Gijn 1990). Until the Uppsala conference in 1989, discussions were made whether the low or high-power method was the best to study use wear traces. During the congress it became clear that these methods are not interpreted as competing techniques, but two alternative strategies of which method the chosen depends on the research questions asked (Grace 1996, 211). The combination of both techniques is also possible (Grace 1996, 211).

As mentioned above, use wear can be divided into four different categories: polish, striations, edge removals and edge-rounding (Grace 1996; Keeley 1980; Lammers-Keijsers 2007; Van Gijn 1990). Below these terms will be explained and which definition is used for this research.

<u>Polish</u>: The visible alteration of the surface of the artefact due to the reflectivity of light when viewed through the microscope (Grace 1990, 210). In the previous century there was discussion between researchers what polish exactly is and what caused it. Keeley (1980) was the first researcher to mention polish as results between various contact-materials, but he did not give a definition. In 1981 Vaughan came with a definition of describing polish as an altered surface of the artefact which reflects light and what cannot be removed with acids, solvents and bases (Vaughan 1981, 132). However, according to research by Van Gijn (1990), polish can be removed or heavily affected by the use of chemicals. This makes the definition of polish even more unsecure. Other researchers have tried to describe polish with subjective words as ‘smoothness’ or ‘melting snow bank’, but this is opinion based and differs between researchers (Grace *et al.* 1985, 112).

Polish as the main variable to relate use wear to function is inadequate. The formation of polish is very complex. The variety of contact-materials in combination with different motions leaves a complexity of traces. For example, an unretouched flake used for whittling wood causes different polish as for scraping wood with an end-scraper (Grace *et al.* 1985, 118).

<u>Striations</u>: Most researchers rely on striations for the inference of the motion involved as mentioned in Keeley (1980), Vaughan (1981) and Van Gijn (1990). Keeley even went further to specify length, width and depth of striations to a certain contact-material. Tiny particles can break off during processing of the tool. Researchers generally agree about the presence of these tiny, abrasive particles as cause of striations (Van Gijn 1990).

Striations can be further divided and described according to the state of the surface during the utilization of the tool (Mansur-Franchomme 1983, 229). Not all tools are used for the same exact amount of time and leave therefore different type of striations. The abrasive particles which break off during processing of the tool act upon gel, because the motion causes the siliceous surface of the tool to transform into a silica gel. Therefore, Mansur-Franchomme has divided striations in three different categories according to the amount of liquid added during the process. The solid gel state correspondents with working with little dissolution, when the worked materials are almost dry or the tool is in use for a short amount of time. The striations which occur have a granular bottom. The fluid-gel state, as what the name suggests, is working with maximum dissolution, when the materials are wet or fresh. Very few striations form. The intermediate-gel state is in between the previous two states, working with wet hide. The striations caused have a 'smooth' bottom with a linear deformation along the edge surface (Mansur-Franchomme 1983, 229).

Considering striations as the main variable for use wear can be helpful, but the abrasive particles caused during motion are dependent on different variables such as contact-material, motion and state of fluidity, and therefore are not suitable for consideration as the main factor.

Edge removals: The chipped-edge of an artefact is recognized as edge removals or retouch. The size and shape of such 'chipped edge' is relatable to the different contact-materials used, the resistance and friction of these contact-materials and the motion used (Odell and Odell-Vereecken 1980; Tringham *et al.* 1974). Scraping skin would leave different traces than scraping bone. To make a distinguish between the "hardness" of different contact-materials involved, the following 'rank-list' was made:

1. Soft materials: meat, skin and fat from animals and tubers, rhizomes, stalks and leaves from vegetal substances. The scarring is small with feather terminations.
2. Soft to medium materials: coniferous trees and fresh stalks as example for soft woods. The scarring is larger (visible with naked eye) and has usually feather terminations.
3. Medium to hard materials: hard woods, soaked antler and fresh bones. The scarring is medium to large sized and hinged.
4. Hard materials: bone, antler and hard, dry wood. The scarring is stepped medium to large in size with stepped terminations.

(Odell and Odell-Vereecken 1980, Tringham *et al.* 1974)

Edge removals can be used as a characteristic for intentional damage. However, edge removals can also be caused by other, not intentionally caused factors. For instance, trampling, transport and soil compaction might cause damage after the time of inhabitation of the site where the artefact was found. Also, during the excavation, the sieving and transportation can cause scattering of the edge (Lammers-Keijsers 2007; Marreiros *et al.* 2015; Van Gijn 1990; Vaughan 1981). Chipping of the edge also might happen as by-product of intentional retouching. Therefore, edge removal is not a dominant characteristic for intentional damage and best considered in conjunction with other characteristics for use wear (Van Gijn 1990).

Edge-rounding: The edge of the tool is less sharp, and rounded. This will be caused to some extent by any contact-material. The difference in rounding of the edge can sometimes be related to the type of contact-material used, with hide-working caused a more rounded edge then working bone (Van Gijn 1990, 8).

Edge rounding is not recommended as a main variable for use wear because other factors such as the lithic embedded in a sandy matrix can also cause edge rounding (Van Gijn 1990, 8).

4.3.3.2 Classification

For this research the low and high-power methods mentioned above were both used for making a distinction between the 35 lithics for which lithic is definitely used and which one has no trace of wear. First the lithic had been studied for traces of wear as edge removals, edge rounding, striations and polish with the low power method by using a Leica DM with magnifications up to 100x. If traces of use wear were encountered, notes were placed on the drawing of the lithics for registration. Initially, the high power method was applied by using a Leica DM with magnifications up to 400x, for gaining a better overview of the entire surface of the flakes of mostly sedimentary rocks. But because the primary focus of this research was the presence of use wear traces and not for the contact-material, the high-power method was not used for further identification of the use wear traces.

Even though the contact material has not been identified, the motion has been interpreted by the traces of use wear presented. In this research, the motion is described either as transverse motion, longitudinal motion, or a combination of both (see fig. 4.3). Transverse motion is where the tool is placed crosswise to the axis of the object worked on, and longitudinal motion is where the tool is placed parallel to the axis of the object worked on (Andrefsky 2005).

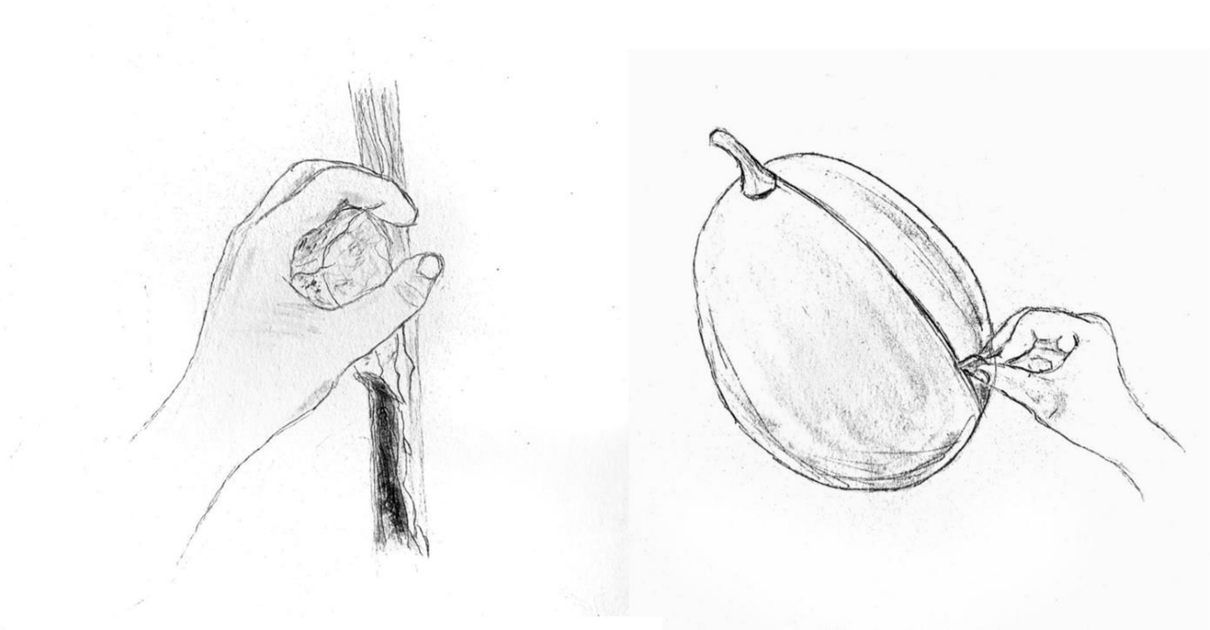

Figure 4.3: *An example of a transverse motion (scraping) and longitudinal motion (cutting). Drawing by Betül Türkyilmaz.*

Five categories of tool-use were identified according to the traces of wear encountered during analysis of the low. This are: ‘definitely used’, ‘possibly used’, ‘intentional debitage’, ‘not used’ and ‘indeterminate’. The distinction between each category depends on the developed wear traces of use encountered and if motion was identified.

4.3.3.3 Cleaning

All artefacts were cleaned with tap water. The 16 artefacts, which had been in the ultrasonic bath for 6 mins or in some cases 12 to 18 minutes, were not cleaned again after drying for one night and stored in a new, plastic bag. The 19 artefacts designated solely for the use wear analysis were washed twice by hand and dried 30 minutes on each side before storing in the plastic bag.

After washing, all artefacts contained still areas with residue. Therefore, it was decided that hydrochloric acid 10% would be used to remove the remaining sediment. We started with sample 19CA and 31CA. This consisted of 5 minutes in a plastic cup with hydrochloric acid 10% in the ultrasonic bath to remove the sediments, followed by 5 minutes in a cup with potassium hydroxide (KOH) to neutralise the acid. After this process, the artefact was held under running water with plastic tongs to allow manual handling of the artefact afterwards. After drying for two times 30 minutes on each side, the artefact no longer had any residue, however the hydrochloric acid 10% did affect the surface of the lithic as well. This could mean that possible use wear also could be affected by the hydrochloric acid 10%.

It could be possible that 19CA and 31CA are metamorphic stones and could contain a small amount of limestone, what is heavily affected by hydrochloric acid. To be sure that this was not a coincidence, a drop of hydrochloric acid 10% was placed on sample 21CA, 26CA and 30CA. All three samples reacted differently with the hydrochloric acid, but enough to stop cleaning the other artefacts with hydrochloric acid. This therefore implies that most lithics have traces of residue from the soil where the lithic had been preserved in.

4.3.3.4 Limitations

As mentioned as characteristic of edge removals, there are certain limitations of use wear analysis and therefor for this research as well. First to expand with post-depositional traces. Edge removals, edge-rounding, abrasion, metal polish, friction polish and patina might also be caused by post-depositional traces. This can be caused by the environment in which the artefact was located in, for example by taphonomic processes such as, water, wind, heating, erosion or soil acidity. Archaeological research itself might also cause traces by excavating with shovel or trowel, or by trampling or transport (Andrefsky *et al.* 2005; Grace 1996; Keeley 1980; Lammers-Keijsers 2007; Marreiros *et al.* 2015; Van Gijn 1990; Vaughan 1981).

The author of this thesis has no previous experience with material culture studies. This means that all results are based on currently built knowledge and minor experience with practicing with the microscope (Leica M80 for the low power method and Leica DM1700 for the high-power method) with experimental artefacts in the science lab at the Faculty of Archaeology, Leiden University. At the final stage of the research, all results were checked by Dr. Tom Breukel to prevent misinterpretations.

Only the motion used had been identified with the use wear analysis. The contact-material was not further researched as the research question was about the presence of use wear for indicating use. This has limited the scope of this research in the broad view of interpretations of the domestic and craft activities carried out El Carril.
All artefacts were extremely weathered. Therefore, it has been in some cases almost impossible to give a clear identification of the use wear encountered, if there was any. All lithics have been washed with tap water and soap, but this did not provide the desired outcome. To overcome the problem of visibility of use wear traces, two lithics had been cleaned with hydrochloric acid for testing. The results of these tests will be further discussed in Chapter 4, but it became clear that the hydrochloric acid highly affected the lithics leaving no surface with traces. Lithics which contained convincing use wear traces for this thesis continued to be studied without further cleaning. For future research an improvement in the cleaning process is recommended.

4.4 Overview

The flaked materials were analysed in line with the methodology of the combined starch grains-use wear approach. First, the residue of the flaked materials was extracted and analysed for the presence of starch grains. The dry scraping method was initially applied in order to see if certain spots contained more starches then the entire surface of the flaked materials, which were then subjected to the ultrasonic bath method. Thereafter the flaked materials were researched with the use wear analysis to indicate if traces of use wear were present. This was mainly indicated with the low power method, the high power method had not been further applied for the identification of the contact-material of the use wear traces. Lastly, the flaked materials had been studied by the students of the Free University of Amsterdam for identification of the rock genesis.

The next chapter will present the results of the combined starch grain-use wear analysis and the identification of the raw materials used. The domestic and craft activities carried out in El Carril can be identified from the results presented and will be further examined in the discussion.

5. Results

This chapter will present the results of the combined starch grain-use wear approach explained in Chapter 4. The results will be described according to the order in which the methods were used, as mentioned in Chapter 4. First the results of the rock genesis carried out by students of the Free University of Amsterdam will be described, although this research took place after finishing the combined starch grain-use wear approach, due to scheduling differences. Thereafter the results of the dry scraping method will be described, followed by the results of the starch grain analysis. And, lastly the results of the use wear analysis are described per classification of damage. The chapter will end with the conclusion of the results combined.

5.1 Results for rock genesis

Not all types of lithics present traces in the same way, with differences between fine- and coarse-grained material on whether processes leave a trace and the amount of time needed. The knowledge of the author is insufficient to identify the different lithic types used, therefore all artefacts were studied by BA-student Rosa Verheij and MA-student Denice Borsten with Alice Knaff as supervisor from the Free University of Amsterdam for determination of the rock types. Every lithic was described by the sample size, grain size, fresh surface and weathering surface, with an overall description. Their results are included in Appendix D.

From the 35 lithics researched, the main category of species encountered is siltstone. In total 14 pieces were identified as siltstone, these are 03CA, 04CA, 05CA, 06CA, 07CA, 11CA, 12CA, 13CA, 15CA, 26CA, 28CA, 29CA, 33CA and 34CA. The category is not fully homogenous, only 04CA, 05CA, 33CA and 34CA are. The other artefacts mentioned consist of impure siltstone, impure calcareous siltstone, quartz rich siltstone or banded bioturbated siltstone (see fig. 5.1). Siltstone is a clastic sedimentary rock.

The second largest category is rhyolite. The artefacts with number 02CA, 08CA, 22CA, 23CA and 27CA are subdivided in rhyolite. This category is also not homogenous and contains altered rhyolite, metamorphosed rhyolite with a low grade or foliated. Rhyolite is an igneous rock.

Two categories contain each four lithics. This is the category metamorphosed tuff, containing artefacts with numbers 19CA, 21CA, 24CA and 31CA. Some are poorly sorted or impure. Artefacts with number 09CA, 20CA, 30CA and 32CA are categorised as greenschisted basalt. All artefacts are from this category were homogeneous. Basalt is an igneous rock.

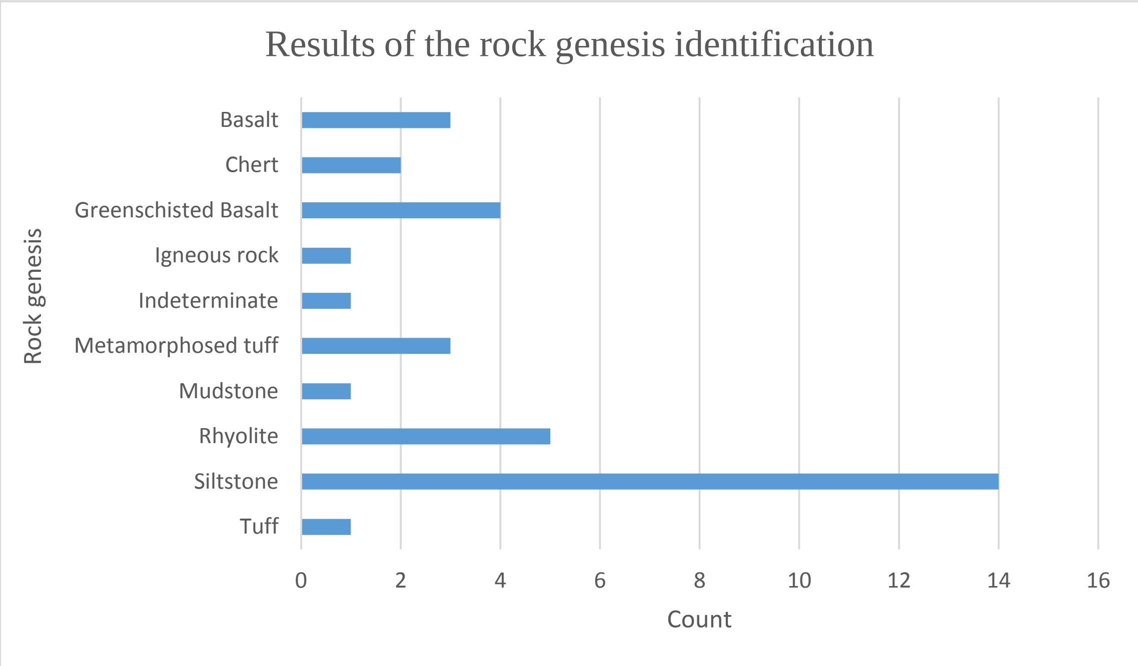

Figure 5.1: *Results of the rock genesis identification.*

Three other artefacts are also made from basalt or an igneous basaltic rock, these are 14CA, 18CA and 25CA. Two artefacts consisted of chert, namely 10CA and 16CA. One artefact was made of impure quartz rich mudstone, 01CA. Another artefact with number 35CA was igneous and one artefact was unable to be identified because this lithic was too much weathered, 17CA.

The two artefacts which were cleaned with hydrochloric acid were still able to be identified, these are 19CA and 31CA. Both are categorised as metamorphosed tuff.

Overall, all artefacts are very weathered which makes precise identification and description very difficult.

5.2 Results Dry Scraping Method

Of the El Carril sampled lithic assemblage, the residue extracted from Samples 09CA-R/U/DS through 16CA-R/U/DS by using the dry scraping method was researched with the starch grain analysis. None of these samples contained starches in either the ventral or dorsal side samples. Most slides were empty and quickly scanned through, only 11CA-R/U/DS contained multiple cellular tissue but nothing of interest for further interpretation.

5.3 Results starch grain analysis

The analysed El Carril lithic assemblage provided positive evidence for the presence of starches on flakes of mostly sedimentary rocks, however, the amount of starches was very limited. From the 16 samples investigated for starch content with the ultrasonic bath method, five samples contained starches (see fig. 5.2). In total six starches were recovered, of which sample 08CA-R/U contained two starches. Sample 03CA-R/U, 05CA-R/U, 07CA-R/U, and 09CA-R/U each had one starch recovered. Of these six starches, four starches were identified to family level because they were slightly damaged and two starches were too damaged to be identified to any taxonomic level.

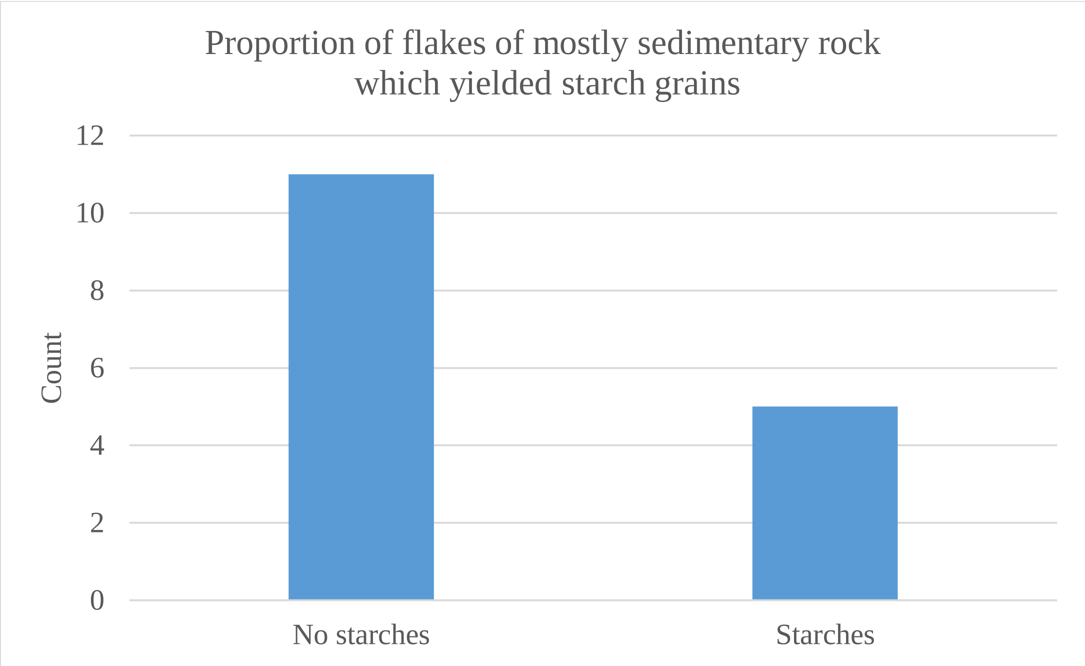

Figure 5.2: *Proportion of flakes of mostly sedimentary rocks which yielded starch grains.*

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Usually the identification of the starch grain is based on a comparison with a large amount of starches from multiple species of a modern reference collection as well as an extensive comparison with published sources. The identification of starches of this thesis was based on a comparison of recovered ancient starches with the published reference collections in '*De antiguo pueblos y culturas botánicas en El Puerto Rico* indígena' (2007) and '*Almidos Guía de material comparatio modern del Ecuador para lose studios paleoetnobotánicos en el neotrópico'* (2015) both written by Dr. J. R. Pagán-Jiménez and a host of other published sources regarding archaeological starch identification and interpretations of culinary practices (Chinique de Armas *et al.* 2015; Mickleburgh and Pagá-Jiménez 2012; Piperno and Dillehay 2008) .

All starch grain analyses have first been carried out by the author and afterwards checked by PhD. candidate Andy Ciofalo for verification and advice. All characteristics of the starches mentioned below are based on those used by Pr. Dr. J.R. Pagán-Jiménez (2015).

5.3.1. Sample 03CA-R/U

The starch recovered from sample 03CA-R/U was extremely damaged, likely as part of culinary practices, and it cannot be identified to a certain taxonomic level (see fig. 5.3). The starch grain measured 19,61 µm x 15,25 µm and had a truncated oval shape. No lamellae are visible. The extinction cross is visible, but partially damaged and therefore, the shape of two of its extinction cross arms was undetermined. The starch has a dark lined border.

The starch grain was extremely damaged. This is visible by the central depression in the starch. The cause of this damage was probably from heating a part of a plant in a humid and hot cooking environment, but not boiling, before using this artefact to further process the plant (Crowther *et al.* 2012; Henry *et al.* 2009). Experiments preparing plants in humid and hot cooking environments produce similar central depressions and partial damage to the extinction cross on a variety of plant's starch grains, which lead to this interpretation (Ciofalo *et al.* 2019; Crowther *et al.* 2012; Henry *et al.* 2009; Pagán-Jiménez 2017).

Figure 5.3: *Starch grain from sample 03CA-R/U: a. taken with dark field and cross polarised light; b. taken in non-polarised light, c. taken in bright field. Scale bar indicates 10 µm.*

5.3.2. Sample 05CA-R/U

The identified *Fabaceae* (bean) starch grain measured 28,25 µm x 22,93 µm and had an oval shape with no compression facets (see fig. 5.4). A centric, 'X'-shaped extinction cross, with four straight arms are visible. Undulating lamellae are visible on this starch granule. No hilum or fissure are visible. The size, shape, lamellae and extinction cross characteristics are consistent with *Fabaceae* starch grains of our reference collection and published sources (Chinique de Armas *et al.* 2015; Mickleburgh and Pagán-Jiménez 2012; Pagán-Jiménez 2007; Piperno and Dillehay 2008).

The starch is heavily damaged. The white, triangular patches, between the extinction cross seen in cross-polarised and darkfield view are faint. The starch body is a bit twisted, which was probably caused by heating a plant organ with some water present as part of culinary practices, but not enough heat and/or water to boil (Crowther *et al.* 2012; Henry *et al.* 2009). This was likely done prior to using artefact 05CA-R/U to further process the plant organ. Perhaps this made processing the plants easier, the taste more desirable, or as a way to remove any actual or perceived toxins or "spirits" (Pané *et al.* 1996, 26).

Figure 5.4: *Starch grain from sample 05CA-R/U: a. taken with dark field and cross polarised light; b. taken in non-polarised light, c. taken in bright field. Scale bar indicates 10 µm.*

5.3.3. Sample 07CA-R/U

The starch is identified as a *Fabaceae* starch grain measured 29,21µm x 18,45 µm and had an oblong shape with no compression facets (see fig. 5.5). A centric, 'X'-shaped extinction cross is partly visible with four straight arms. The granule contains faint but symmetrical lamellae. No hilum or fissure are visible. The shape, extinction cross, lamellae, and size characteristics are consistent with *Fabaceae* starch grains in our reference collection and from published sources and help identify this starch as *Fabaceae* (Chinique de Armas *et al.* 2015; Pagán-Jiménez 2007; Mickleburgh and Pagán-Jiménez 2012; Piperno and Dillehay 2008). No damage was observed on this starch grain

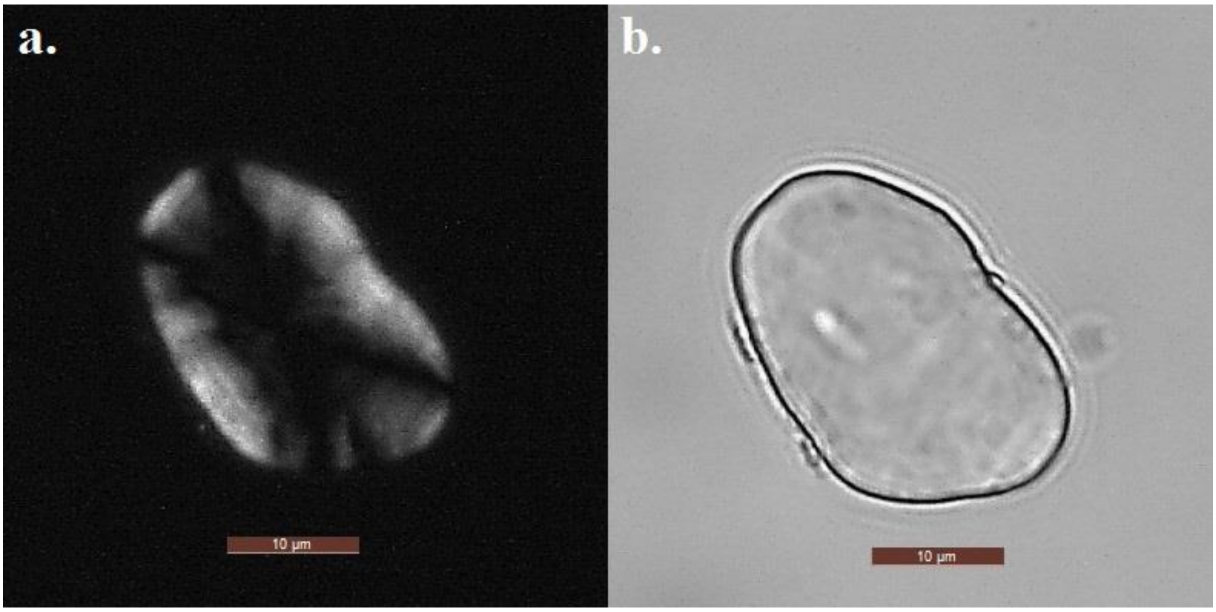

Figure 5.5: *Starch grain from sample 05CA-R/U: a. taken with dark field and cross polarised light; b. taken in non-polarised light. Scale bar indicates 10 µm.*

5.3.4. Sample 08CA-R/U_2

The securely identified *Dioscorea sp.* (yam) starch grain measured 12,9 µm x 10 µm and had an ovate shape with one concave distal facet (see fig. 5.6). A slightly eccentric, 'X'-shaped extinction cross, with four wavy arms was visible. The granule contains symmetrical lamellae concentrated around the hilum. The shape, facet, extinction cross, lamellae and size characteristics are consistent with *Dioscorea sp.* starch grains from our reference collection and of published sources (Fullagar *et al.* 2006; Pagán-Jiménez 2007, Pagán-Jiménez 2015; Piperno and Holst 1998). The starch shows little damage, with radial striation lines that were likely caused by a little pressure as part of culinary practices (Mickleburgh and Pagán-Jiménez 2012, 2480-2487). This could have been caused by soft pressure from grating, cutting or slicing (Mickleburgh and Pagán-Jiménez 2012, 2480-2487). Alternatively, it could have been a starch less affected by severe pressure from grinding or pounding if it was located in an area not directly affected by the pressure as part of culinary practices.

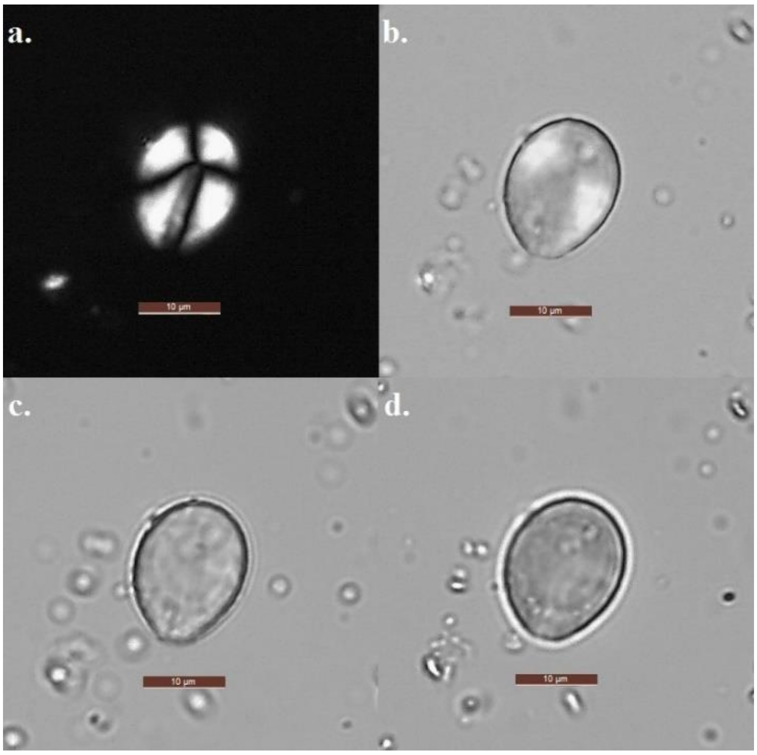

Figure 5.6: *Starch grain from sample 08CA-R/U_2: a. taken with dark field and cross polarised light; b. taken in polarised light; c. taken with bright field; d. taken with bright field, with striations visible. Scale bar indicates 10 µm.*

5.3.5. Sample 08CA-R/U_1

The identified *Dioscorea sp.* (yam) starch grain measured 16,48 µm x 12,65 µm and had an oval shape with one distal concave compression facet visible (see fig. 5.7). A slightly eccentric, X-shaped extinction cross, with two curved arms, was visible. The lamellae concentrated around the hilum. The shape, extinction cross, lamellae, and size characteristics are consistent with *Dioscorea* starch grains from our reference collection and published sources it is also similar to the starch from 08CA-R/U_2 (Fullagar *et al.* 2006; Pagán-Jiménez 2007, Pagán-Jiménez 2015; Piperno and Holst 1998). The starch of 08CA-R/U_1 shows light damage in the form of pits, which are slightly visible on the surface of the starch, probably caused by enzyme degradation, which is an early part of the fermentation process. This can happen accidently during storage or intentionally as part of culinary practices. Because this starch was recovered from a lithic artefact, it has been interpreted that a yam tuber was left in storage for a bit long and naturally began the fermentation process. This could have been intentional as some recipes call for slightly fermented plants or it could have been a natural process of the plant (Ray and Sivakumar 2009; Elias *et al.* 2000).

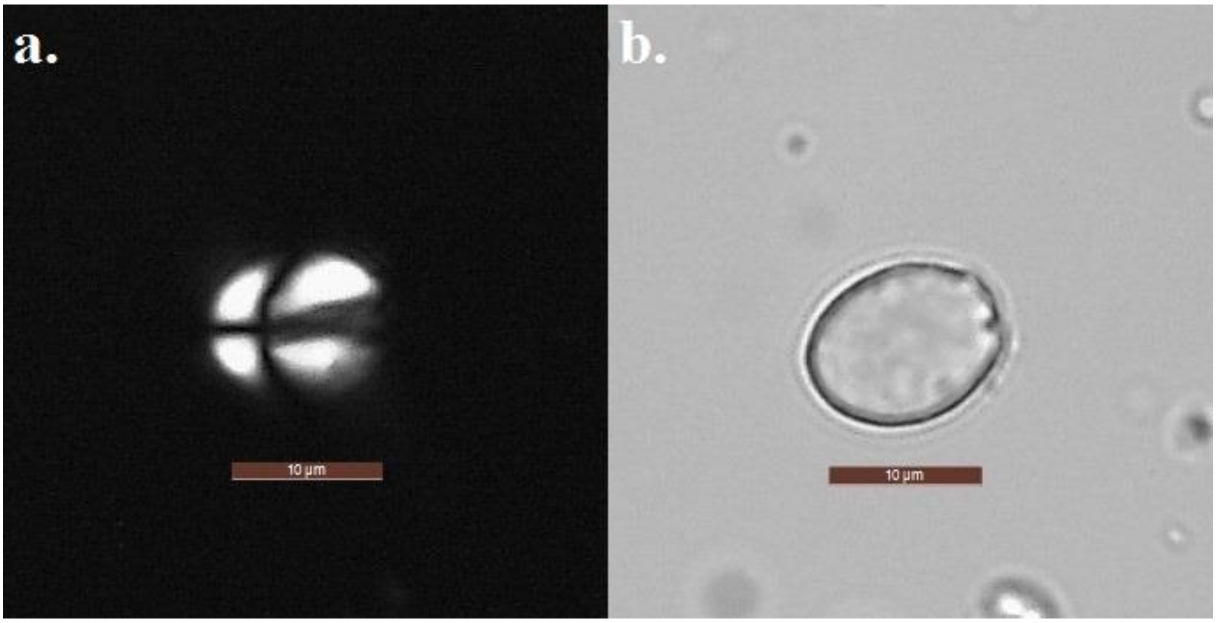

Figure 5.7: *Starch grain from sample 08CA-R/U_1: a. taken with dark field and cross polarised light; b. taken with bright field. Scale bar indicates 10 µm.*

5.3.6. Sample 09CA-R/U/DS

This unidentified starch grain measured 20,68 µm x 11,98 µm and had a truncated elliptical shape with no one flat compression facets (see fig. 5.8). A highly eccentric, 'X'-shaped extinction cross, with one angular arm was visible. No hilum, lamellae, or fissure are not visible. Because of the shape and position of the extinction cross, it is probable that this starch was from an underground storage organ. There are particles on the surface of this starch, the surface of the starch looks crumpled, and there is a visible crack in the border, these damage signs suggest the starch experienced pressure and a hot dry heated environment as part of culinary practices (Beck and Torrence 2006; Henry *et al.* 2009; Mickleburgh and Pagán-Jiménez 2012).

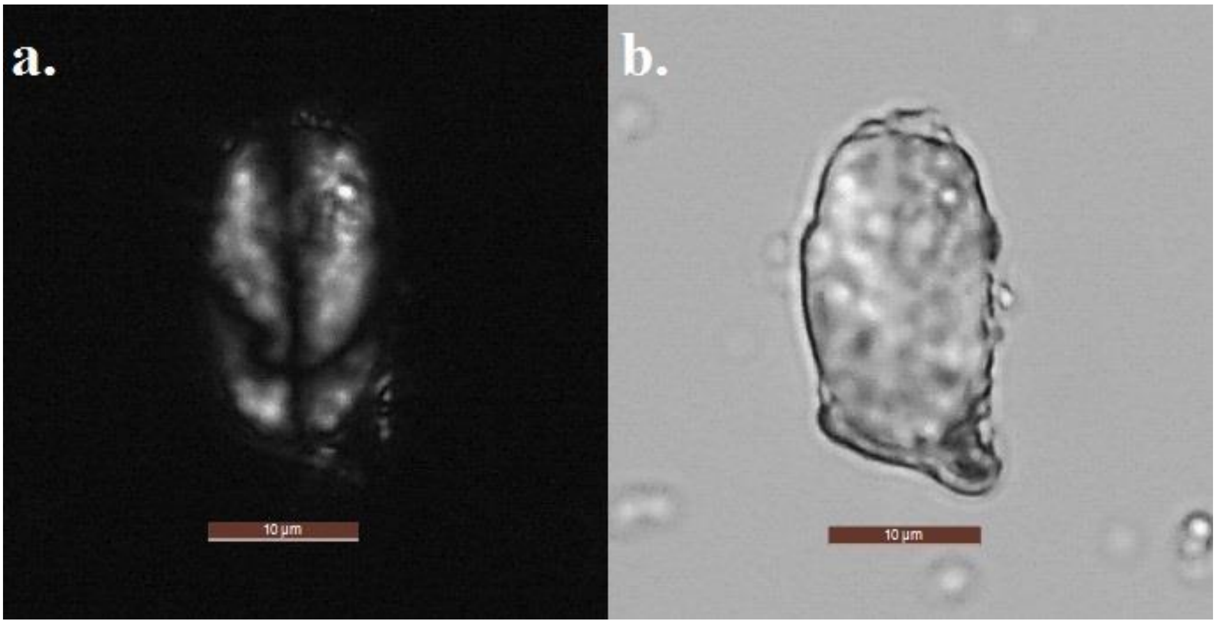

Figure 5.8: *Starch grain from sample 09CA-R/U/DS: a. taken with dark field and cross polarised light; b. taken with bright field. Scale bar indicates 10 µm.*

5.3.7. Overview

In total, six starches have been recovered from five of the 35 lithics artefacts that were sampled and analysed for starch content. Of these six starches, two were identified as *Fabaceae* (bean), two starches were identified as *Dioscorea* sp. (yam), and two starches were too damaged to make an identification possible. See Appendix B.

The recovered starches show traces of damage, except for sample 07CA_R/U which starch (*Fabaceae*) did not contain damage. Artefact 03CA_R/U had one starch (unidentified) recovered with damage signs associated with humid heating. Artefact 05CA_R/U had one starch (*Fabaceae*) recovered as well and showed signs of damage associated with humid heating. The same can be said for the starch (unidentified) of artefact 09CA_R/U. Artefact 08CA_R/U had two starches recovered, one starch (*Dioscoreae* sp.) showed damage signs associated with sign of pressure being applied as part of culinary practices, the other starch (*Dioscoreae* sp.) showed traces of a little pressure as well, but also traces of enzyme degradation.

5.4 Results of use wear analysis

After finishing the starch grain analysis, all 35 lithic artefacts were studied for use wear traces. First the lithics were studied with the low power method for modifications such as striations, edge rounding, and edge removal. Edges or surfaces with possible use wear were marked on the drawing. A picture was also taken with the Leica 1200 DM. According to the present features as edge removal, edge rounding, striations and polish from use as described in Chapter 3.4, the artefacts were divided under the following categories: definitely used, possibly used, not used, intentional debitage and indeterminate, of which the results are elaborated below (see fig. 5.9).

All use wear analysis was carried out by the author, and afterwards checked by Dr. Tom Breukel, who guided me in interpretation.

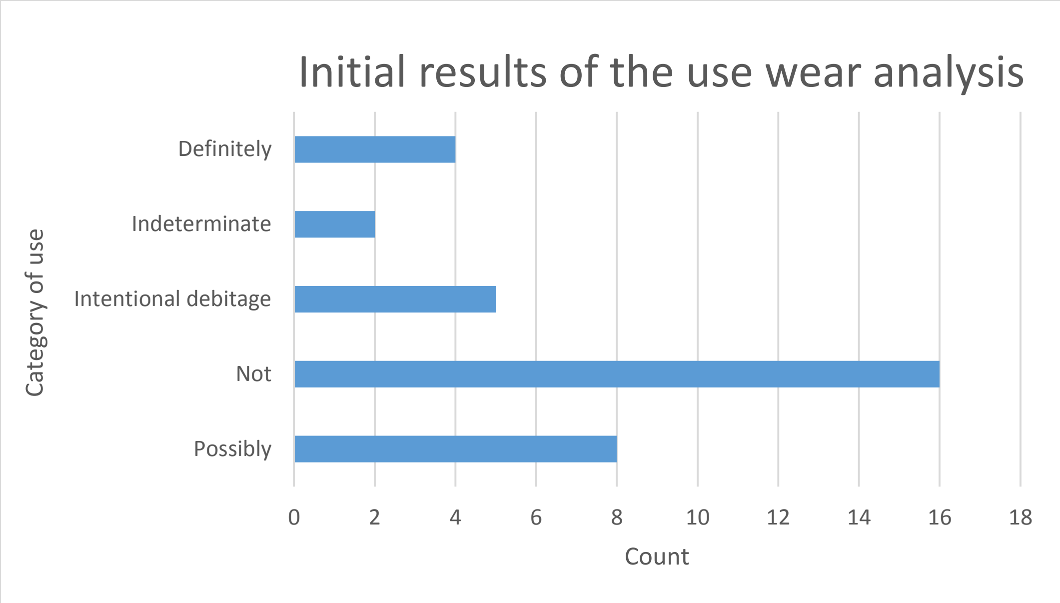

Figure 5.9: *Initial results of the use wear analysis*.

5.4.1. Definitely used

Four artefacts are categorised as definitely used. These are numbered: 10CA-R/U/DS, 11CA-R/U/DS, 15CA-R/U/DS and 16CA-R/U. The first three lithics were first studied by the dry scraping method and afterwards, including 16CA-R/U, with the ultrasonic bath method. All four artefacts did not contain starch.

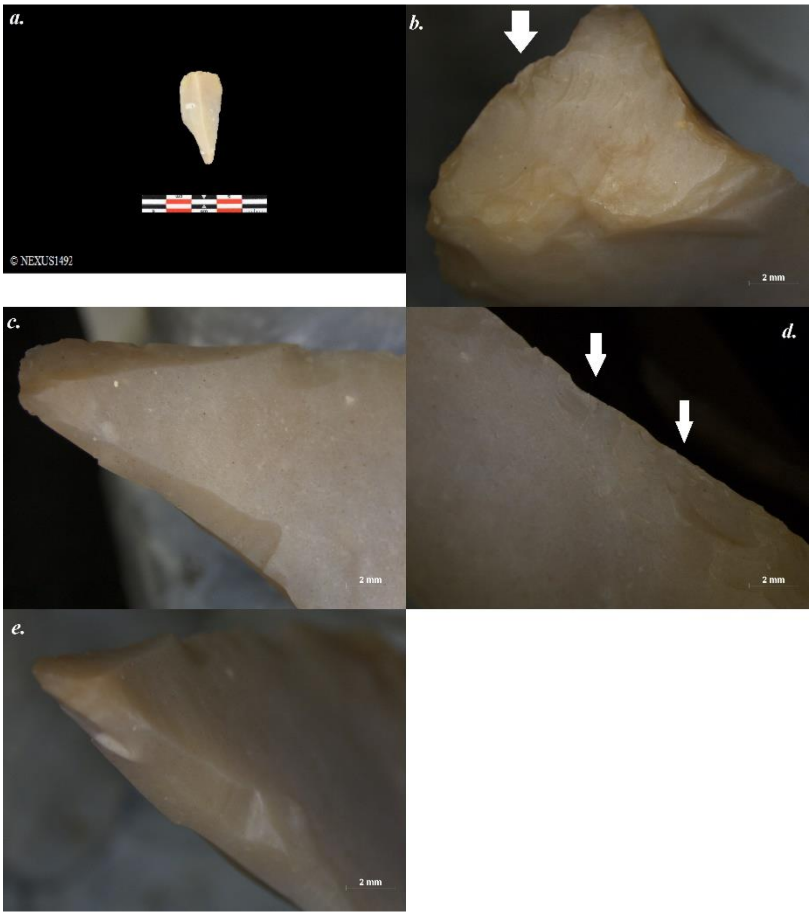

Figure 5.10: *Sample 10CA-R/U: a. dorsal side, b. proximal side, c. distal end of ventral side, d. left edge on ventral side with retouch, e. distal end of ventral side from different angel.*

Artefact 10CA-R/U contains retouch and polish on the edges of the ventral and dorsal side (see fig. 5.10). The first rib on the left edge of the ventral side contains retouch as well. The polish indicates the working of a hard plant material. The striking platform and the tip both contain small to medium sized feather terminations, initiating that this artefact was creating by using the bipolar reduction technique. The shape of the artefact indicates a spear point, but the cross section might be too thick for a spear point. The use of this artefact is more related to wedging (Personal communication with A. Verbaas).

The shape of artefact 11CA-R/U/DS is triangular with three different edges and a platform on the proximal part, of which the rib in the middle is worn (see fig. 5.11). Along the entire edge on the distal end on the dorsal side the artefact contains retouch and polish on the outside of the retouch. Striations are running on the surface from the distal edge to the left edge on the dorsal side. Polish is visible on the left rib as well on the left edge from the distal end to halfway of the edge. The angle of the distal end is suited for scraping or cutting.

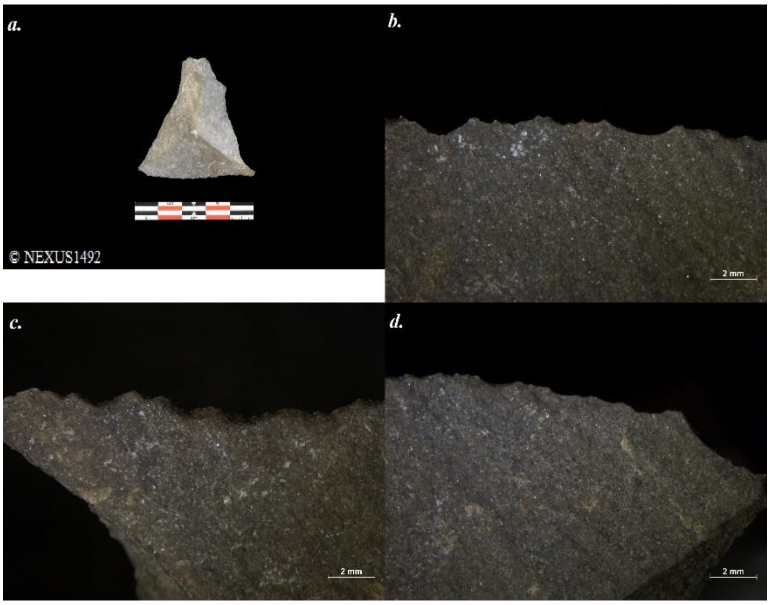

Figure 5.11: *Sample 11CA-R/U/DS: a. dorsal side, b. distal end ventral side, c and d from distal end dorsal side.*

Artefact 15CA-R/U/DS is triangular shaped with two ribs on the ventral side (see fig. 5.12). Retouch is centered on both edges on the medial side of the ventral as well as the dorsal side. The left edge of the dorsal side contains polish near the distal end until halfway of the medial side. Both edges are suited for cutting or scraping.

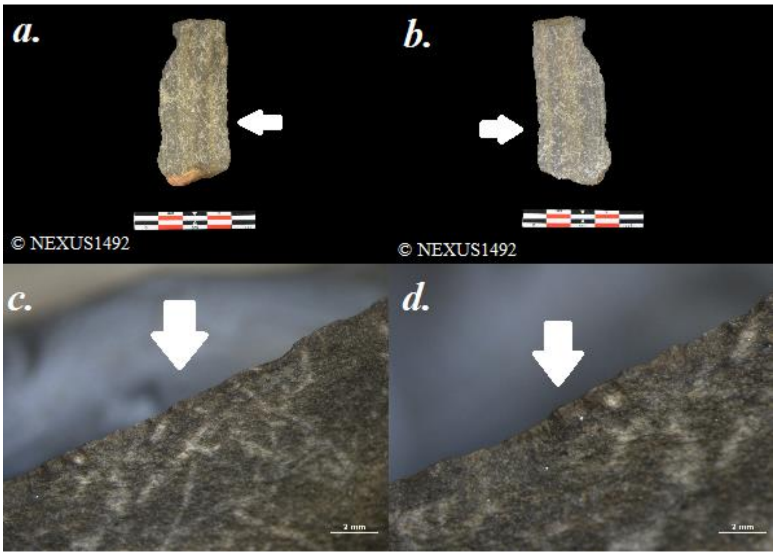

Figure 5.12: *Sample 15CA-R/U/DS: a. dorsal side, b. ventral side, c. left edge of ventral side, d. right side of dorsal side.*

Artefact 16CA-R/U is irregular shaped with the striking platform outstanding (see fig. 5.13). The surface of the dorsal side is very irregular, three bigger ribs are present and multiple minor ones created by use. The surface of the ventral side is also irregular. All edges from the ventral side, except for the right top halve contains retouch and polish formation. On the dorsal side, all edges have retouch and polish as well, except from the same edge concentrated on the left top halve. The angle of the all edges except for the striking plat form are suited for scraping.

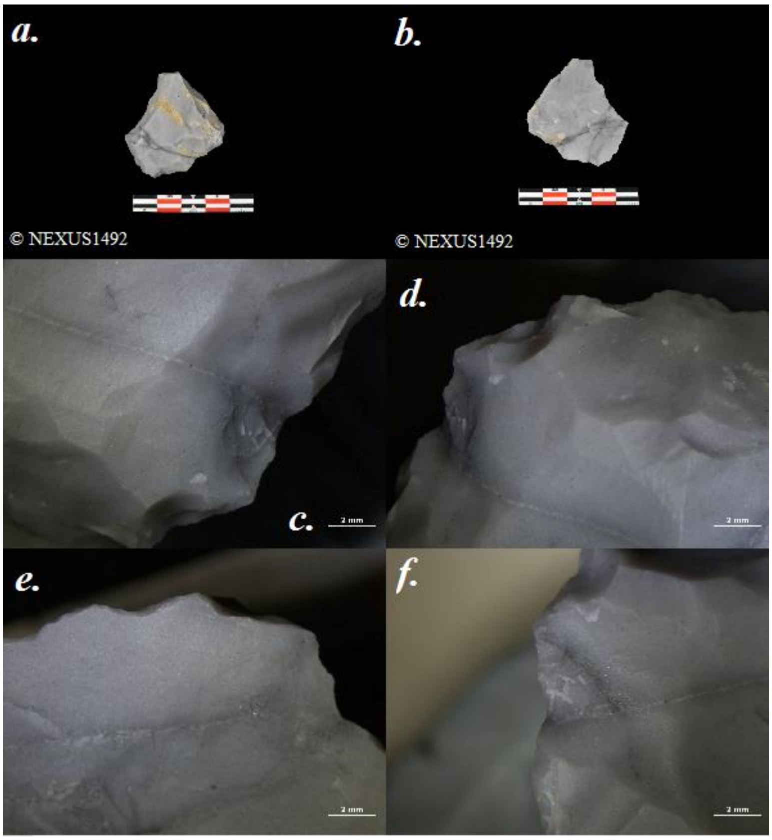

Figure 5.13: *Sample 16CA-R/U/DS: a. dorsal side, b. ventral side, c. distal end dorsal side, d. distal end dorsal side but from different perspective, e. distal end ventral side and f. distal end of dorsal side.*

All four artefacts are placed in the category of definitely used according to the wear of use encountered. These four artefacts all also have edges which are suitable for transverse motion.

5.4.2. Possibly used

Eight lithic artefacts are categorized as 'possibly used'. The numbers of these artefacts are: 01CA-R/U, 04CA-R/U, 08CA-R/U, 14CA-R/U/DS, 25CA, 27CA, 32CA and 35CA. The first four artefacts have been studied for starch grains with the ultrasonic bath method, with 14CA-R/U/DS also treated with the dry scraping method. Artefact 08CA-R/U contained two starches recovered using the ultrasonic bath method.

The use wear traces of the eight artefacts mentioned above are visible but not distinctive enough to identify definitive use. The traces could also have been caused by post-depositional processes. The form of some artefacts is also irregular, lacking an edge with an angle suitable for cutting or scraping for example, with this considered during analysis, even though artefact morphology is not the main factor in this research for categorizing the lithics.

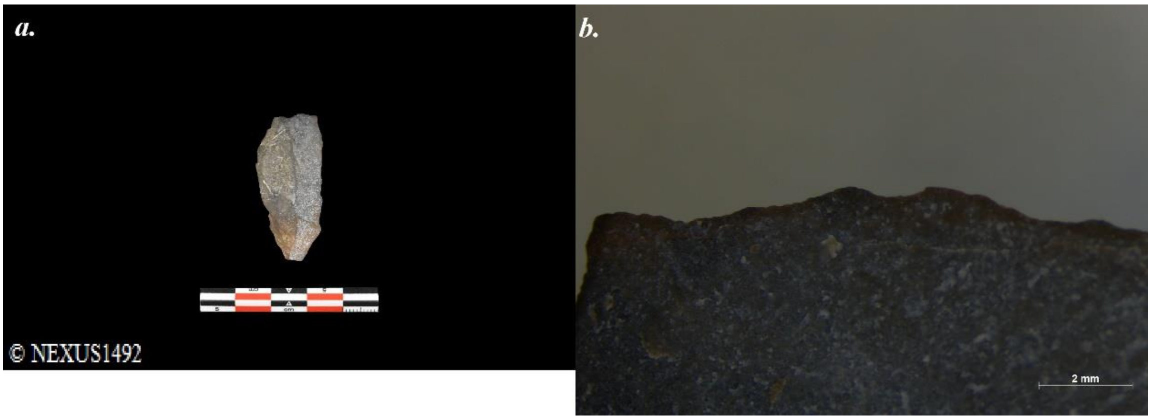

Figure 5.14: *Sample 01CA-R/U: a. dorsal side, b. right edge of dorsal side.*

The artefacts that were analyzed for starch grain analysis are discussed first. Artefact 01CA-R/U contains retouch on the right edge of the side containing white minerals of quartz (see fig. 5.14). This edge is suited for transverse motions. The shape of the artefact is irregular.

Artefact 04CA-R/U contains retouch and polish on the left edge on the side with cortex (see fig. 5.15). The edge mentioned is suitable for transverse motions.

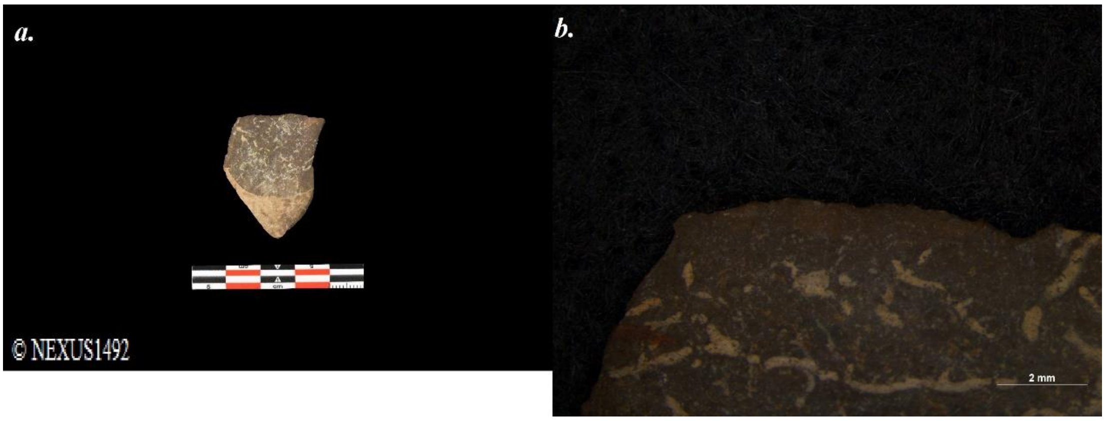

Figure 5.15: *Sample 04CA-R/U: a. dorsal side, b. distal end of ventral side.*

Artefact 08CA-R/U is shaped as an elongated triangle with an irregular surface (see fig. 5.16). The smallest edge on the side with one rib and the edge in the opposite of the rib contain both edge removals. Both edges are suited for transverse motions.

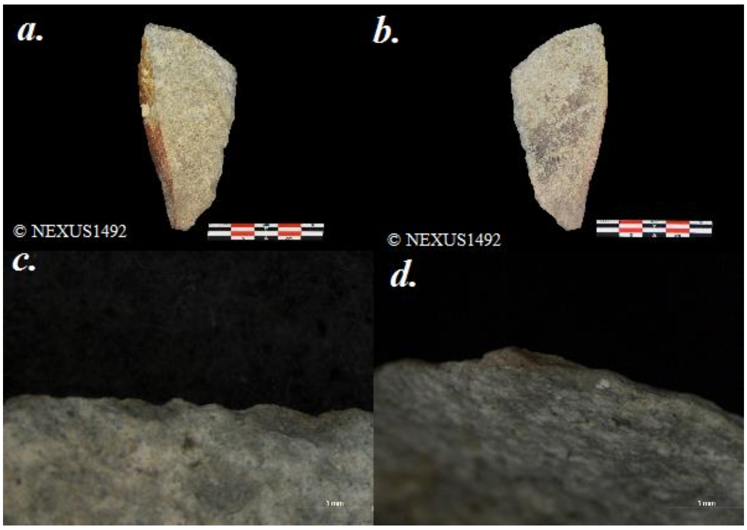

Figure 5.16: *Sample 08CA-R/U: a. dorsal side, b. ventral side, c and d showing the edge removals.*

Artefact 14CA-R/U/DS contains edge removals on both edges, on the dorsal side (see fig. 5.17). Horizontally layered striations are encountered near the edge on the proximal and medial end on the ventral side. The artefact is very weathered, therefore these traces of wear could also have been caused by post-depositional processes. Both edges are suited for transverse motions.

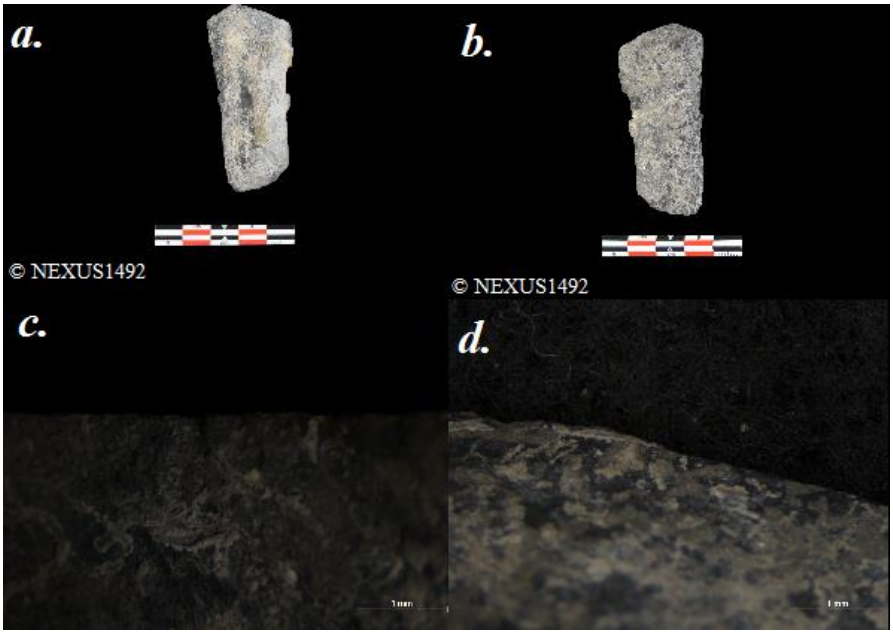

Figure 5.17: *Sample 14CA: a. dorsal side, b. ventral side, c and d showing the very weathered edges.*

The following artefacts were only studied for the use wear analysis. Artefact 25CA is triangular shaped with both edges on the dorsal side suitable for cutting or scraping (see fig. 5.18). The proximal end on top of the artefact is flat with striations in the length of the surface. These striations might be caused by hafting.

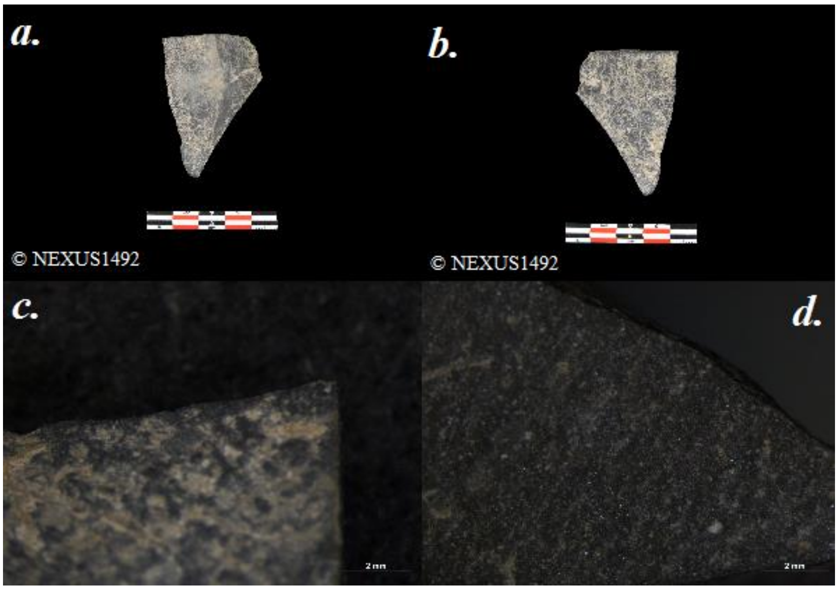

Figure 5.18: *Sample 25CA: a. dorsal side, b. ventral side, c and d showing the striations.*

Artefact 27CA contains on the lowest left edge on the dorsal side a notch which could have been caused by scraping the edge of objects (see fig. 5.19). Polish had been encountered around this notch. The distal end of this artefact is broken off.

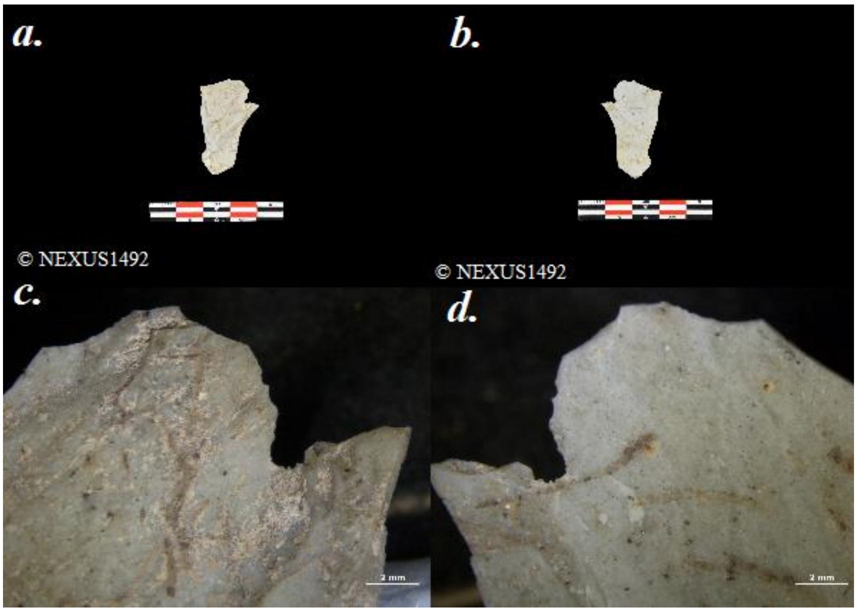

Figure 5.19: *Sample 27CA: a. dorsal side, b. ventral side, c. the notch seen from the dorsal side, d. the notch seen from the ventral side.*

The shape of artefact 32CA looks similar to a drill (see fig. 5.20). The tip of this artefact contains polish. Edge removals have been found near the tip of this artefact, continuing to the medial end of the left edge on the dorsal side. The distal end is suited for a drill tool. Artefact 35CA is small, roundish shaped with edge removals on two sides (see fig. 5.21). The shape suggests being used as a ‘grater tooth’, but no polish had been found on the edges with edge removals to ensure this use.

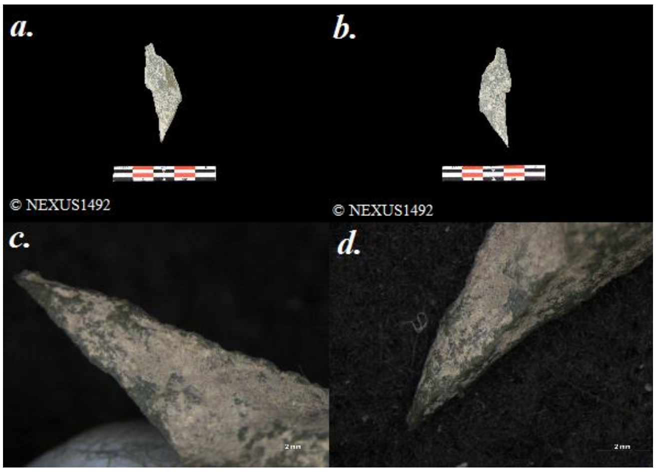

Figure 5.20: *Sample 32CA: a. dorsal side, b. ventral side, c. the notch seen from the dorsal side, d. the notch seen from the ventral side.*

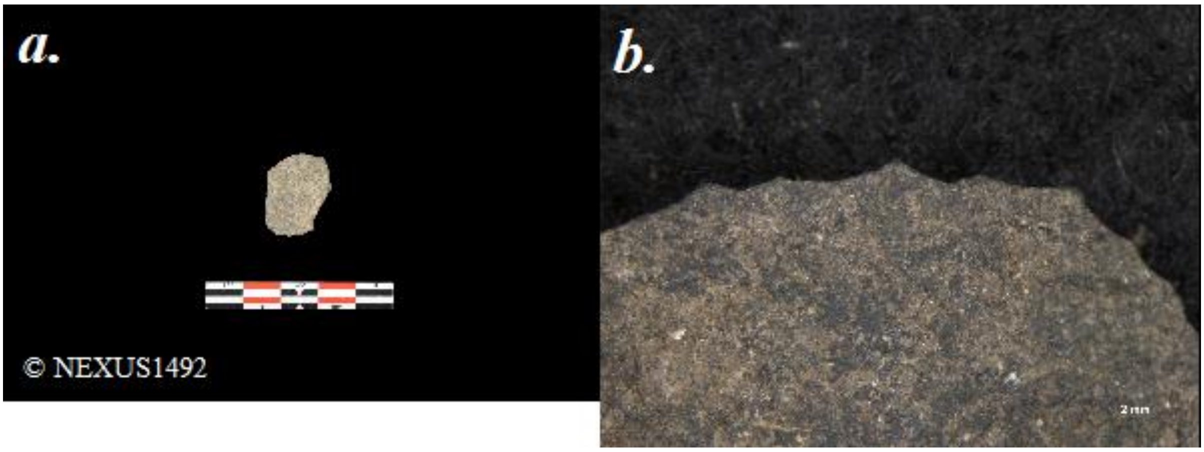

Figure 5.21: *Sample 35CA: a. one side on the artefact, b. the edge showing the edge removals.*

The previous mentioned artefacts all contain traces of use wear which can be related to the possible use of these artefacts, however, the traces could also be caused by post depositional processes. These artefacts contain edges which are suitable for cutting, scraping or transverse motions. The combination of these characteristics was decisive to place these artefacts in the category of possible used.

5.4.3. Not used

In total 14 artefacts are placed in the category of not used. The numbers of these 14 artefacts are: 02CA-R/U, 03CA-R/U, 05CA-R/U, 12CA-R/U/DS, 18CA, 20CA, 21CA, 22CA, 24CA, 26CA, 28CA, 30CA, 33CA and 34CA. The first three artefacts have been studied with the ultrasonic bath method for starch grains, the fourth artefact also studied with the dry scraping method. Artefact 03CA-R/U and 05CA-R/U each contain one starch, with the latter identified as a bean starch (*fabaceae*).

The 14 artefacts mentioned above are placed in this category because the artefacts do not all contain wear traces of use. Some artefacts do contain edge removals, edge rounding, polish or striations, but in consideration of the irregular shapes of these 14 artefacts, the wear traces are potentially caused by post-depositional processes. To elaborate, artefact 02CA-R/U contains edge removals on the thinnest edge but the angle of the edge is not suited for scraping. Artefact 21CA has edge removal at the rounded edge, but the artefact is too weathered to distinguish other traces for possible use of artefact 21CA. Artefact 22CA is probably a scatter from a larger lithic, therefore containing a small, smooth stroke with polish which was possibly the surface of the larger artefact. The other areas of artefact 22CA are irregular, supporting the possibility of being part of a larger artefact.

5.4.4. Intentional debitage

Of the 35 artefacts, 7 artefacts are debitage from intentional flaking and do not contain wear traces from use. The numbers of these 7 artefacts are: 06CA-R/U, 07CA-R/U, 09CA-R/U/DS, 13CA-R/U/DS, 17CA-R/U/DS, 23CA and 29CA. The first four artefacts have been studied for starches with the ultrasonic bath method, with the last two artefacts also studied with the dry scraping method. Artefact 07CA-R/U and 08CA-R/U contained each one starch grain.

From these seven artefacts, six artefacts have each a ventral and dorsal side, and a striking platform. Artefact 06CA-R/U and 23CA contain each one side with cortex. All six artefacts lack traces of wear as edge removal, edge rounding, polish and striations.

One artefact is not debitage from intentional flaking the core but broken off from a larger artefact during. Artefact 09CA-R/U/DS is roundish in shape with the force of impact on the top point of the outer side. The shape indicates have being part of a larger artefact as for example an axe or awl. The combination of the shape and force of impact are possible indications for human interference and are therefore placed in not used.

5.4.5. Indeterminate

Two artefacts have been cleaned with hydrochloric acid, 19CA and 31CA. Both artefacts reacted heavily with the hydrochloric acid which resulted in the loss of any residue or traces on the two artefacts. On 19CA negatives of flaking are still visible and 31CA could show striations, but without the ‘top layer’ of the surface it is not possible to categorize these artefacts for use. Therefore, both artefacts have been categorized as indeterminate.

5.4.6. Overview

To sum up the results of the use wear analysis, all 35 lithics have been analysed with the low and high-power method in order to identify use wear traces, showing which artefacts were definitely used as a tool, probably used as a tool, not used at all, are intentional debitage from flaking, or indeterminate. In total four lithics contained traces of use wear and workable edges for transverse motion to be categorized as definitely used as tool. Another eight lithics had wear traces visible, but this could also have been caused by post-depositional processes. For 14 lithics no traces of wear were visible and the lithics were irregularly shaped. These 14 lithics were categorised as not used. Another 7 lithics contained no traces of use wear, but the flakes contained characteristics such as an obvious ventral and dorsal side, as to be categorised as intentional debitage. For two lithics it was impossible to categorize these, due to the damage done by cleaning with hydrochloric alcohol. No traces at all were visible on these two tools.

5.5 Conclusions

To summarize the results of the combination of the starch grain-use wear approach, in total six starches have been discovered on five flakes of mostly sedimentary rocks. Two starches were too damaged to be identified, but the other four starches were identified to family level as *Dioscoreae sp.* (yam) and *Fabaceae* (beans), two of each family. The five flakes of mostly sedimentary rocks on which the starches were recovered from, were categorised one lithic flake as possibly used (the lithic with two starches identified as *Dioscoreae sp.)*, two flakes of mostly sedimentary rocks as not used (inderterminate and *Fabaceae*) and two flakes as intentional debitage (*Fabaceae* and indeterminate). The possibly used lithic flake 08CA-R/U contained traces of edge removal and suitable edges for transverse motions. The two artefacts 03CA-R/U and 05CA-R/U were considered not to be used as tool due to the irregularity of the artefact and combination of use wear caused by post depositional processes. The other two flakes 07CA-R/U and 09CA-R/U/DS were categorised as intentional debitage because the flakes showed characteristics of being knapped, but no traces of use wear.

With these combined results no obvious relationship between rock type, movement, and plant species can be discerned. However, taking into account the earlier discussed limitations of Chapter 4, the 35 lithics are extremely weathered. Use wear could have been caused by taphonomic processes, or these lithics have been used as expedient tools, and not used for enough time to develop clear traces.The following chapter will discuss the possible interpretation as expedient tools of the 35 lithics researched.

6. Discussion

In this chapter the domestic and craft activities carried out in El Carril will be discussed according to the results of the combined starch grain/use wear approach on the lithic artefacts and confronted with previous research on domestic and craft activities of the Caribbean in general. This chapter also contains an evaluation of the methodology used and discusses the combined starch grain-use wear approach.

6.1 Introduction

To briefly summarize the carried-out research, some of the domestic and craft activities of El Carril were inferred through the combination of the starch grain-use wear approach. This combined approach had been applied on 35 flakes of mostly sedimentary rocks recovered during the excavation in 2017 and 2018. These 35 flakes are irregularly shaped and do not fit into any clear lithic tool typology based on macroscopic examination. Flakes 01CA-R/U till 16CA-R/U/DS have been researched with starch grain and use wear analyses, while flakes 17CA-R/U/DS through 35CA-R/U/DS were only subjected to use wear analysis. The combination of both analyses provides specific information about the flakes of mostly sedimentary rocks regarding the potential contact material they were used with, as well as the form of motion they were used in, and any traces of starches from plants they encountered. In this way the starches recovered from the flakes can be related to the type of use wear present on the lithic flake and linked with the domestic or craft activities carried out in El Carril. To research this, sub-questions were formulated about the domestic and craft activities known of El Carril, based on previous research of lithic flakes in the Caribbean, and what kind of starch grains, use wear and raw materials were encountered (Briels 2004; Lammers-Keijsers 2007). By doing so, more information can be gained about the domestic and craft activities of El Carril, but also about the toolkit used wherein some flakes were used as expedient tools.

6.2 Domestic and craft activities

Domestic and craft activities cover a wide variety of tasks carried out in the Caribbean. The study into flaked stone artefacts can be of guidance for the understanding and interpretation of the domestic and craft activities carried out (Briels 2004; Lammers-Keijsers 2007; Falci 2015; Breukel 2019).. Different activities leave a variety of micro traces behind, which with the appliance of use wear analyses, can be related to the motion and contact-material used. The combination of the starch grain-use wear analysis has proven to be informative about the domestic and craft activities carried out. With the gained information from the results and the background chapters, the sub-questions formulated at the beginning of the research will be discussed below.

6.2.1. El Carril

The domestic and craft activities carried out in El Carril that involved some of these flakes of mostly sedimentary rocks can be related to at least two different activities. First, the crafting activity of ad hoc production flakes for the task required, and secondly the processing of yams and beans (see fig. 6.1).

Figure 6.1: *Peeling yam. Drawing by Betül Türkyilmaz.*

The first activity carried out is described as the crafting of ad hoc producing flakes of mostly sedimentary rocks for the task required, in other words, the production of expedient tools. One needs to take into account that the identification of expedient tools is based on the traces of use wear present on the lithic flakes, meaning that the lithics could have been used as formal tools as well, which were not always visible as the lithic flakes are very weathered. But, considering the next action seen during the excavation, the identification as expedient tools is more reliable. During the excavation in 2018, the local people who helped with the excavation used lithics from the nearby surrounding to repair broken tools, make alternative tools instead or to support ladders which were placed off balance. After use, these lithics were thrown away. The lithics were chosen by their characteristics for the tasks required. A similar ad hoc crafting activity can be interpreted from the use wear of the lithic flakes researched. The shape of the flake does not matter, as long as it has the qualities needed for the task to be carried out. After use, the lithic flake can be discarded or used for another activity as long as it contained the qualities preferred. In this case, the qualities needed is a workable, sharp edge for activities such as peeling yams or cutting grasses.

The second identified domestic activity can be related to the peeling of yams and beans as mentioned above, while cutting grasses is not. For further explanation, the idea behind the combination of the starch grain and use wear analysis was to specify domestic and craft activities carried out through the identification of the motion, contact-material and starches. Not all flakes of mostly sedimentary rocks researched contained starches, therefore the information we did gain with the starch grains identified was very limited to one single activity, but does not limit the further identification of the possible domestic and craft activities carried out in El Carril. While we did not find starches related to grasses or other plants, we know from ethno/historical sources that baskets or containers were made from grasses which probably were cut with lithic flakes (Briels 2004; Lammers-Keijsers 2007). Such baskets or containers made from grasses are perishable materials and are rarely recovered in the archaeological record (Briels 2004; Lammers-Keijsers). The same can be said over crafting activities as crafting wooden hunting or cooking gear, or the crafting of wedging tools, or wooden statues or ornaments (Briels 2004; Lammers-Keijsers 2007).

For instance, phytoliths recovered from the soil samples of the El Carril mounds showed evidence of the presence of *Sabal domingensis,* as well from Marantaceae, Cannaceae and Costaceae families. These are plants which leaves are attractive for wrapping food (Pagán-Jiménez *et al.* 2020). Such containers were not discovered, but it is high likely to state that the related crafting activities of cutting the leaves was carried out. For this pilot study, with the only four starches identified it is at least possible to identify the processing of yams and beans.

6.2.2. The Caribbean

The second sub-question is about the use of lithic flakes in wider Caribbean context. The addition of the interpreted domestic and craft activities from El Carril is of value for the current knowledge of the use of lithic flakes in the Caribbean. As seen with Plum Piece in Saba and Morel and Anse à la Gourde in Guadeloupe, lithic flakes in the Caribbean have been related to domestic and craft activities in general such as scraping, cutting and whittling for example (Briels 2004; Lammers-Keijsers 2007). For the lithic flakes of Plum Piece this could be further specified in the processing of siliceous plant materials with a perpendicular motion (Briels 2004; Hofman *et al.* 2008). However, this identification still misses the specification on what kind of plants the lithic flakes are used on. With such specification further interpretations can be given about the domestic and craft activities carried out, as plant materials used in crafts such as basketry are typically not recovered from the archaeological record. Expedient lithics and rough lithic flakes can provide a valuable window into the use of these perishable materials in the Caribbean, with the combined starch grain-use wear approach offering an excellent route of investigation.

In worldwide context, the identification of domestic and craft activities with the combination of the starch grain-use wear approach on the material researched had been used for the interpretation of site function. As seen with the researched flakes from Australia, Tasmania and Papua New Guinea, the identification of the use of lithic flakes has been linked to site function, and the interpretation of sites as temporary dwellings ((Fullagar and Jones 2004; Hayes *et al.* 2014; Li *et al.* 2018; Li *et al.* 2020; Liu *et al.* 2020; Torrence and Fullagar 1998).

This pilot study only focused on the identification of domestic and craft activities carried out, but in the long term, with more flakes of mostly sedimentary rocks sampled from all units excavated at El Carril or the combination of the starch grain-use wear analysis applied to flaked material from other sites in the Caribbean, more details can be given which can be related to site function. For this research only lithic material from 14 units of the in total 53 units excavated till 2018 were researched. With more lithics from different units, maybe the dispersion of the mounds can also be linked with site function as most lithics flakes researched were recovered from mounds.

6.3 Results of the combined starch grain-use wear method

The third and fourth sub-question are related to each other and both results will therefore be combined. The questions presented in the beginning of the pilot study are related to the presence of starch grains and traces on the researched flakes of mostly sedimentary rocks and if so, to which plant species of the starch grains and to what motion and contact-material can the traces of the use wear, be related with?

The interpretation of domestic and craft activities carried out in El Carril by the research with the combination of starch grain-use wear analysis proved to be useful. One might have the expectation of identifying more domestic and craft activities related with plant materials, but the absolute number of identified starches is low. Therefor only certain related domestic and craft activities can be inferred. In total six starch grains were discovered of which four were able to be identified, two starches as *Dioscorea* sp. and two starches as *Fabaceae*. This low number of recovered starches could be the result of many different factors.

One factor that may have impacted the number of recovered starches is the research method used. As mentioned before, the researched flakes had only been soaked in water for 8 minutes to loosen the sediment. Perhaps a longer submersion of flakes of mostly sedimentary rocks would have loosened more sediment, allowing the recovering of more starches.

Another explanation for the low number of recovered starches would be that the lithic flakes examined using starch grain analysis were used on non-plant materials, or on not starchy-rich plant material. In addition, the preservation of starch is understood to be encouraged by the artefact itself. Meaning that artefacts with pores, cracks, holes and grooves in the surface, such as grinding stones, have a better chance of preserving starch and thus recovery than artefacts with a smooth surface as lithic flakes.

Next to a low identified number of starches identified, the interpretation of the domestic and craft activities carried out also depended on the identification of the use wear traces. In this case, one might expect the motion and contact-material used to be related with domestic and craft activities, but for this thesis only the motion used had been identified to affirm the use of the 35 flakes of mostly sedimentary rocks. In this way the use of the lithic flakes had been identified as expedient tools, despite the irregularity of the shapes suggesting on macroscopic examination that they were not used. Care must be taken for the relation of use wear traces to tool use, because traces of use wear as edge removal, striations and polish could also have been caused by post-depositional processes such as trampling, patination and abrasion (Andrefsky *et al.* 2005; Grace 1996; Keeley 1980; Lammers-Keijsers 2007; Marreiros *et al.* 2015; Van Gijn 1990; Vaughan 1981). The flakes of mostly sedimentary rocks were very weathered, which made research with the high power method difficult, even after cleaning.

Even with these limitations in mind, the lithic flakes were related with transversal motions as scraping and peeling, and longitudal motions as cutting and sawing. This was based on the flakes researched in Plum Piece, Saba and Morel and Ansà la Gourde in Guadeloupe where the use of the lithic flakes had been related with domestic and crafting activities as cutting branches, hollowing out fruit containers or scraping wood (Briels 2004; Lammers-Keijsers 2007).

The fifth research question is related to the identification of the raw materials used for the flakes of mostly sedimentary rocks. Interesting here is that almost halve of the researched flakes are identified as siltstone and in total nine different type of raw materials had been used for the production of lithic flakes. This diversity in raw materials supports the interpretation of the flakes of mostly sedimentary rocks used as expedient tools. Local available material had been used to shape lithic flakes, providing the flake contained the qualities needed for the task to be carried out.

6.4 Validity of the combined approach

The combination of the starch grain and use wear analysis has not been carried out before in the Caribbean context. There are is no previous research of the Caribbean to compare the methods and results with, only for instances where the two analyses employed separately of each other. Therefore, the order in which the research was carried out was done in the most logical way that prevented possible contamination through artefact handling: first with the starch grain analysis, then the use wear analysis.

The starch grain analysis was divided between two methods: the dry scraping and the ultrasonic bath method. For this pilot study, the dry scraping method was carried out before the ultrasonic bath method to see if certain areas contained more starches then the entire surface of the lithic. However, the dry scraping method does not have to be necessarily carried out if the researched object, in this case the flakes of mostly sedimentary rocks, are uncertain to be identified as tools, or expedient tools and therefore may not have had time to develop traces of use wear. The dry scraping method is a more suitable method for flakes with more developed traces of use wear. For future research, a quick microscopic observation of the flakes of mostly sedimentary rocks should be carried out to identify which lithics have these traces to consider if the dry scraping method can be applied as well.

The other part of the combined method is the use wear analysis. For this part it was chosen to work with the low as well as the high-power method. The low power method was used for quick scanning of all 35 flakes of mostly sedimentary rocks for interesting spots with possible use wear, and the high-power method to get a better view of these spots. The high-power method was then used for a complete scanning of the flakes. As described by Lammers-Keijsers: “only high-power analysis sheds light on the actual use of a tool, while the low power approach may only lead to a hypothesis on the possible function of an artefact or to low level inferences.” (2007, 137). This is especially important to consider when the focus is on irregularly shaped lithics of unknown function, as in this research. Carrying out the low power method did not provide more information than a macroscopic visual examination. For future research, only applying the high power method for identifying traces of use wear should be adequate, however this does depend on the research questions asked.

7. Conclusion

The research into the domestic and craft activities of El Carril with a combined starch grain-use wear approach was designed out as pilot-study, to investigate the potential of this methodology for the Caribbean context. For the first time starch grain analysis was combined with use wear analysis and applied on irregular flakes of mostly sedimentary rocks of sedimentary rocks, which are an under researched artefact class in the Caribbean. This research carried out was at times challenging, but has yielded a satisfying outcome, to be continued by future researchers.

Some of the domestic and craft activities carried out at El Carril can be related with an expedient tool technology and the processing of yams and beans can be recognized. This must be seen as the start for further research, as this pilot study had been carried out on flakes of mostly sedimentary rocks of a sedimentary rock type and with an irregular shape whereof the use had not been attested before. Flakes were shaped from lithics locally available whereby the shape did not matter, as long as the flake contained the qualities needed for the task carried out. Here qualities are referred to as workable, sharp edges for the processing of peeling or scraping yams and beans. These two identified plants are the only plants recorded in this research and resemble only a small percentage of plants known to be used in the Caribbean during AD 900-1450. More plants were used for domestic and craft activities, but starches relating to these were not recovered on these flakes of mostly sedimentary rocks researched. This pilot study evidences a promising start for further research into the domestic and craft activities of El Carril and other sites through the combined starch grain-use wear analysis.

7.1 Further Directions

The research provided a promising start for a glimpse into the domestic and craft activities carried out in El Carril. However, there are some features which can be taken into account during future research for further contributions towards understanding domestic and craft activities.

First, the limitation of the time used for soaking the lithics. The researched lithics were only soaked for 8 mins, whereby little to no residue came off the lithics for the starch grain analysis. Later during the use wear analysis, the flakes of mostly sedimentary rocks turned out to be very weathered. Cleaning with hydrochloric acid did not provide to be useful, maybe soaking for 24 hours in water could have resulted in more residue becoming loose, and therefore less weathered lithics. This is something what should be done differently next time.

Another feature for future researches is that the combination of the starch grain-use wear analysis should be carried out on any raw material in search for specification of domestic and craft activities. There is also potential to carry out inter-site analysis using this tool, where archaeological materials from two or more sites occupied during the same time frame can be compared to investigate mutual site function and the relationship between sites and site activites. In doing so, a broad spectrum of domestic and craft activities can be interpreted. Similarities in domestic and craft activities between sites can be identified out, but also differences. This will shed light on the interconnectivity of domestic and craft activities in the Caribbean.

And last but not least, this research has presented a methodological challenge, as the flaked sedimentary rocks focused on in this research had not been macroscopically recognised as tools and little research had been carried out before on such flaked materials. Future researchers should be more aware of the presence of expedient tools of this kind of tool during excavations such as flakes which are easily seen as waste material or natural rock. Even the smallest or most irregular shaped lithics could be used as ad hoc tools and should therefore be recovered as part of the find materials during excavations. Studying such neglected flaked material of mostly sedimentary rocks has proven to be promising and fruitful for more nuanced interpretations of domestic and craft activities carried out by the Indigenous Peoples of El Carril, of which the local people today are the historical legacies of these activities.

Abstract

At the site of El Carril flaked materials from mostly sedimentary rocks have been excavated and examined to get a better understanding of domestic and craft activities that were carried out there by the indigenous peoples in AD 900-1450. This research has been carried out as a pilot study wherein the combination of starch grain-use wear approach has for the first time been applied to flaked materials from sedimentary rocks.

These flaked materials are irregularly shaped and therefore not included in the finding materials during excavations, as these flaked materials are not recognised as tools at first eye sight. With the combination of the starch grain-use wear approach it had been able to identify the domestic and craft activities carried out. The starch grain analysis enables the identification of plant species used, the use wear analysis for attesting the presence of use wear. Afterwards all flaked materials from mostly sedimentary rocks had been researched by students from the Free University of Amsterdam to identify the rock genesis of the raw materials used.

The combination of the starch grain-use wear results identified at least two domestic and craft activities carried out in El Carril. First the ad hoc crafting of the producing flaked materials for the domestic or craft activity required and secondly the processing of yams and beans. The flaked materials from mostly sedimentary rocks are expedient tools which were produced for the task needed. Shape does not matter as long as the flake contained the qualities required for the task. After use the flaked material would be discarded or used for another task as long as it contained the qualities required, such as a sharp edge. Remarkable, this activity of creating ad hoc tools is still in use today by the local people who helped during the excavation. The starch grains were identified as *Dioscorea* sp. and *Fabaceae*, otherwise known as yam and beans. The flaked materials were used for the peeling of yam and beans.

Interpreting the domestic and craft activities by studying flaked materials shown to be promising for future searchers and created awareness to include flaked materials with irregular shaped in the archaeological record to not miss expedient tools.

At the site of El Carril flaked materials from mostly sedimentary rocks have been excavated and examined to get a better understanding of domestic and craft activities that were carried out there by the indigenous peoples in AD 900-1450.

Nederlandse samenvatting

De huishoudelijke en ambachtelijke activiteiten in El Carril zijn onderzocht door de afslagen van gesedimenteerde stenen te bestuderen. Dit onderzoek is uitgevoerd als ‘pilot-study’ waarbij de combinatie van de zetmeelanalyse en gebruikssporen analyse is gecombineerd op afslagen van gesedimenteerde stenen. De afslagen waren gevonden tijdens archeologisch onderzoek in El Carril in de zomer van 2017 en 2018. Tijdens de opgraving in 2018 werden er steeds meer afslagen met een onregelmatige vorm gevonden. Op eerste oog lijkt het alsof deze afslagen niet zijn gebruikt als voorwerpen, maar nadat er steeds meer van dit soort afslagen gevonden werden, bestond het vermoeden dat de afslagen wel degelijk gebruikt waren voor huishoudelijke en ambachtelijke activiteiten. Mogelijk zou het gaan om een eenmalig gebruik van de afslagen.

Om hier achter te komen, zijn de zetmeelanalyse en de gebruikssporen analyse gecombineerd. Deze combinatie maakt het mogelijk om de zetmeelkorrels te koppelen aan de gebruikssporen. De zetmeelanalyse is als eerste uitgevoerd om verdere vervuiling van de afslagen te voorkomen. Deze analyse is verdeelt over twee methodes: het afschrapen van delen van de afslag en het lostrillen van residu van de gehele afslag. Dit was gedaan om uit te zoeken of een bepaalde punt van de afslag meer zetmeelkorrels zou bevatten dan de hele oppervlakte van de afslag. Na de zetmeelkorrelanalyse is de gebruikssporen analyse uitgevoerd. Ook deze methode kon de uitvoering verdeelt worden over twee methodes, de ‘lage’ en ‘hoge’ vermogen methode. Het verschil tussen deze methodes heeft betrekking op de gebruikte vergroting van de miscroscoop. Tijdens het onderzoek bleek echter dat de uitkomsten van de ‘lage vermogen’ methode voldoende waren om te kunnen aantonen dat deze afslagen daadwerkelijk gebruikt zijn. Daarom is besloten om de ‘hoge vermogen’ methode niet verder uit te werken. Nadat beide analyses zijn toegepast, zijn de afslagen ook nog onderzocht door studenten van de Vrije Universiteit in Amsterdam. Zij hebben onderzocht van welk steensoort de afslagen zijn gemaakt.

De combinatie van de zetmeelanalyse en gebruikssporen analyse heeft aangetoond dat slechts vijf van de vijfendertig onderzochte afslagen zetmeelkorrels bevatten Vier van deze zetmeelkorrels konden worden geïdentificeerd, twee stuks als *Dioscoreae* sp. (yamswortel) en twee stuks als *Fabaceae* (bonen). Deze vijf afslagen bevatte geen overtuigende gebruikssporen en bevestigde daarmee het vermoeden dat de afslagen gebruikt werden als gebruiksvoorwerpen voor eenmalig gebruik. Het onderzoek naar de gebruikte steensoorten heeft aangetoond dat de samples uit ‘siltstones’ en rhyoliet bestaan. Deze twee steensoorten kunnen in de lokale omgeving van de site teruggevonden worden.

De huishoudelijke en ambachtelijke activiteiten van El Carril werden zodoende gerelateerd aan twee verschillende activiteiten die in ieder geval werden uitgevoerd. De eerste activiteit is de productie afslagen van lokale stenen die konden worden gebruikt voor andere activiteiten. De vorm maakt niet uit, zolang één rand van de afslag geschikt was voor de taak waarvoor het gebruikt ging worden. Na uitvoering van de taak kon of de afslag nogmaals gebruikt worden voor een andere activiteit, of worden weggegooid. Deze activiteit wordt nog steeds gebruikt door lokale mensen. Zij gebruikte de stenen die voorhanden waren om een activiteit uit te en na gebruik werden deze stenen weggegooid. De tweede activiteit die opgemaakt kon worden uit de resultaten van de gecombineerde analyses, is het pellen van yamswortel en bonen.

Het identificeren van de huishoudelijke en ambachtelijk activiteiten uitgevoerd in El Carril heeft veel belovende resultaten opgeleverd. Toekomstige onderzoekers zouden deze gecombineerde methode van zetmeel- en gebruikssporenanalyse vaker moeten toepassen, ook op andere ruwe materialen of van materialen afkomstig van verschillende sites tegelijk. Hiermee kunnen de onderlinge overeenkomsten en verschillende tussen de verschillende sites duidelijk worden. Daarnaast, toekomstige onderzoekers kunnen hiermee (wat) op deze manier bewust worden. Ondanks dat in eerste opzicht de afslag niet op een gebruiksvoorwerp lijkt, wel als tool kan zijn gebruikt.

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List of Figures

List of Appendix

Appendix A

Flaked material combined results list and site information.

Number	Find number	… used	Starches	Rock genesis	Unit	Zone	Sector	Square	layer	Feature
01CA-R/U	3607	Possibly	-	Mudstone	53	1	25	53	15	
02CA-R/U	3072	Not	-	Rhyolite	47	91	44	71	2	
03CA-R/U	3207	Not	Indeterminate	Siltstone	47	91	44	71	6	44-01
04CA-R/U	3478	Probably	-	Siltstone	51	1	15	77	8	15-03
05CA-R/U	3492.1	Not	Family *Fabaceae*	Siltstone	52	1	35	30	3	
06CA-R/U	3213.1	Not	-	Siltstone	45	91	63	28	4	
07CA-R/U	3507	Not	Family *Fabaceae*	Siltstone	53	1	25	52	5	
08CA-R/U	2236	Possibly	*Discorea trifida L.F.*, genus *Dioscoreaceae*	Rhyolite	45	91	63	28	4	63-03
09CA-R/U/DS	3439	Possibly	Genus *Dioscoreaceae*	Basalt	53	1	25	52	2	
10CA-R/U/DS	3594	Definitely	-	Chert	53	1	24	43	11	
11CA-R/U/DS	3557	Definitely	-	Siltstone	51	1	15	77	12	15-03
12CA-R/U/DS	3372	Not	-	Siltstone	52	1	34	38	1	34-46
13CA-R/U/DS	2175	Not	-	Siltstone	43	91	22	67	3	
14CA-R/U/DS	1043	Possibly	-	Basalt	19	91	69	82	6	
15CA-R/U/DS	630	Definitely	-	Siltstone	10	91	89	79	1	
16CA-R/U	1061	Definitely	-	Chert	21	91	49	90	1	
17CA	1820	Not		Indeterminate	37	91	45	99	1	
18CA	2032.1	Not		Basalt	39	91	54	93	8	
19CA	2201	Indeterminate		Metamorphosed tuff	45	91	63	38	2	
20CA	2264	Not		Basalt	45	91	63	39	5	63-01
21CA	2281	Not		Metamorphosed tuff	36	91	15	59	1	
22CA	3021	Not		Rhyolite	45	91	63	29	7	
23CA	3061	Not		Rhyolite	47	91	44	70	1	
24CA	3213.2	Not		Tuff	45	91	63	28	4	
25CA	3225	Probably		Basalt	38	81	73	83	5	
26CA	3376	Not		Siltstone	51	1	15	66	2	
27CA	3432	Probably		Rhyolite	51	1	15	76	7	
28CA	3544.1	Not		Siltstone	50	91	85	25	10	
29CA	3462	Not		Siltstone	51	1	15	67	9	15-03
30CA	3482	Not		Basalt	51	1	15	76	9	15-03
31CA	3491	Indeterminate		Metamorphosed tuff	52	1	35	40	3	35-02
32CA	3492.2	Possibly		Basalt	52	1	35	30	3	
33CA	3492.3	Not		Siltstone	52	1	35	30	3	
34CA	3544.2	Not		Siltstone	50	91	85	25	10	
35CA	2032.2	Possibly		Igneous rock	39	91	54	93	8	

Appendix B

List of steps taken per flaked material for the ultrasonic bath and dry scraping method.

Number	*Find number*	***Ultrasonic bath method – minutes in bath***	***Ultrasonic bath** - 50 ml tubes used*	***Dry scraping method (before ultrasonic bath method) –** area of interest*
01CA-R/U	3607	6	1	
02CA-R/U	3072	6	1	
03CA-R/U	3207	6	2	
04CA-R/U	3478	6	2	
05CA-R/U	3492.1	6	1	
06CA-R/U	3213.1	12	1	
07CA-R/U	3507	18	1	
08CA-R/U	2236	12	3	
09CA-R/U/DS	3439	6	1	Dorsal side – proximal end
10CA-R/U/DS	3594	6	1	Ventral side – Right edge
11CA-R/U/DS	3557	6	2	Dorsal side – proximal end
12CA-R/U/DS	3372	12	1	Dorsal side – right edge
13CA-R/U/DS	2175	6	1	Ventral side – right edge
14CA-R/U/DS	1043	6	1	Dorsal side – proximal end
15CA-R/U/DS	630	6	1	Dorsal side – right edge
16CA-R/U/DS	1061	6	1	Dorsal side – right edge
17CA	1820			
18CA	2032.1			
19CA	2201			
20CA	2264			
21CA	2281			
22CA	3021			
23CA	3061			
24CA	3213.2			
25CA	3225			
26CA	3376			
27CA	3432			
28CA	3544.1			
29CA	3462			
30CA	3482			
31CA	3491			
32CA	3492.2			
33CA	3492.3			
34CA	3544.2			
35CA	2032.2			

Appendix C

Individual results from the starch grain analysis.

Site El Caril	Sample ID																	
	03CA-R/U	**05CA-R/U**	**07CA-R/U**	**08CA-R/U/DS**	**09CA-R/U/DS**	**01CA-R/U**	**02CA-R/U**	**04CA-R/U**	**06CA-R/U**	**10CA-R/U/DS**	**11CA-R/U/DS**	**12CA-R/U/DS**	**13CA-R/U/DS**	**14CA-R/U/DS**	**15CA-R/U/DS**	**16CA-R/U/DS**	**Total starches**	**Ubiquity (%)**
	Siltstone	Siltstone	Siltstone	Rhyolite	Basalt	Mudstone	Rhyolite	Siltstone	Siltstone	Chert	Siltstone	Siltstone	Siltstone	Basalt	Siltstone	Chert		
***Dioscorea sp*. (yam)**				2													2	6,25
***Fabaceae* (bean)**		1	1														2	12,5
Not identified	1				1												2	--
Individual Starch count	1	1	1	2	1												6	--
Minimum species richness	1	1	1	1	1												--	--
Starch damage- Humid Heat, Dry Heat, Enzyme, Pressure	HH	HH		E, P	DH, P													

Appendix D

Results of the rock genesis carried out by BA-student Rosa Verheij and MA-student Denice Borsten with NEXUS1492 PhD Alice Knaff as supervisor from the Free University of Amsterdam.

Number	**Find number**	**Weathering surface**	**Fresh surface**	**Grain size**	**Sample size**	**Description**	**Rock name**
01CA-R/U	3607	brown/grey	dark grey/black	< 1 mm	2 by 5 cm	this sample has a dark grey/black colour. One fracture surface is covered by quartz grains (< .1 mm) giving a sugary texture. The bulk rock is grey-red, this could be from iron oxidation. The generally very fine grained matrix contains <20% grains mostly of angular to rounded quartz grains with 10% of the grains being iron oxides and Fe-Mg rich minerals (cpx or amphibole). Poorly developed conchoidal fracture.	impure quartz rich mudstone
02CA-R/U	3072	light and dark green	light and dark green	0.5 – 1 mm	2 by 2.5 cm	The rock is green coloured and has 20% small cavities of 0.1 – 1.5 mm in size. The texture of the rock is sugary, similar to some previous samples. Grey/white coloured mineral grains are visible for 10% of the rock, this is quartz and 5% dark grains are present, probably pyroxene/amphibole. One biotite grain clearly visible.	altered rhyolite

03CA-R/U	3207	moss green	light green	not visible	4.5 by 6 cm	This rock has the same red parts as the previous sample, which are iron oxidation. It also has a sugary texture and is mostly moss green coloured. The texture is fine grained and well sorted, which indicates a sedimentary rock. The features have a different colour then the rest of the rock, lighter in colour or white coloured. The same small cavities as in the previous sample are present here. They are about 0.1 mm in size and cover the rock for 5%. The rock has few minerals with shiny surfaces.	impure siltstone
04CA-R/U	3478	brownish, dark red and black	black, very dark	not visible	2.5 by 2.5 cm	The dark reddish grey rock is formed of a matrix of very fine grained quartz rich material representing a siltstone; very few grains visible (<2%). Cut by 25% linear features that are pale brown and porous. These appear replacement-dissolution features. Weathered surfaces show red iron staining.	siltstone.
05CA-R/U	3492.1	black and brown	there is a white surface, which is a vein of which the top part	< 0.5 mm	2 by 2.5 cm	This rock is dark coloured with replacement dissolution features. The same cavities are present, as we have seen in previous samples. The white surface of the rock is the inside of the vein consisting of quartz. It has a sugary texture and a very dark black matrix. The matrix is very fine	siltstone

			broke of the sample			grained (< 0.5 mm), there are 1% minerals present in the rock.	
06CA-R/U	3213.1	dark/black surface and sand coloured surface	dark/light grey and some white parts	< 0.1 mm	2.5 by 6 cm	the grey surface of this rock has a grey matrix with some lighter coloured parts and the texture is sugary. There are (10%) shiny minerals present of < 0.1 mm. The weathered surface that is dark coloured has the same porous white veinlets as 07CA-R/U, caused by extensive replacement by fluids.	impure calcareous siltstone with replacement textures.
07CA-R/U	3507	dark black/green	dark black/grey	< 1 mm	3 by 3.5 cm	This rock is mostly black coloured with fine grained dark matrix containing quartz grains < 0.1 mm. The weathered surface of the rock has some orange spots from iron oxide breakdown. Metamorphic siltstone that has undergone extensive replacement by fluids leading to porous white veinlets that cross cut the rock and comprises up to 25% linear features that are pale brown and porous.	impure siltstone with replacement textures.
08CA-R/U	2236	light green with dark spots	alternation between light and dark green	< 0.5 mm	4 by 9 cm	the rock has a green matrix with visible black grains, could be pyroxene; these grains cover 10% of the rock and are < 0.5 mm in size. One side of the rock is brown coloured; this could be from the rock	low grade metamorphosed rhyolite

						being baked. The texture of the rock is sugary, mostly dark green and it has very sharp edges. The sugary texture is formed by altered pale green groundmass.	
09CA-R/U/DS	3439	dark green and black	black and greenish, very dark green	< 0.5 mm	3.5 by 3 cm	this rock has a fine-grained equigranular matrix (< 0.5 mm) and one very smooth weathered/polished surface. The colour of the rock is overall very dark green and black. Mm sized mafic minerals make up 5% of the rock. The other surface of the rock is still rough and has some white veins 5 -10 mm in length.	greenschisted basalt
10CA-R/U/DS	3594	beige/light brown	beige/light brown	not visible	1 by 3 cm	this rock is beige in colour. There is no weathering present and there are no visible grains, only two white spots of 2 – 3 mm in size. The silica rich rock shows some conchoidal fractures but does have a very fine grained texture defined by silicified microfossils and fossil fragments.	chert
11CA-R/U/DS	3557	dark/black	black	< 0.05 mm	5 by 6 cm	this rock is dark grey coloured. The rock has a homogeneous fine grain fabric composed of ingrown quartz grains and a darker mostly black matrix (< 0.05 mm). A weak sedimentary layering is preserved in this low grade metasediment.	impure siltstone

12CA-R/U/DS	3372	lightly grey side and a darker black side	not present	not visible	3.5 by 5 cm	this rock is very weathered and has no visible grains. It is difficult to describe since there is no clean surface. It has two different coloured surfaces, which could be from weathering. The one side is darker grey/brown coloured while the other surface is lighter brown in colour. The lighter surface also has some elongated orange spots on it from iron oxidation.	quartz rich siltstone
13CA-R/U/DS	2175	dark black, green and brown	dark/black	< 0.1 mm	3 by 3.5 cm	this rock has a very fine matrix with (< 5%) shiny minerals of < 0.1 mm, probably quartz minerals and is porous <10% cavaties. There are some red parts present, which could be iron oxidation. Some small (0.1 mm) black minerals (3%) with squared shapes are also visible, probably pyroxene.	very impure siltstone
14CA-R/U/DS	1043	black	one small edge only is black	< 0.05 mm	2.5 by 6 cm	this rock is very fine grained (< 0.05 mm). There are small minerals (< 0.05 mm) with a shiny surface present (3%). The black coloured weathered surface has some light coloured plant traces on it. One surface of the rock has a lighter coloured weathered surface.	igneous basaltic rock
15CA-R/U/DS	630	dark and light green bands	Not present	< 0.05 mm	3.5 by 7 cm	this rock has some alternation between light and dark green bands; the green bands differ in width, from	banded bioturbated siltstone.

						1 -5 mm thick. This indicates that it is a sedimentary rock. There are cavities present of < 0.05 mm in size and they cover 10% of the rock. Shiny minerals (5%) are visible and have a size of < 0.05 mm. The matrix is very fine grained (< 0.05 mm) and on the weathered surface there are white traces that are organic in origin. This sample has a red coloured tip, which is weathering.	
16CA-R/U	1061	dark grey and light brown	light – dark grey	no grains visible on the surface, in the vein < 0.01 mm	3.5 by 3.5 cm	this rock has a very smooth surface, which is matt grey coloured. The only visible grains are isolated iron oxides that form < 1% and are 0.01mm, Some black veins appear to be formed at dissolution surfaces filled with (5%) black grain of < 0.01 mm in size of Fe oxides. One surface has open veins with an orange colour, this is iron oxidation. Some conchoidal fractures but generally surfaces are smoothed by weathering or frequent use.	Chert
17CA	1820	dark brown, yellow and greyish	no	Not visible	3.5 by 3.5 cm	This rock is very weathered, it has a dark brown and yellow colour and on one surface there is some yellowish weathering. There are some elongated	Very weathered, not possible to tell what it is exactly

						brown shapes on the rock of which it is not clear if they are from weathering.	
18CA	2032.1	light brown to yellow sand colour	black to really dark green colour	not visible	10 by 6.5 cm	The texture of this sample is sugary on the dark coloured surface. The sand coloured weathered surface has an edge that is discoloured from the rest of the sample. It is reddish to purple coloured, which could be a baked surface. The fresh surface is a really small edge of the sample with a very fine grained texture and black colour.	basaltic rock
19CA	2201	grey	grey	<0.1 – 1 mm	4 by 3 cm	Overall this sample is grey coloured and there are a few black grains present (5%). The matrix is very fine and the small black grains are about < 0.1 mm. There is some brown weathering present, which are the brown stripes on the rock. It has very sharp edges on the side it was broken. This rock is porous and light in weight.	medium to fine grained poorly sorted metamorphosed tuff
20CA	2264	dark green and grey (weathering)	no	Not visible	2.5 by 2.5 cm	Overall this sample is dark green coloured, the weathering is grey and there is no fresh surface. There are altered visible minerals and the texture is sugary. This rock looks similar to the previous rocks, starting at sample 8. These samples all have	greenschisted basalt

						the same texture, green colour and weathering patterns.	
21CA	2281	The weathered surface is mostly covered in dirt and has a grey/brown colour.	black/dark coloured	not visible	4.5 by 5 cm	Overall the rock is covered with a weathering crust, with colours ranging from greyish to brownish. There are no visible minerals present. It has very sharp edges on the breaking surface. The upper surface of the sample has an elephant skin texture. There are some white fragments present, elongated shapes, which can be plant or root fragments.	medium to fine grained poorly sorted metamorphosed tuff
22CA	3021	sugary surface, dark coloured	sugary surface, dark coloured	fine matrix with larger grains: 0.5 mm – 0.1 mm	2.5 by 2 cm	The weathering surface is brown-green, with a sugary texture similar to the previous samples. There is some difference in the colour of the rock; the colour varies from light to darker green. There is a lighter green coloured edge, which is the fresh/polished surface. The sugary texture is formed by altered pale green groundmass and altered feldspar grains that define an igneous texture.	low grade metamorphosed rhyolite
23CA	3061	light yellow	dark green to black	fine grained matrix	2.5 by 3 cm	This rock has a poorly developed fabric. The black grains retain angular shapes. The weathered surface of the rock is light yellow, and contains some orange iron oxidation. Overall	metamorphosed banded rhyolite or layered silica rich tuff.

						the rock has a fine matrix with some darker fragments and foliation.	
24CA	3213.2	black/very dark grey	no	< 0.1 mm	2 by 4 cm	this rock is very weathered and it has as grey colour. There are plant fragments present on the weathered surface. It has a sand like texture, very fine grained (< 0.1 mm) and it is porous. Black grains (10%) are visible < 0.5 mm in size.	impure tuff
25CA	3225	dark coloured, black with brownish weathering	black/very dark	< 0.1 mm – 0.5 mm	3.5 by 5 cm	this rock is overall black and contains black minerals (15%) with a shiny surface, < 0.1 mm in size. The rock has one polished surface. This surface has visible light foliation. The weathering is brownish with plant fragments, which have an elongated shape. There is one white mineral visible (< 0.5 mm) 2% of the rock.	basalt
26CA	3376	light greyish	dark grey	5% grains are < 0.1 mm	10 cm by 6 cm	This rock is mostly weathered, with a grey surface and also some brown/yellow discolouring on one surface. There are small black grains present, about 5% of the rock, which are < 0.1 mm in size. The matrix is very fine and there are no other grains visible. The weathered surface has dark long fragments on the surface, which can be plant fragments.	impure calcareous siltstone

27CA	3432	light/pale green	light/pale green	visible grains are < 1 µm, 10%	2 by 2.5 cm	Visible light coloured foliation, with iron oxides and possible pyroxenes/amphibole up to 0.2 mm. The rock consists of a fine matrix with 10% small black grains, < 1 µm. Some of the black grains are rounded (5%, 0.3 mm) and a few are elongated (1%). The elongated ones are about 2% of the rock. On the clean surface the small black grains have a brownish/green alteration halo (3%).	low grade metamorphic foliated rhyolite
28CA	3544.1	brown coloured with orange stripes (iron)	not present	< 0.5 mm	2.5 by 2 cm	the orange stripes on the weathering surface of the sample are from iron oxidation. The breaking surface has some very small reddish/brown grains, <0,5 mm with a shiny surface. Overall the rock is very weathered and porous, a part of the rock is a little bit broken, but there is no fresh surface. The weathering of the rock is mostly brown with some grey areas. The orange features are from replacement dissolution, they are orange because of the iron.	very weathered siltstone
29CA	3462	dark grey	no	Not visible	2.5 by 2.5 cm	This rock has no fresh surface and has some brown elongated features that are porous. The weathering looks dark grey and brown, the rock has a	impure siltstone with replacement textures

						very fine grained texture. There are no visible minerals and overall it is very weathered. The rock contains (<1%) black grains (0.1 mm).	
30CA	3482	grey (weathering)	dark green	not visible	2.5 by 5 cm	This sample has some alternation between light and dark green colours. It has the same sugary texture as the previous two samples and a very fine grained matrix. There is light grey coloured weathering on the rock. Also the sand coloured top looks as if it is baked or this is also weathering.	greenschisted basalt
31CA	3491	light grey and yellowish	dark grey coloured	not visible	4.5 by 4 cm	this sample looks weathered on both surfaces. There is a fresh surface because it broke. It has a dark grey coloured very fine matrix (< 0.1 mm) with some small black grains (5%). There is orange discolouring present, which is iron oxide. On the weathered surface there are plant parts and brown weathering. It has a sugary texture on the fresh surface, with a few brownish parts in the dark grey. This sample looks similar to sample 15.	poorly sorted metamorphosed tuff
32CA	3492.2	dark green/grey	dark green	1 - 0.5 mm	1.5 by 2.5 cm	this sample has a dark green colour on both surfaces and has two larger grains (5%), which are quartz (1 mm). There is an alternation of light and dark green minerals, with a sugary texture. The dark minerals are about	greenschisted basalt

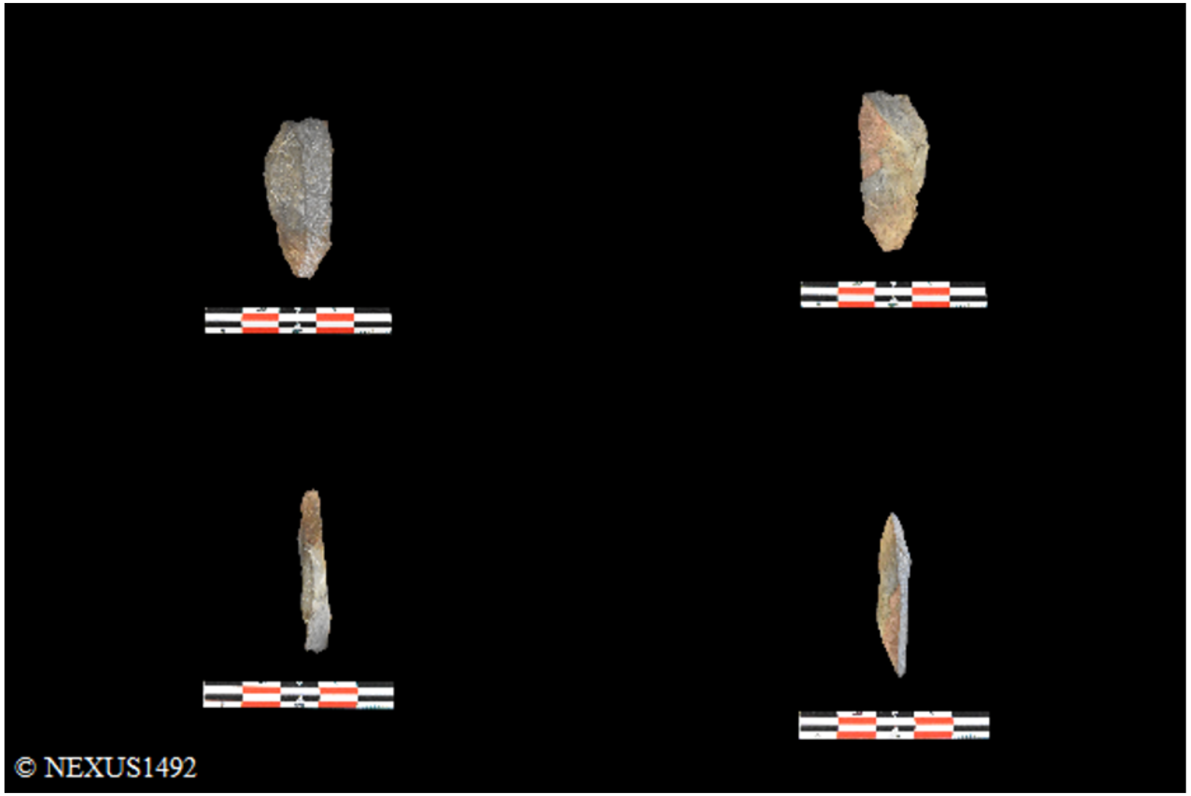
						0.5 mm in size. Approximately 5% of the rock consists of black grains. The weathering of the rock has a greyish colour. The green indicates a greenschisted igneous rock. This sample is similar looking to test, 3482 and sample 2264; they all have a sugary texture and dark green colour.	
33CA	3492.3	dark grey	dark grey	Not visible	2.5 by 2.5 cm	There are brown, reddish replacement dissolution features present. What stands out is one light coloured vein, which goes across the sample. The texture of this rock is homogeneous fine grained	Siltstone
34CA	3544.2	dark grey/brownish	no	visible grains are < 0.1 mm	3 by 4 cm	the rock is fine grained (< 0.1 mm) with a visible white vein going through the rock. It has very sharp edges and some (5%) small black grains (< 0.1 mm). One point/surface of the rock has some reddish discolouring, which could be caused by weathering. On the weathered surface of the rock there are plant fragments present.	Siltstone
35CA	2032.2	dark brown	dark green/black	< 0.1 mm	1 by 1 cm	this is a very small dark coloured rock. The rock itself is dark green and black coloured. The weathering on the surface has a brown colour. There	igneous

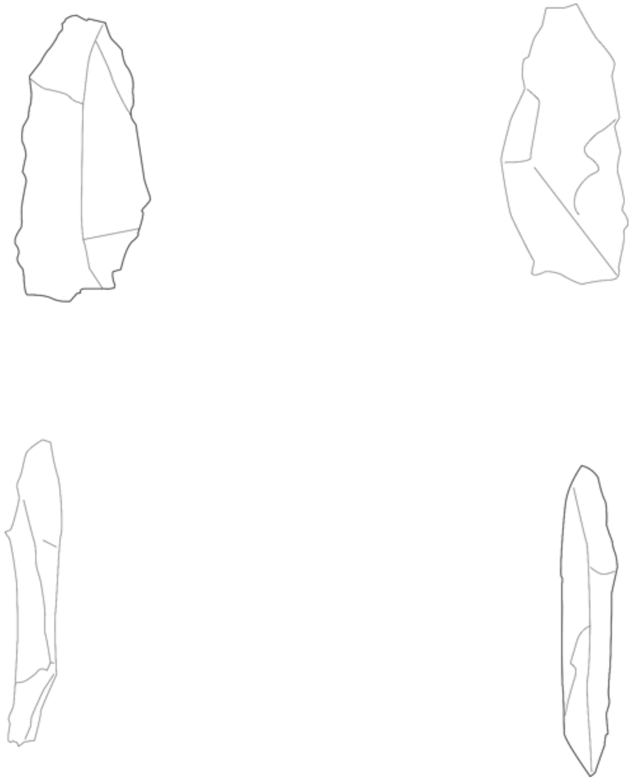
						is no visible clean surface and there are visible grains, which are shiny. The matrix is very fine grained.	

Appendix E

In Appendix E the images of the 35 samples taken by the author are shown. These are modified by Wazoula van Royen. The drawings are made by the author as well and scanned in with the help of Finn van der Leden. The order in which the drawings are shown is not necessarily similar to the pictures.

01CA-R/U





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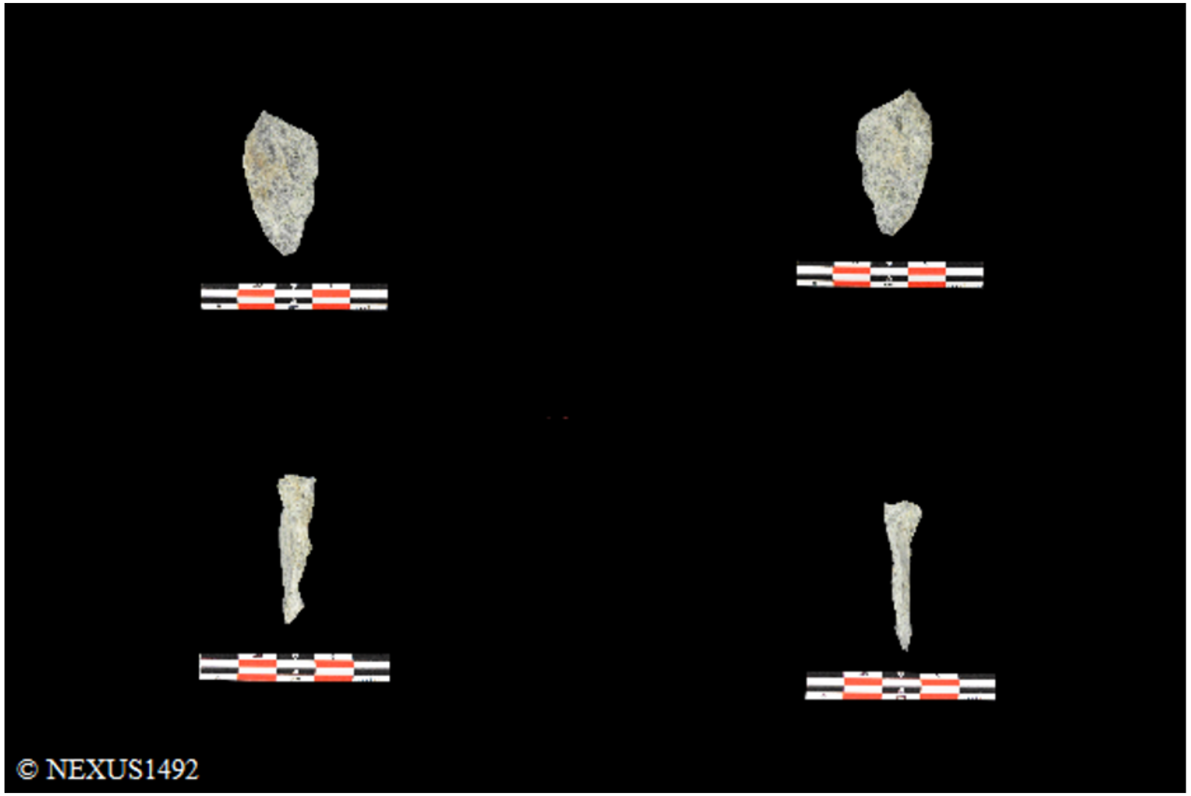

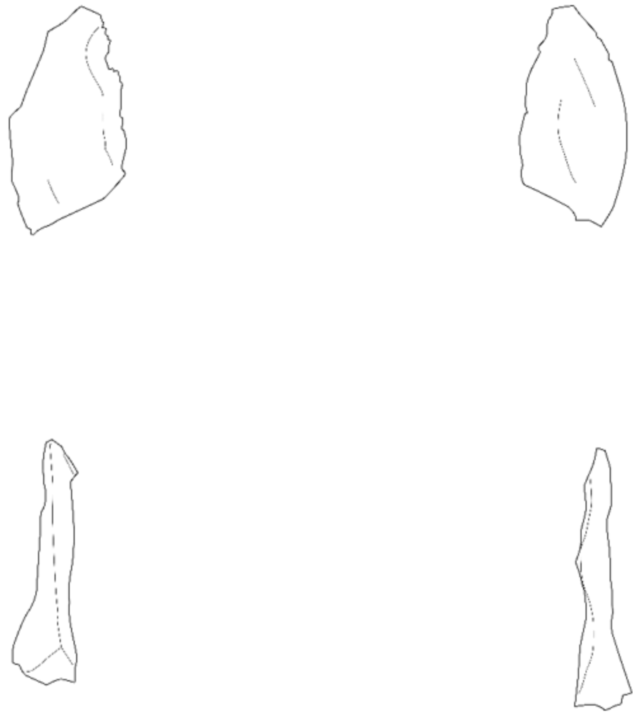

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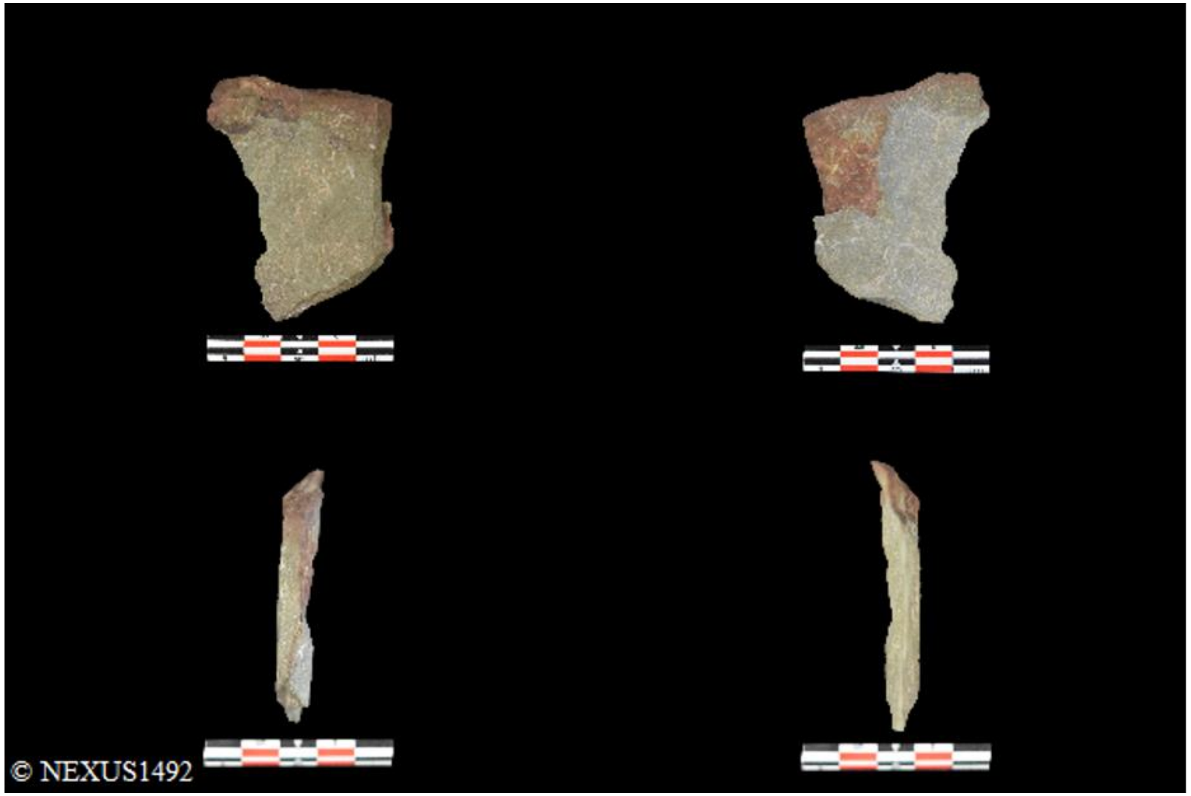

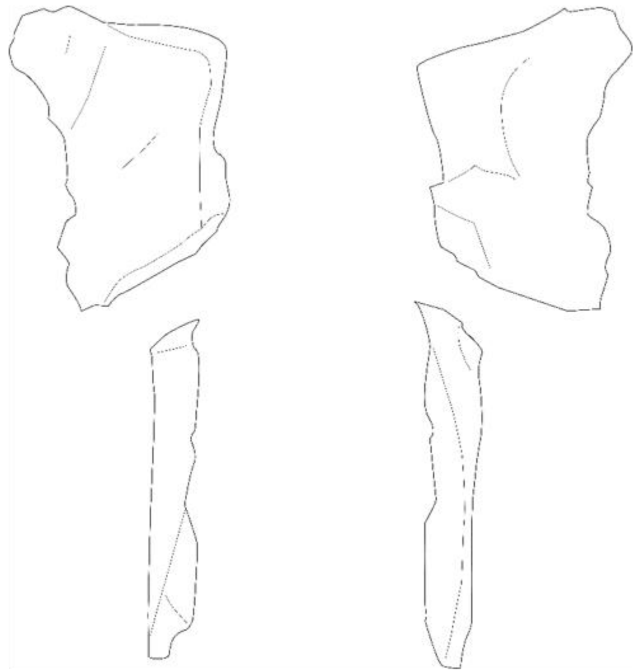

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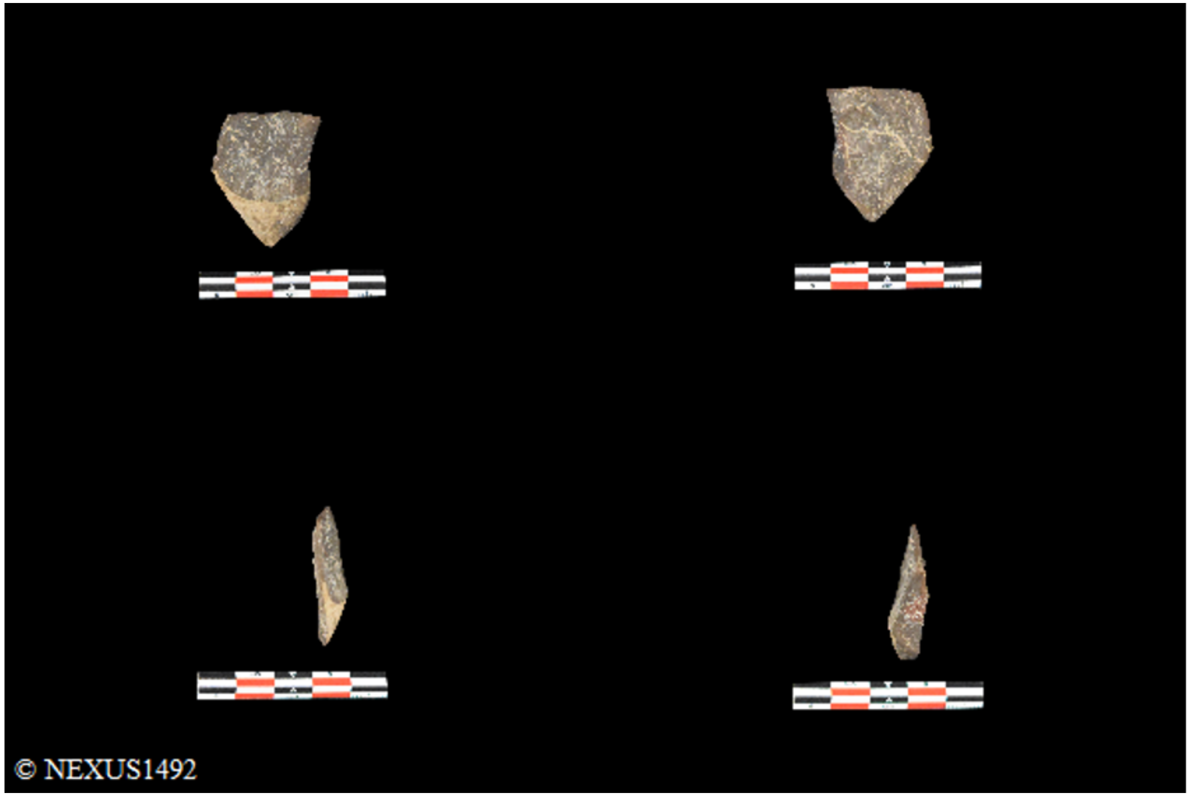

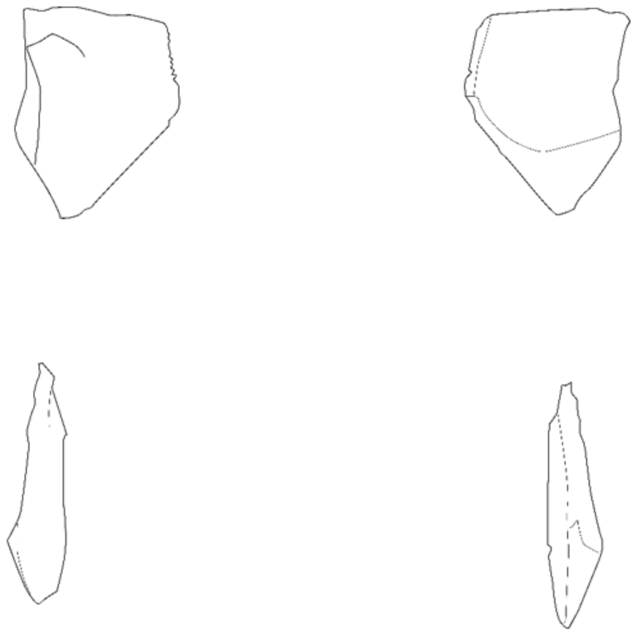

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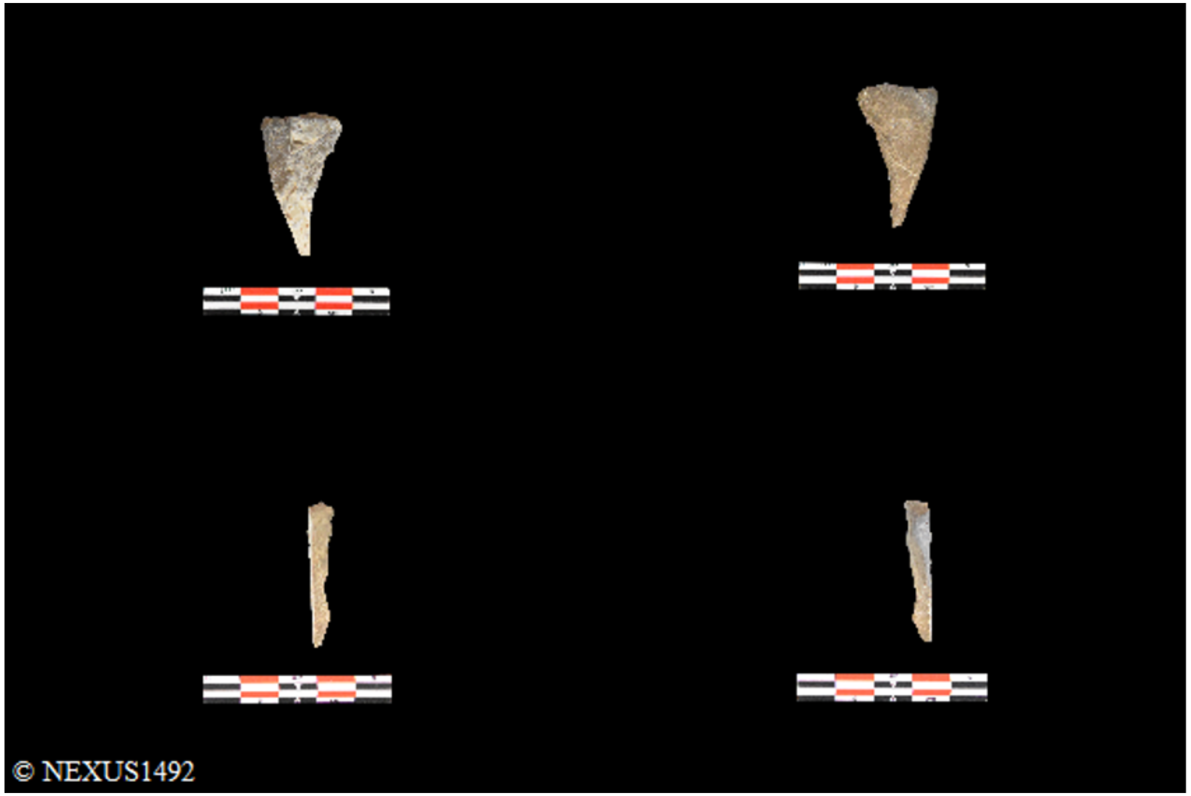

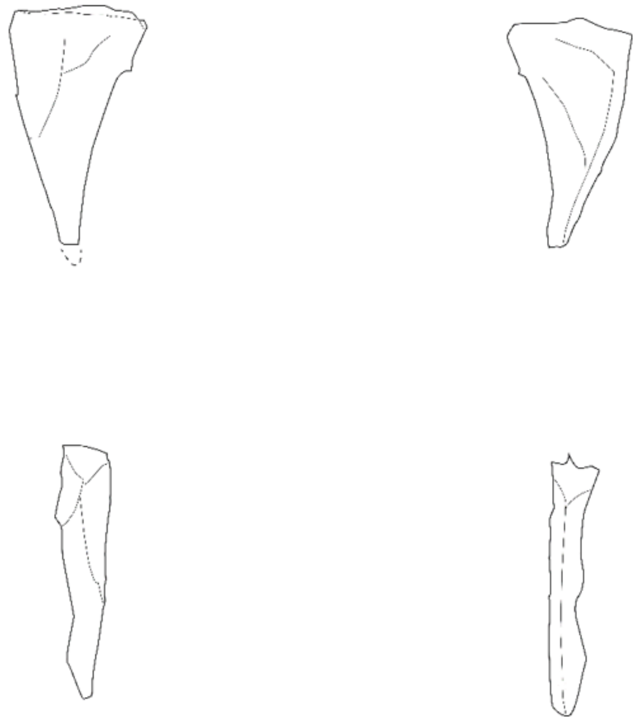

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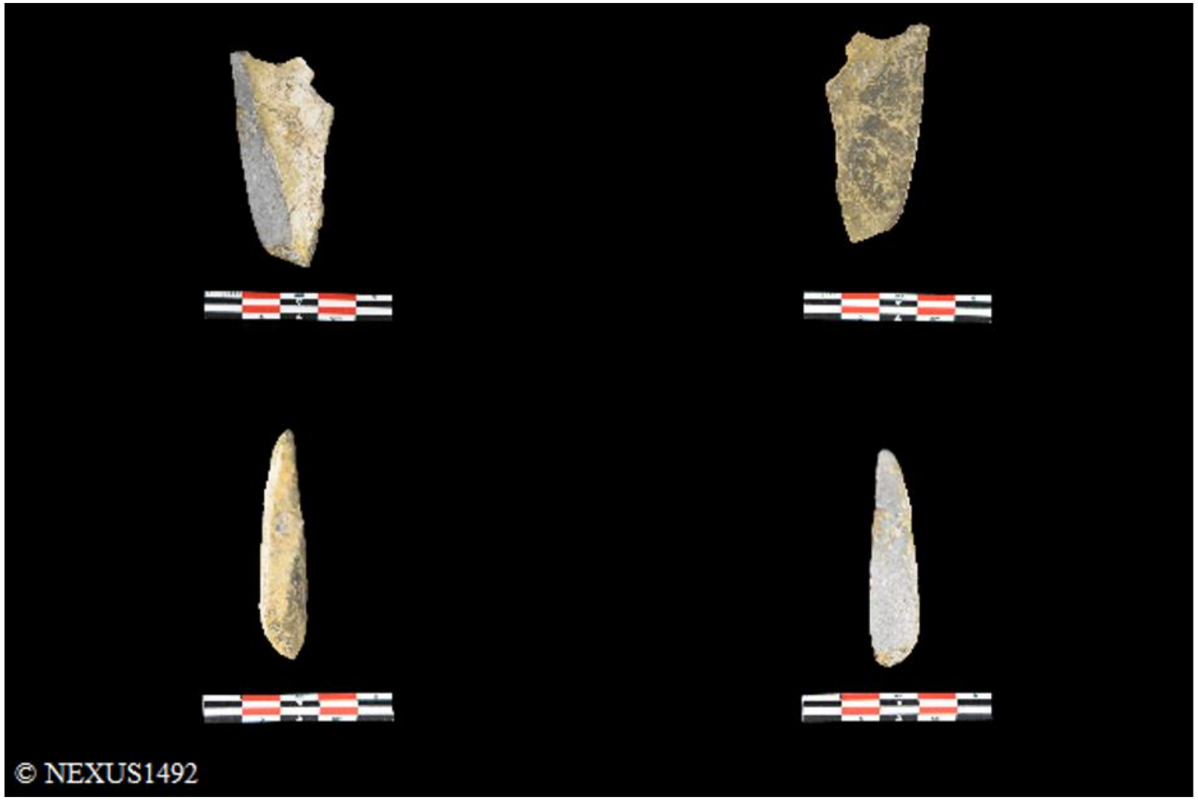

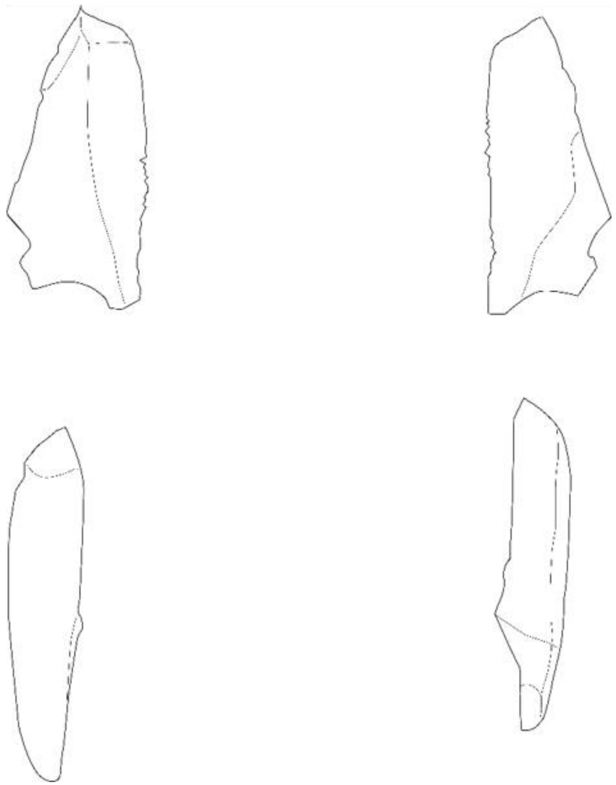

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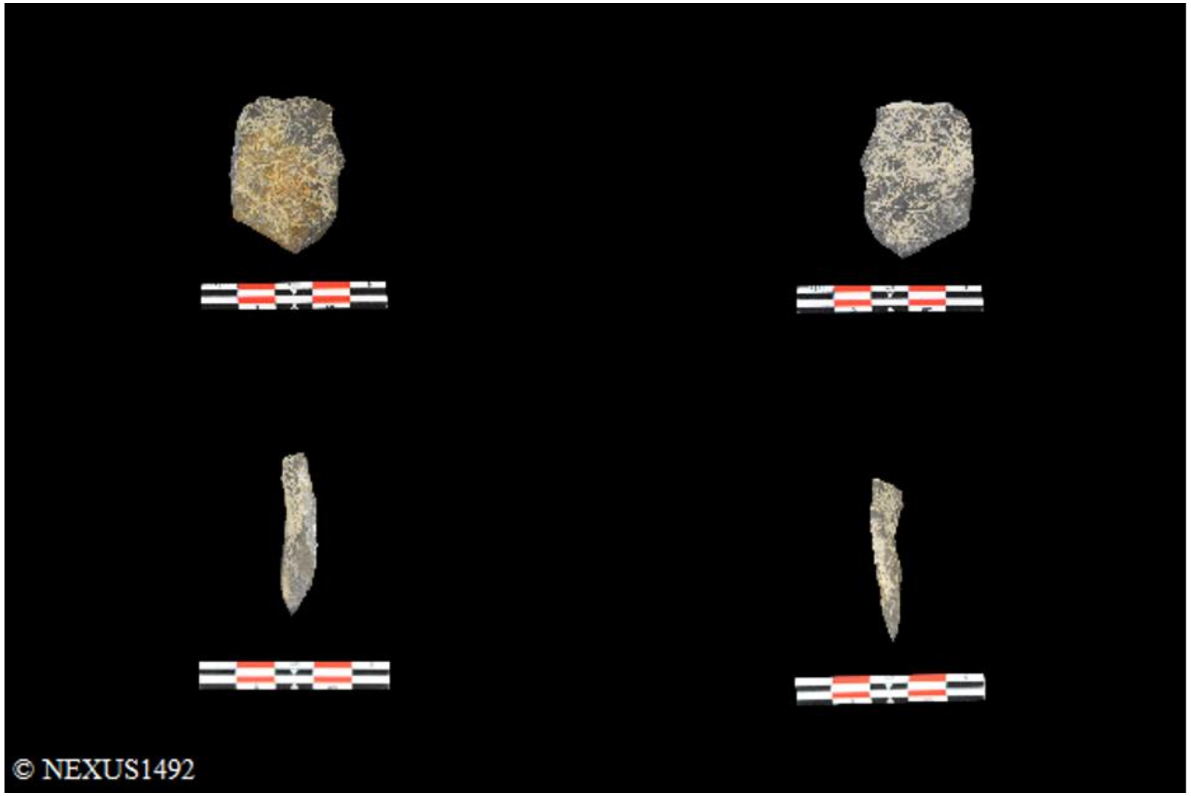

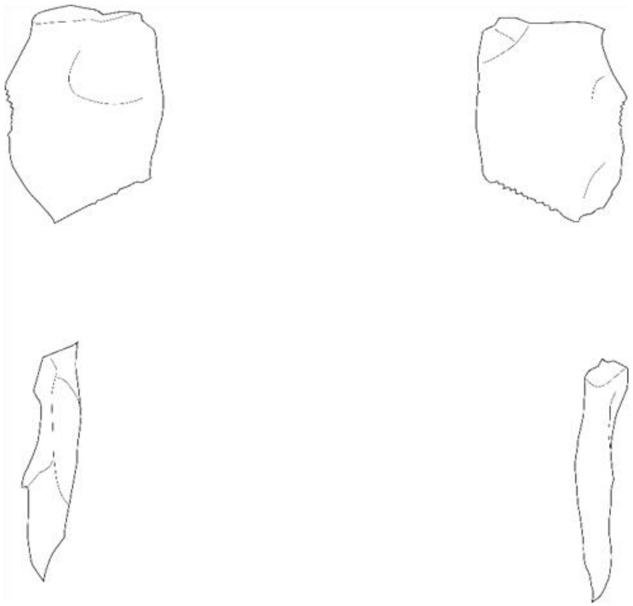

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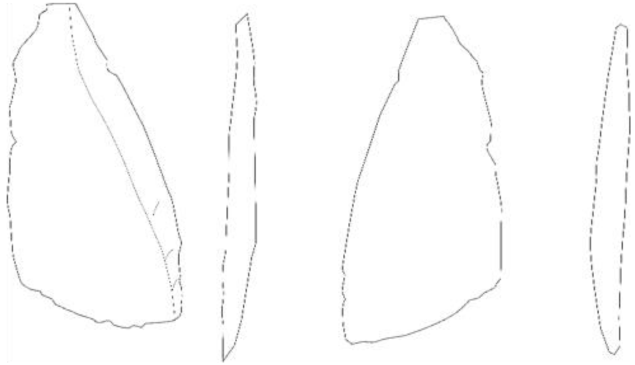

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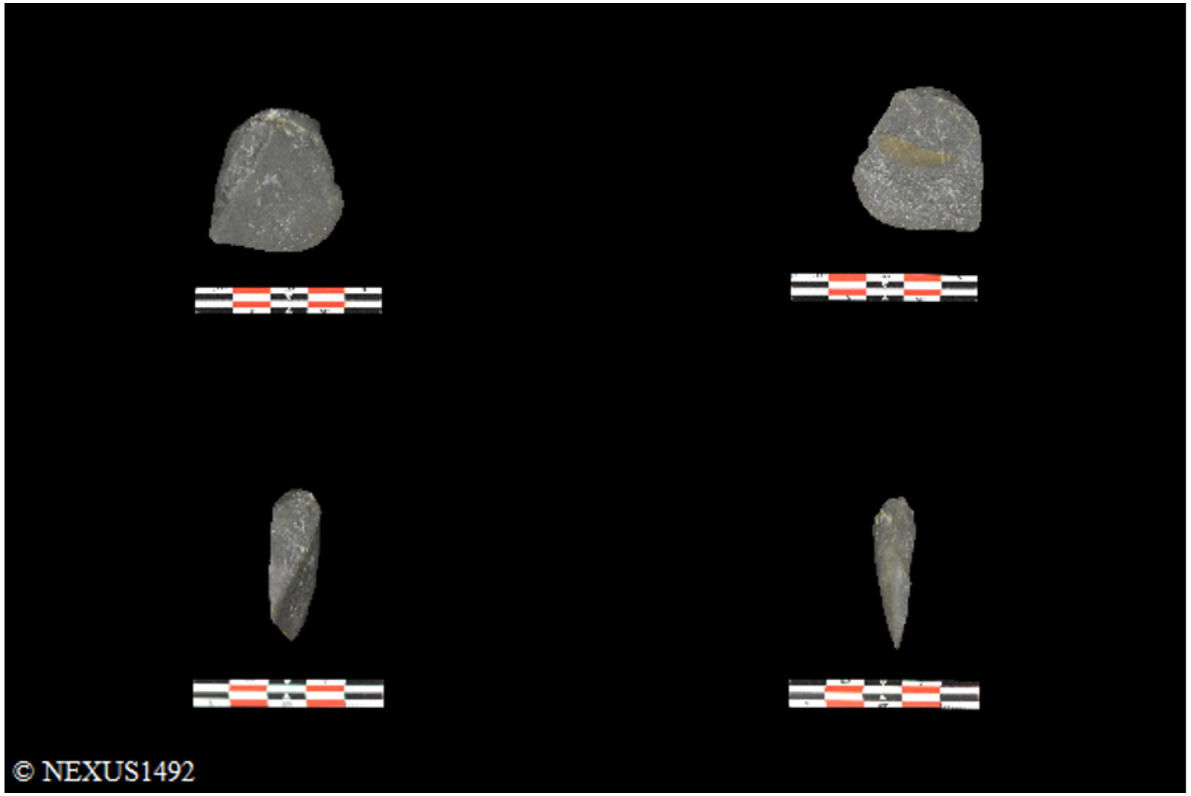

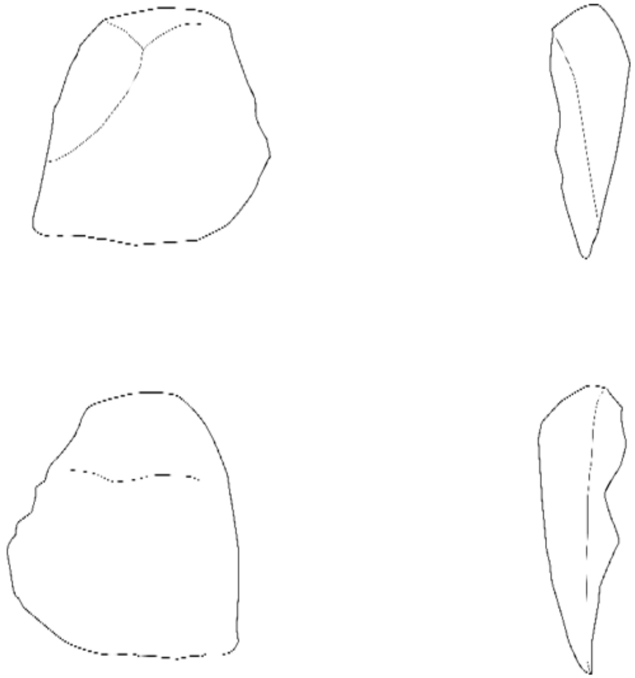

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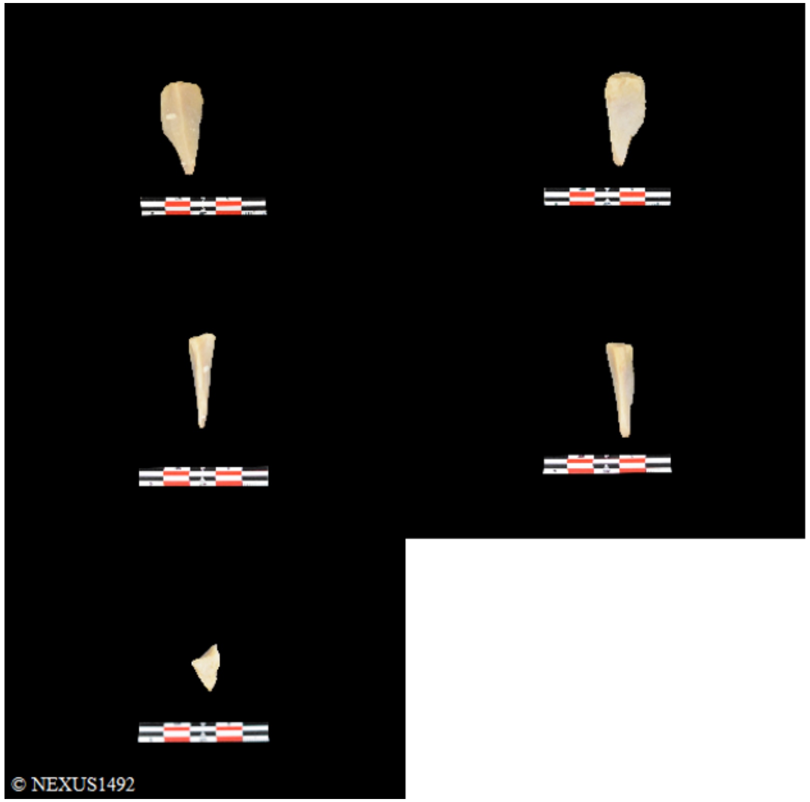

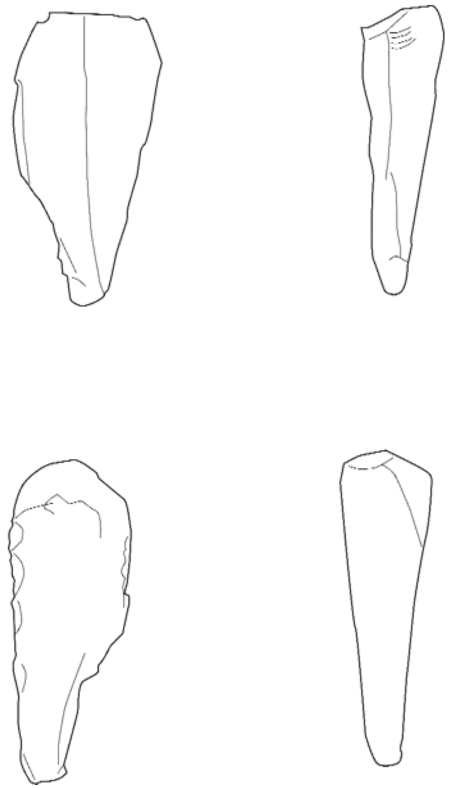

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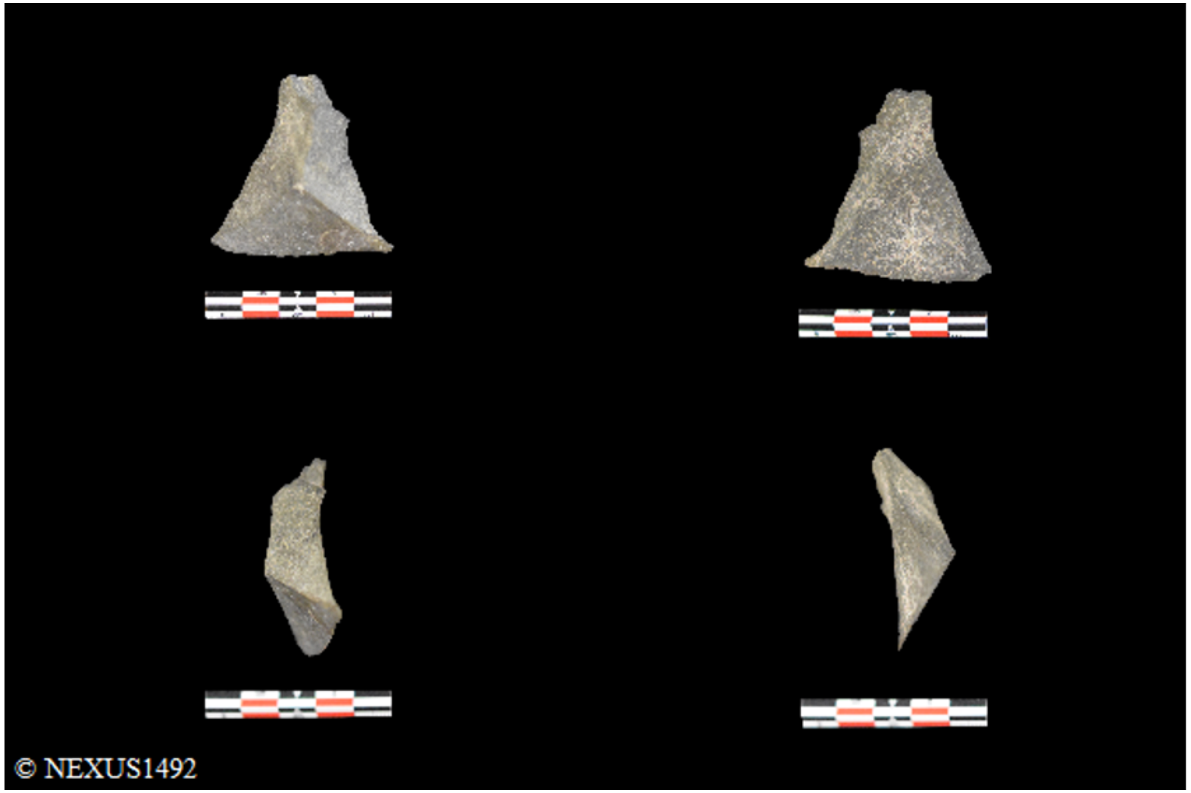

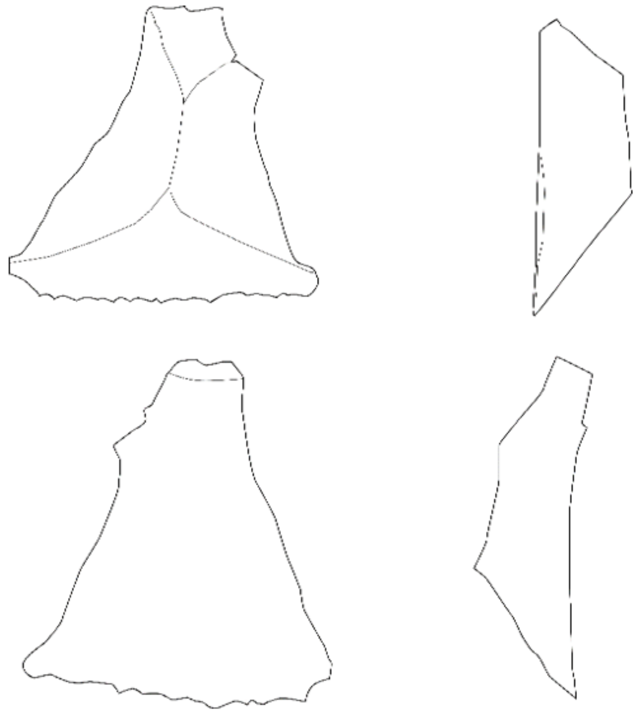

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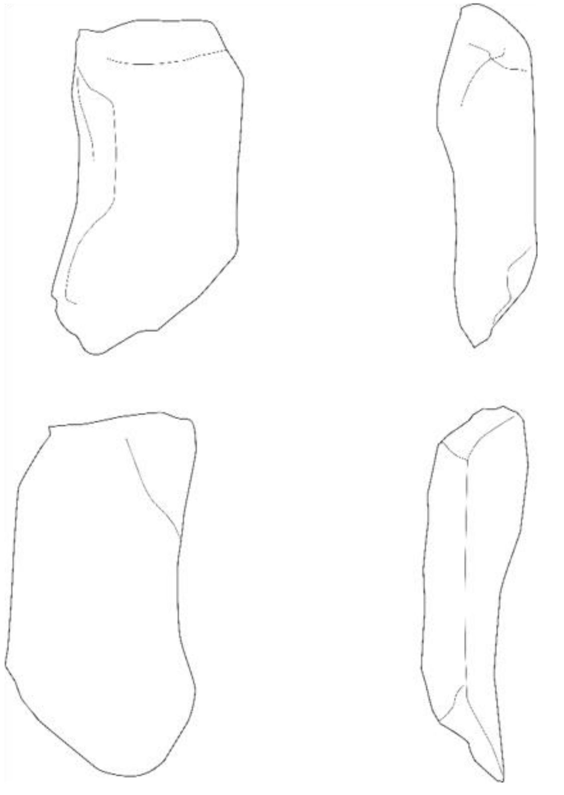

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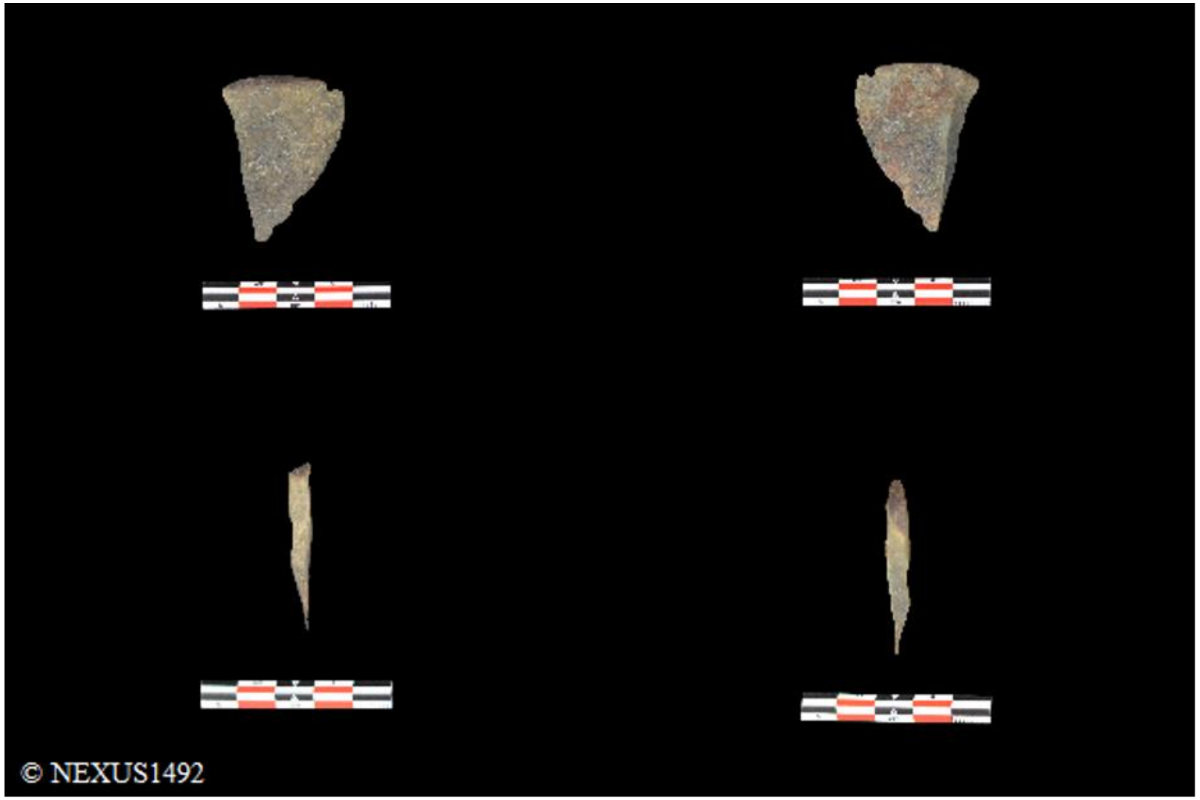

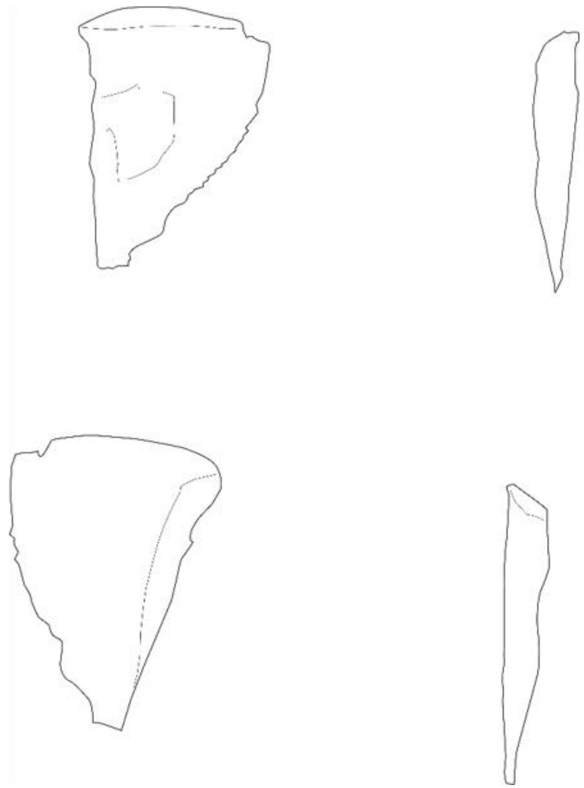

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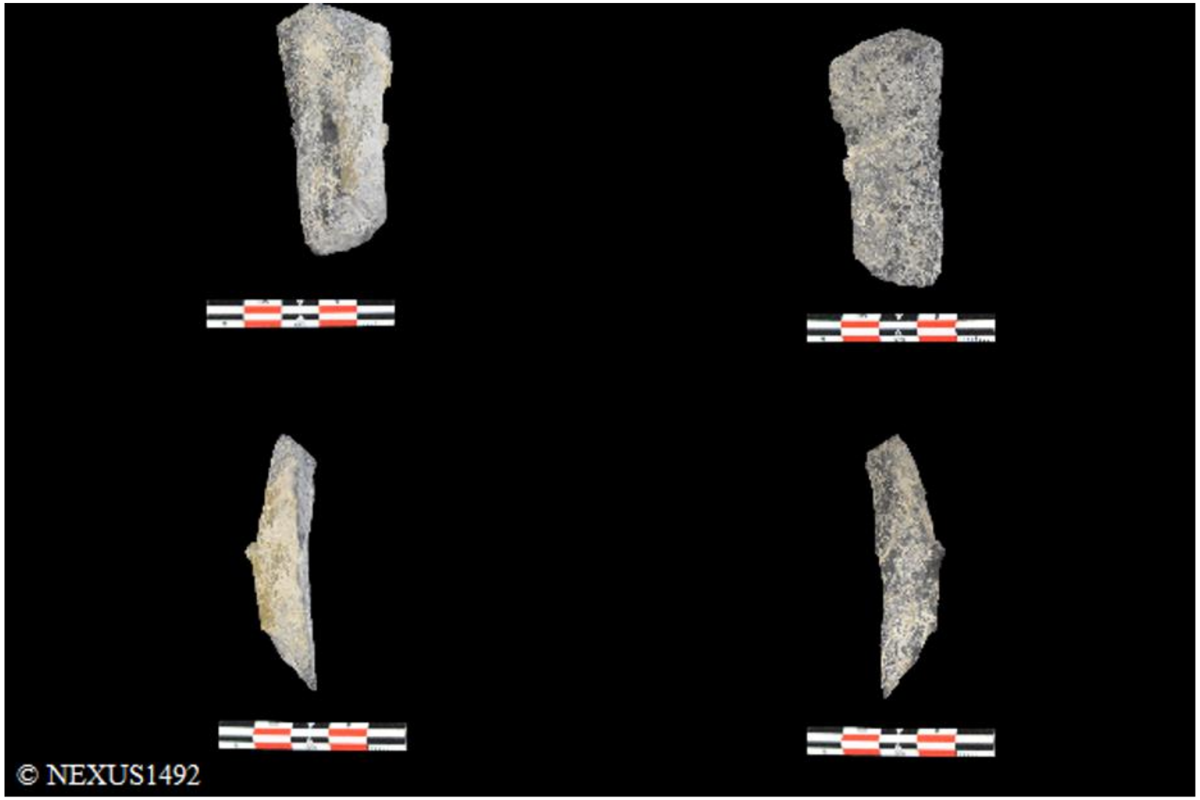

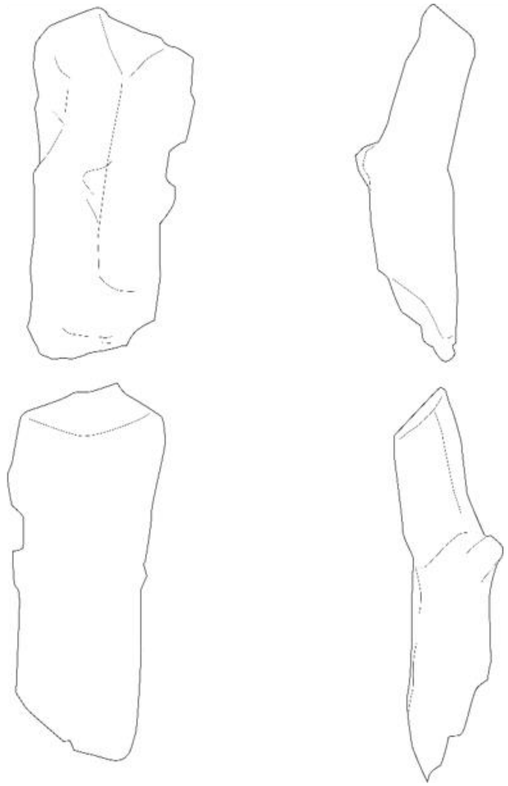

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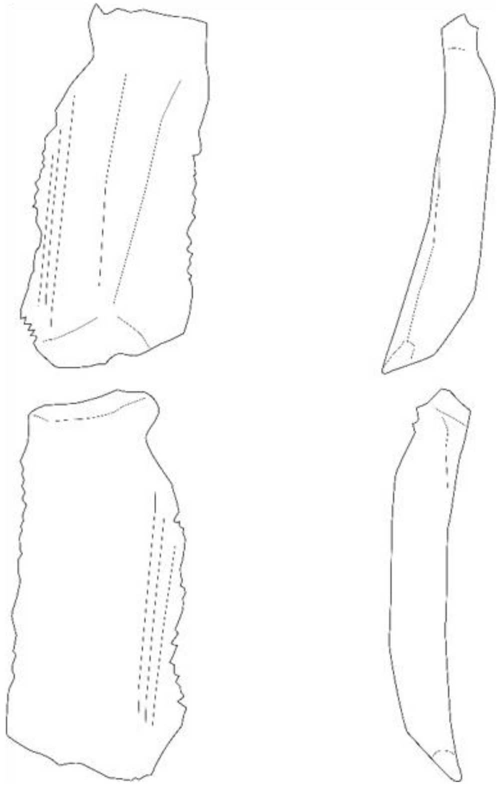

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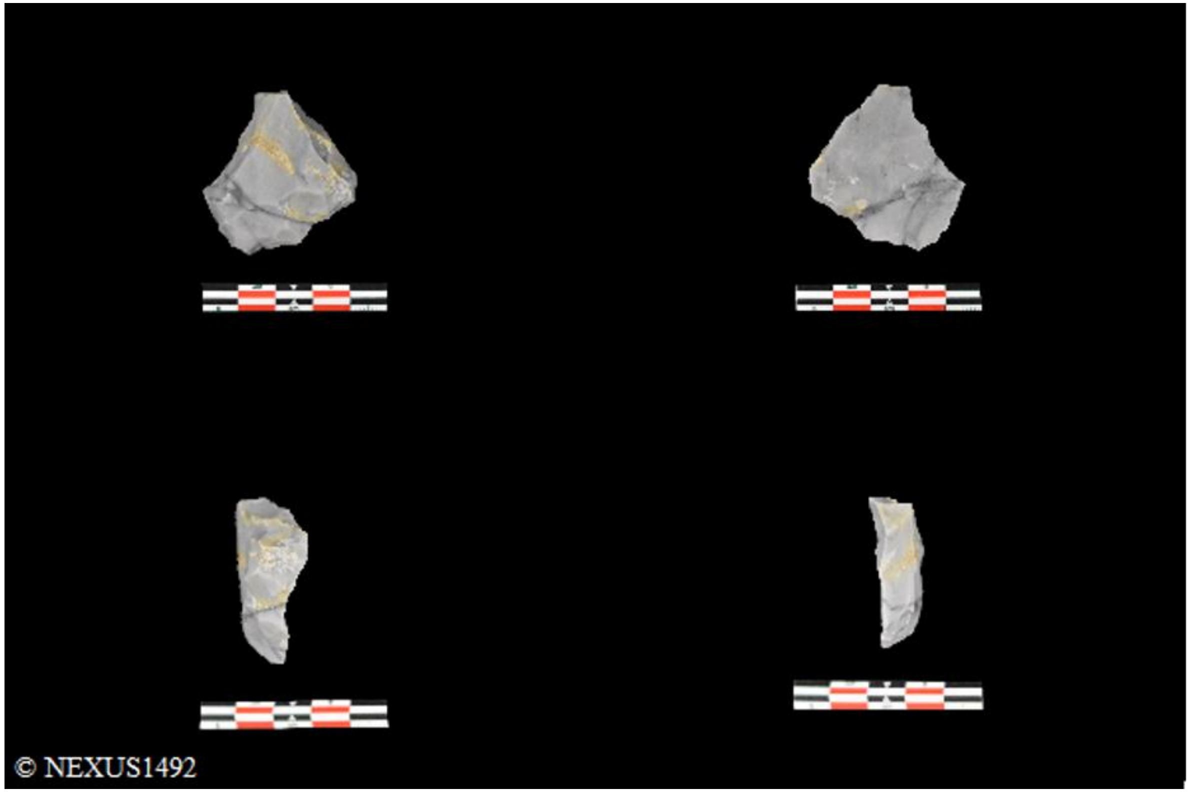

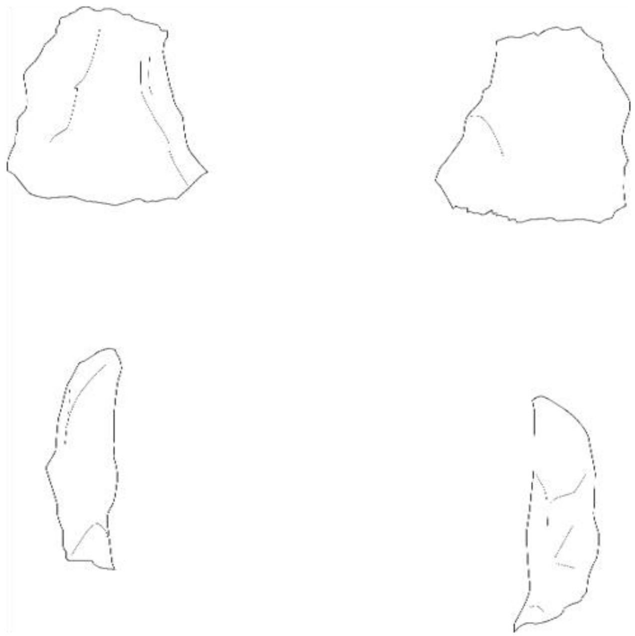

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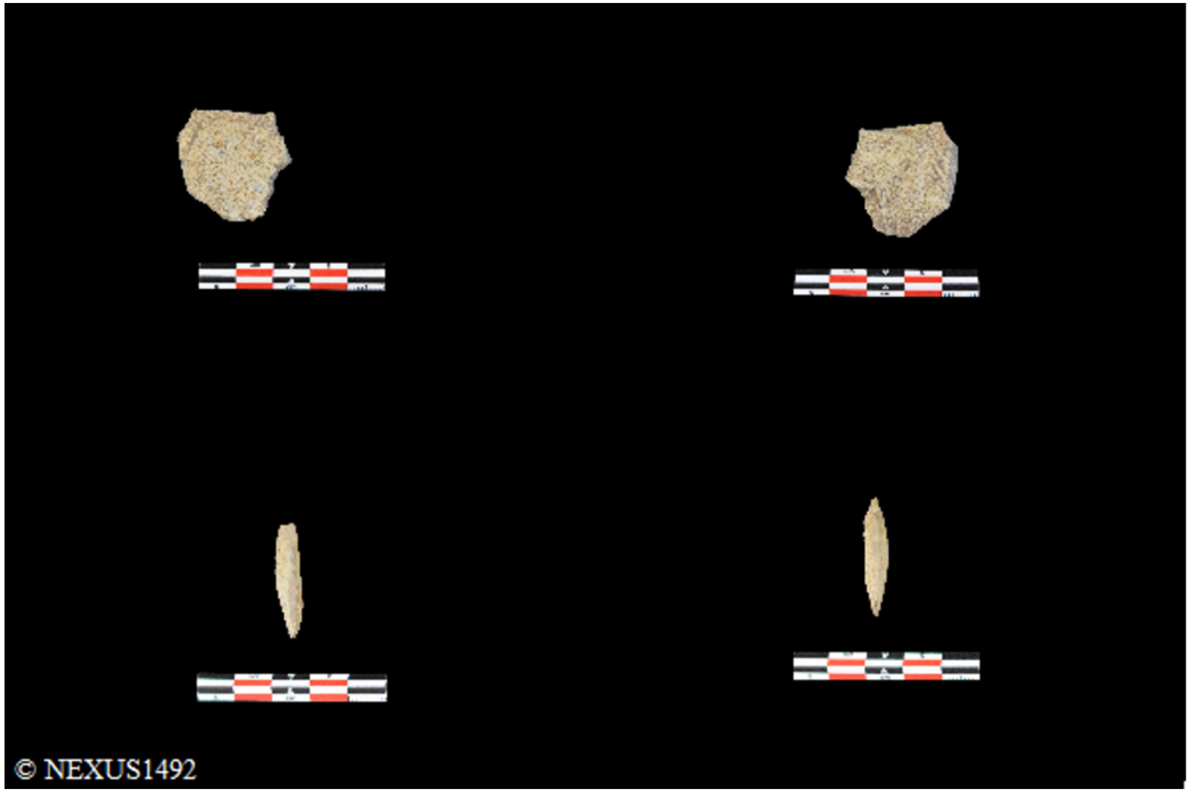

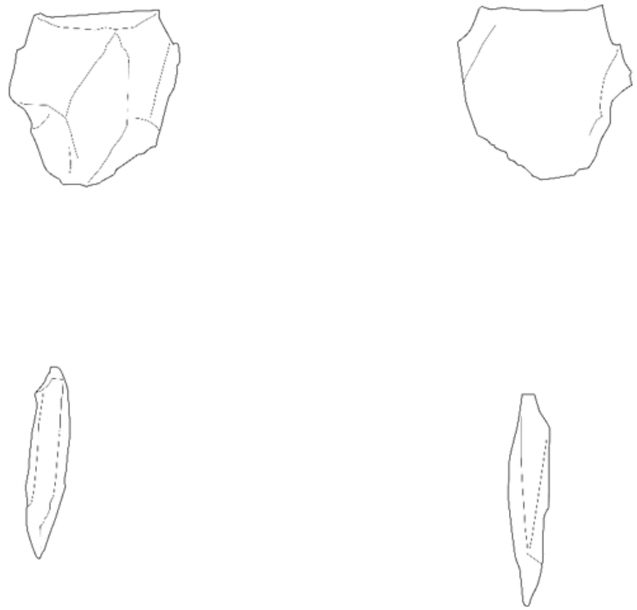

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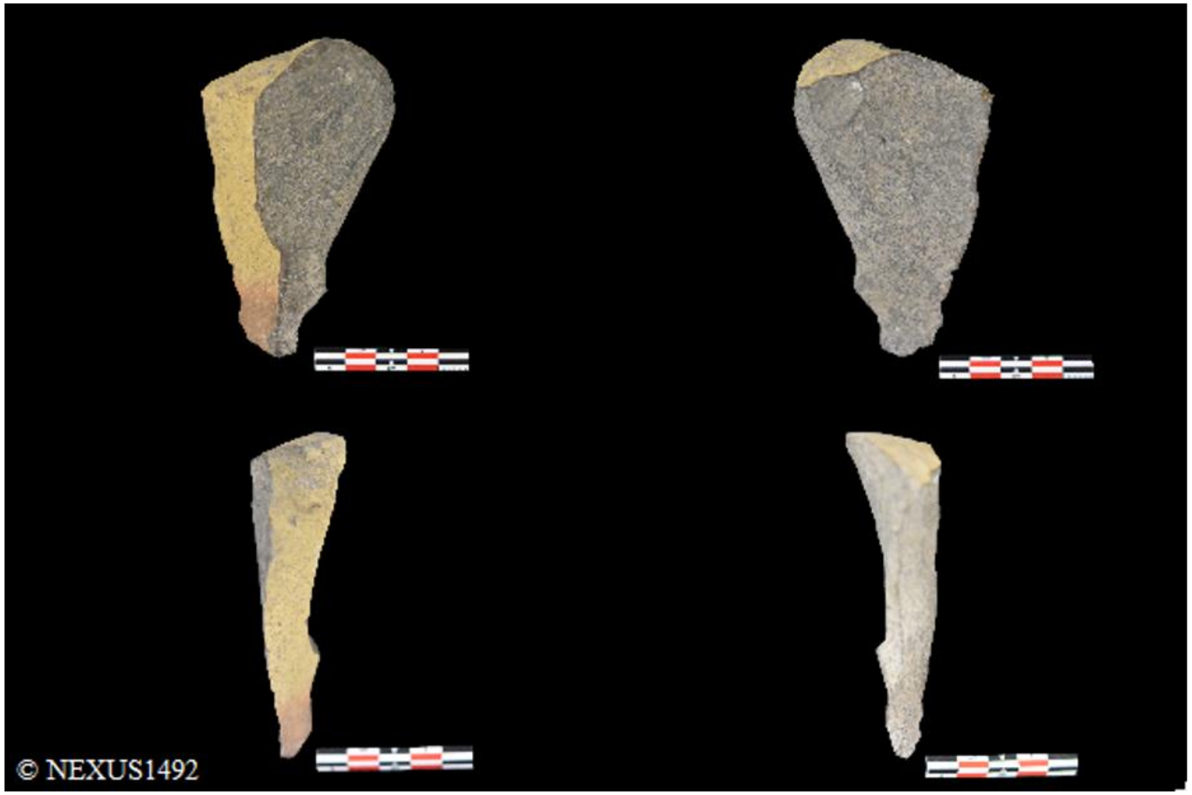

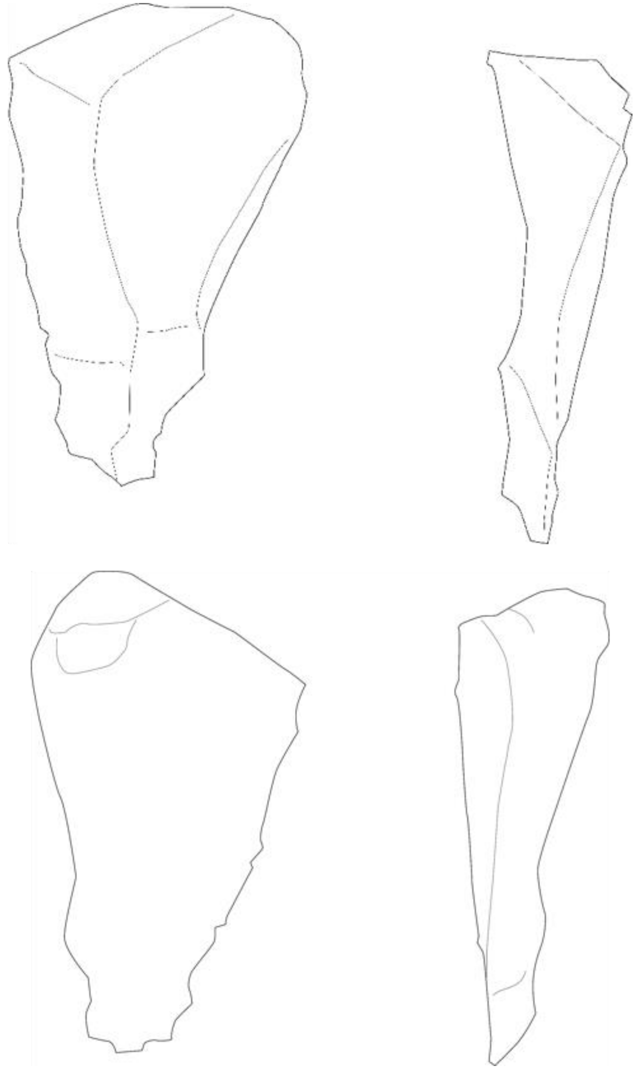

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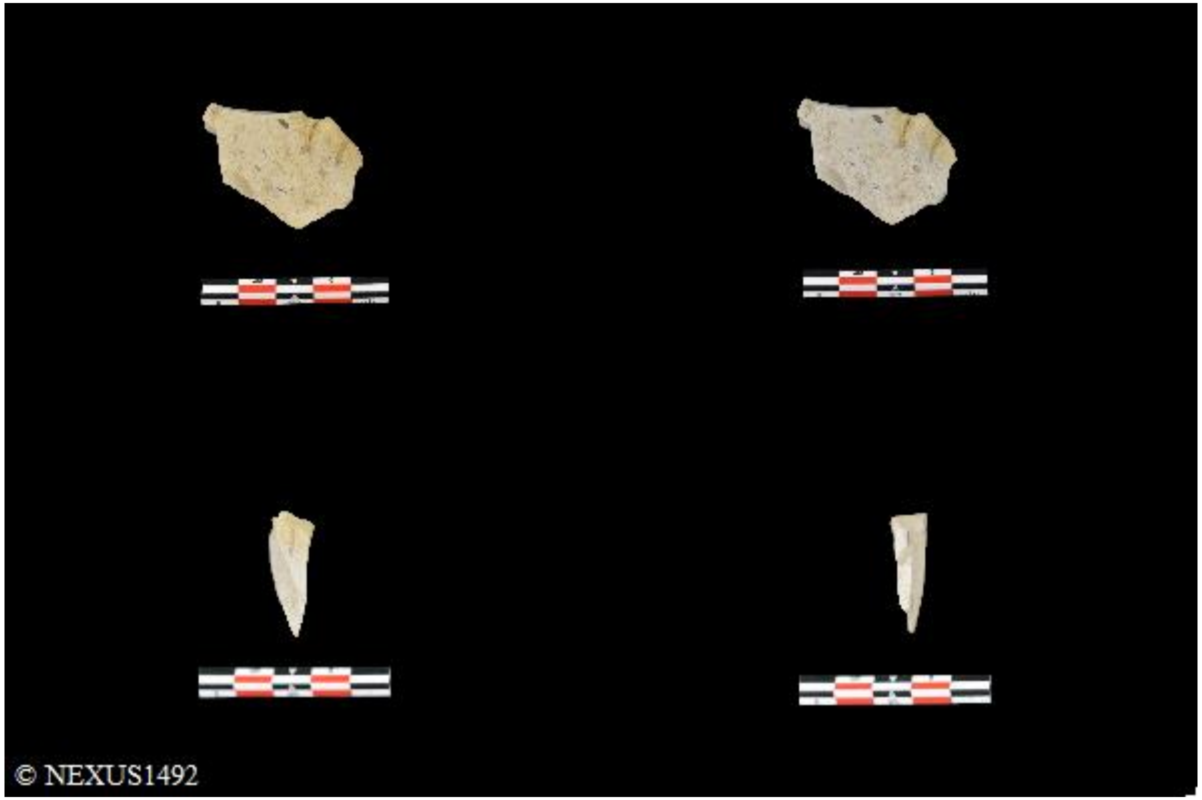

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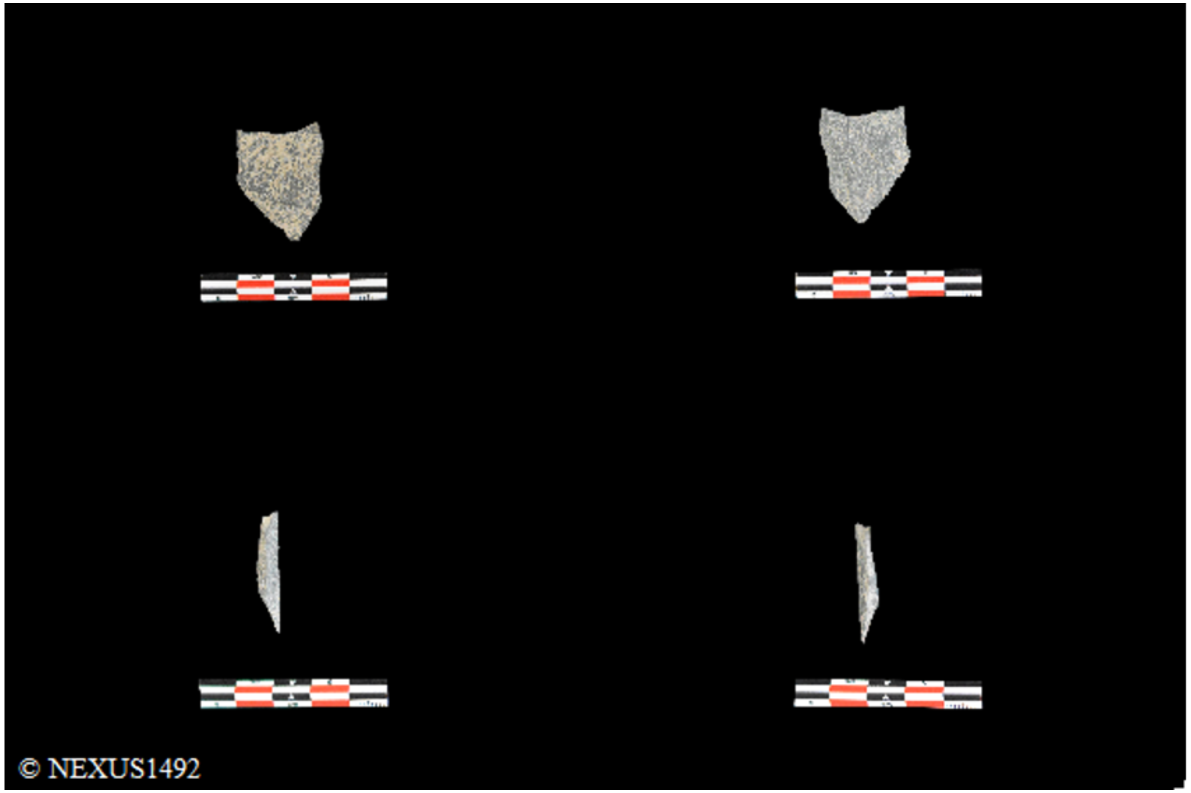

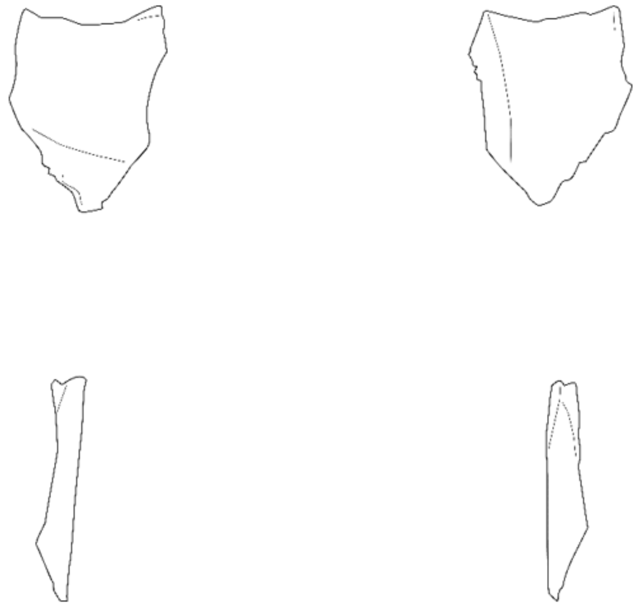

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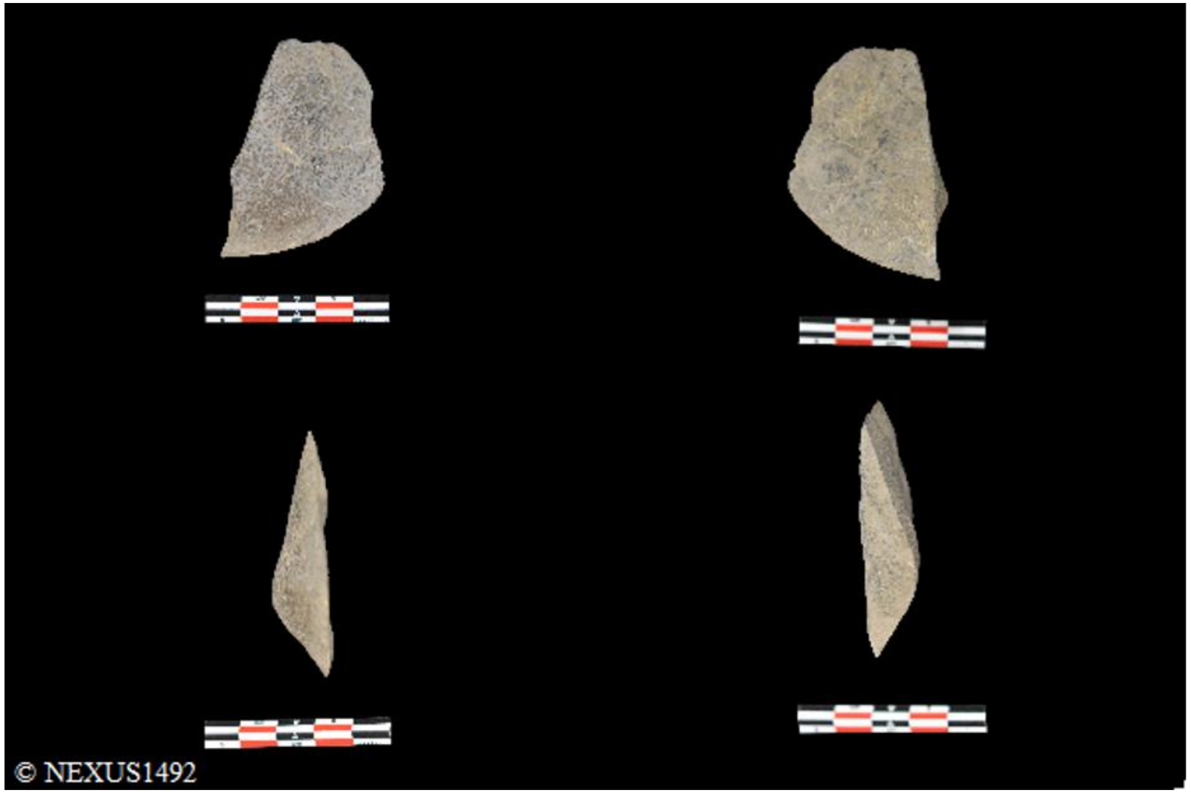

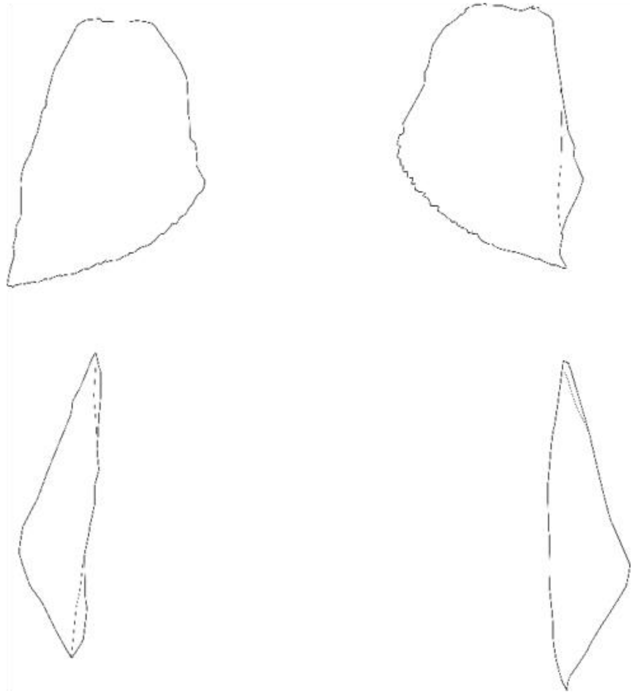

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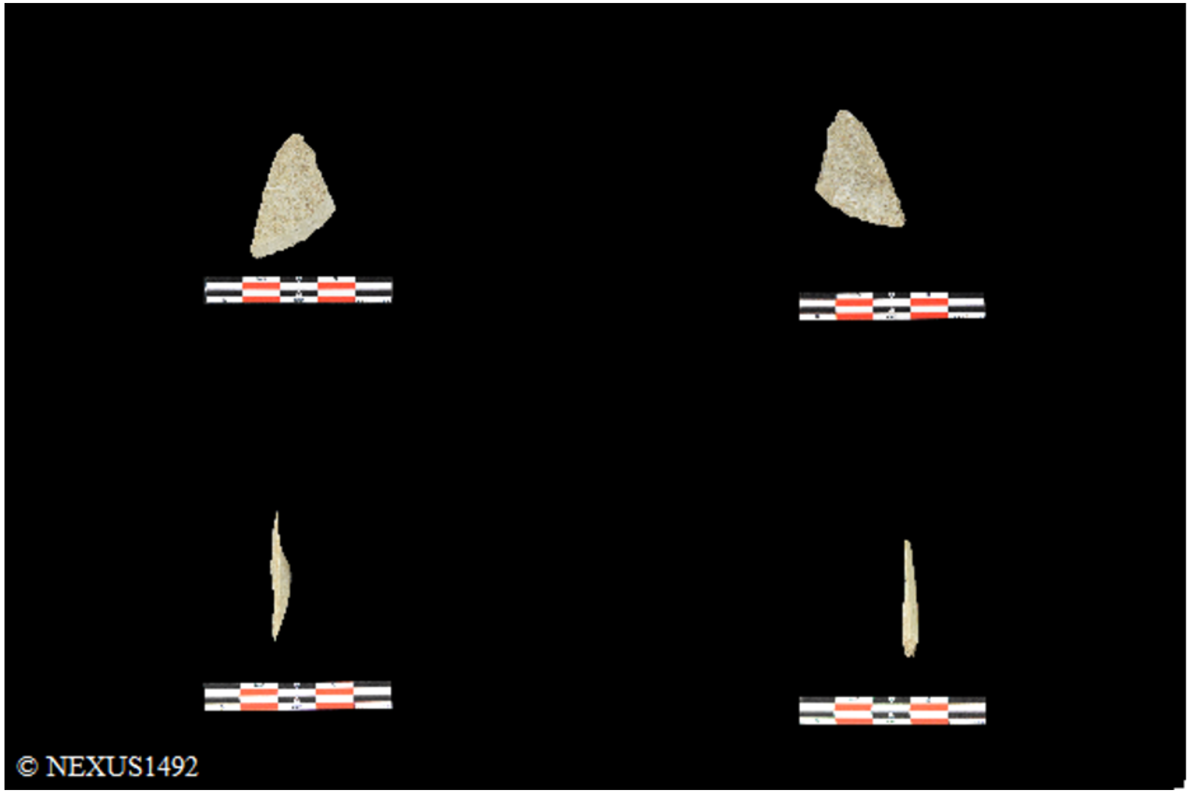

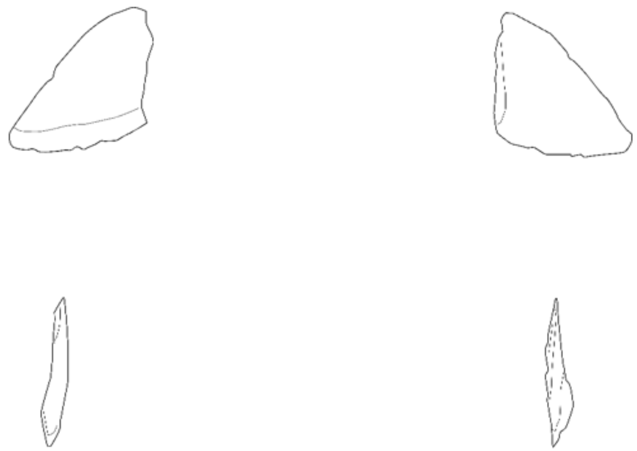

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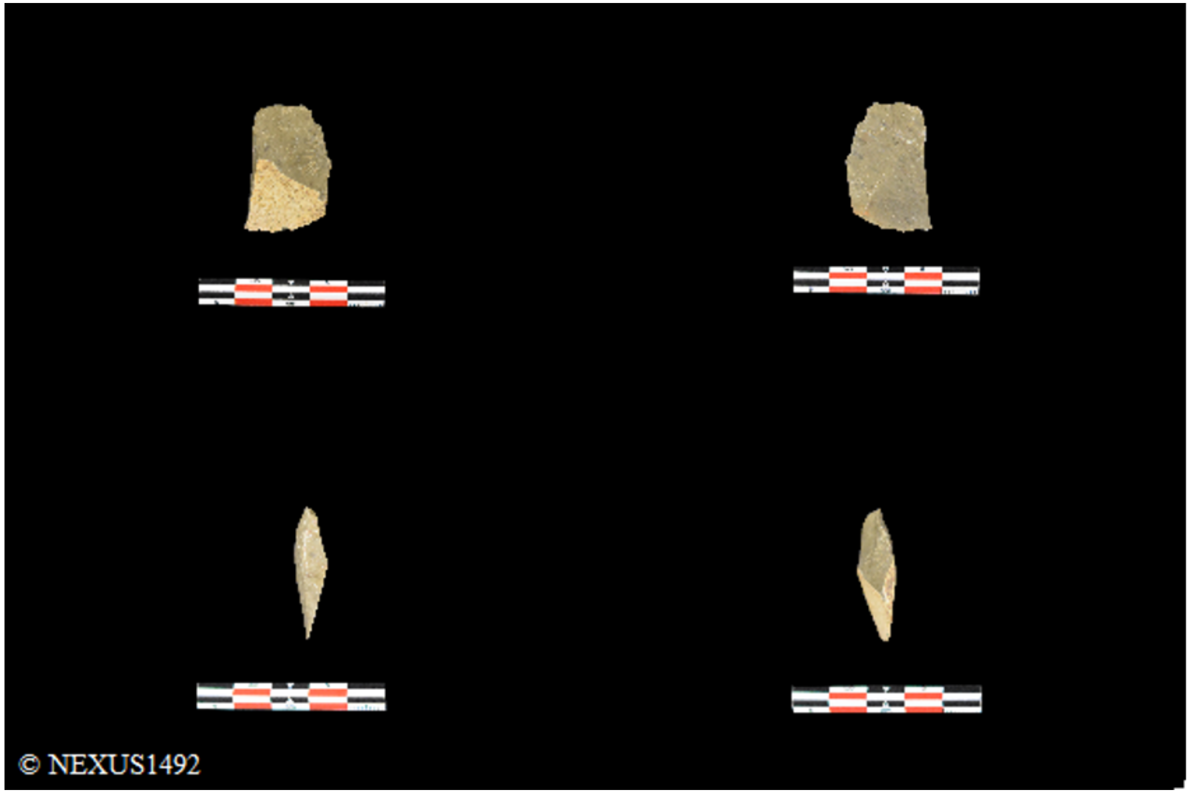

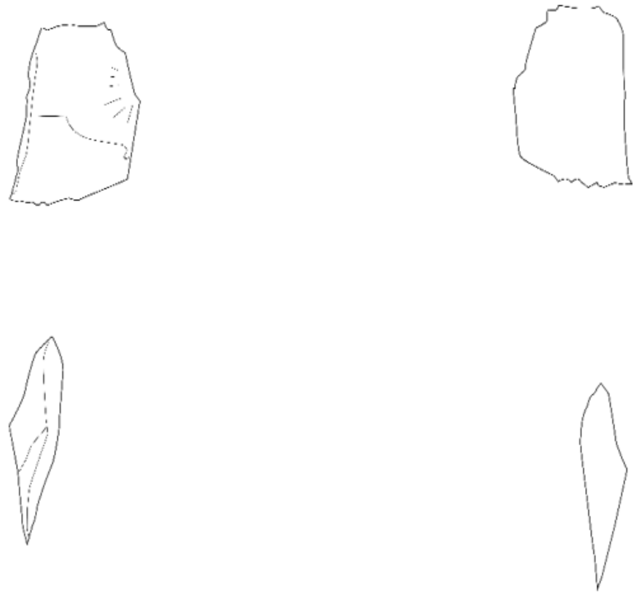

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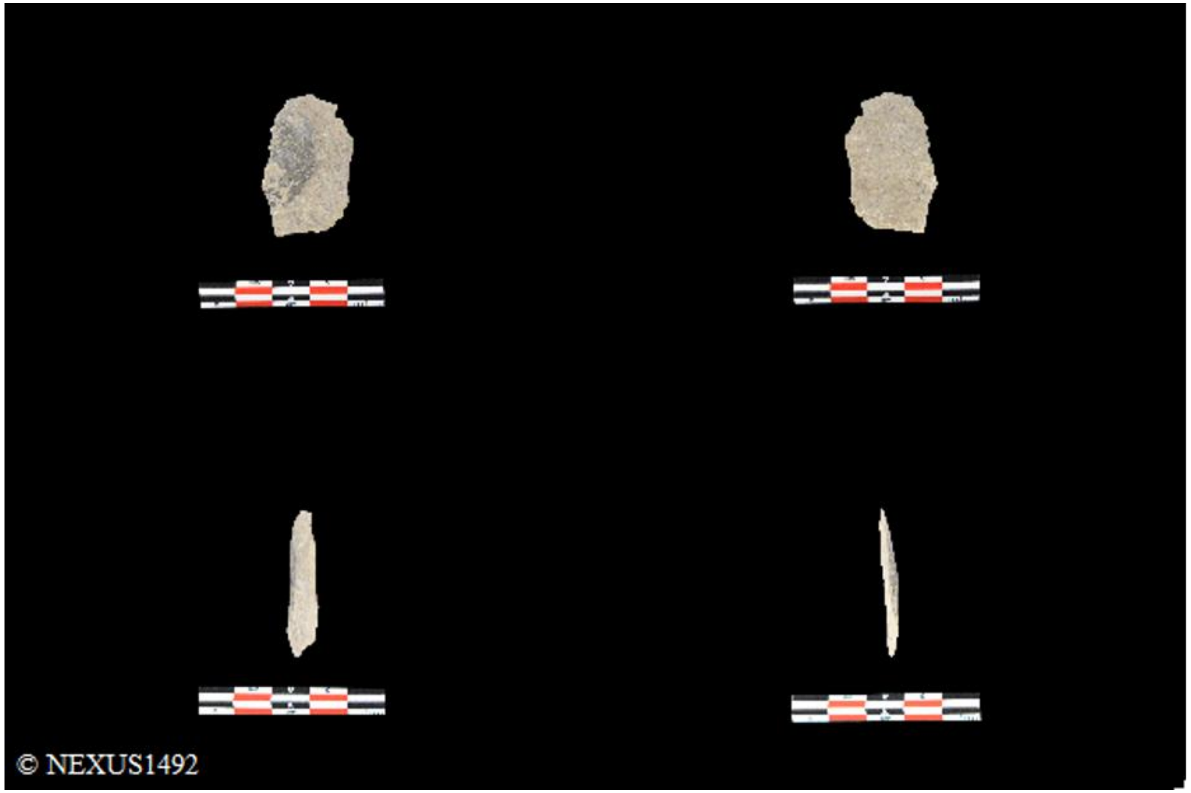

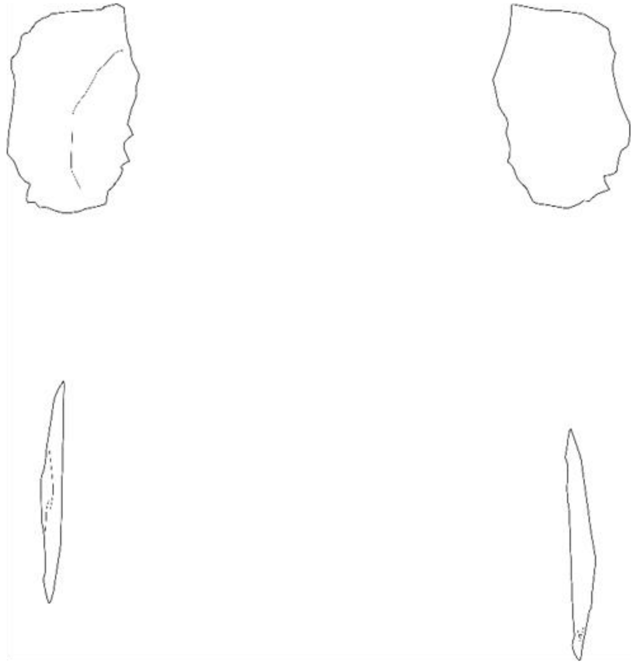

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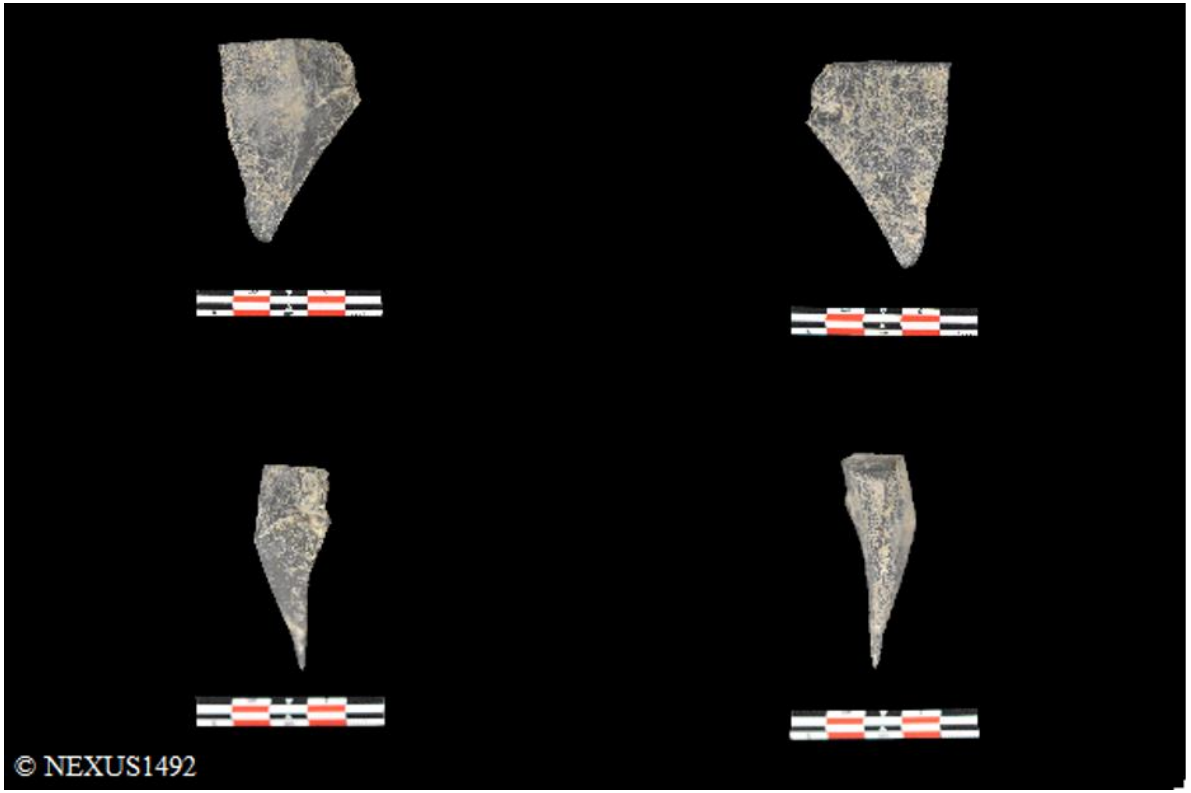

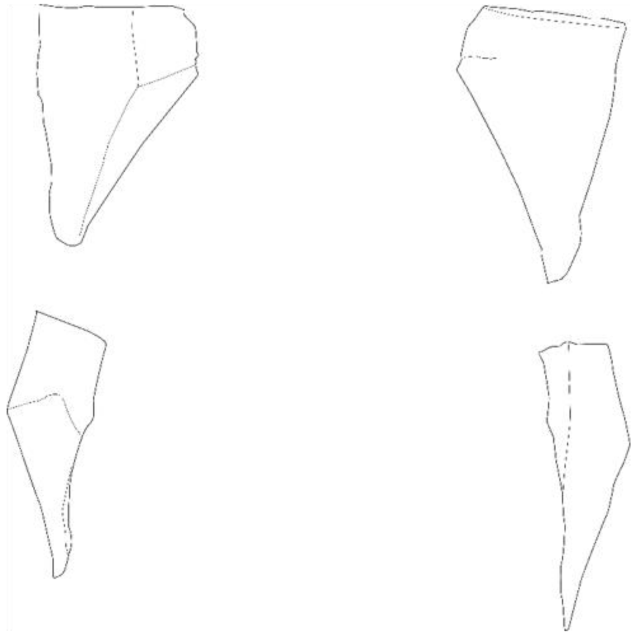

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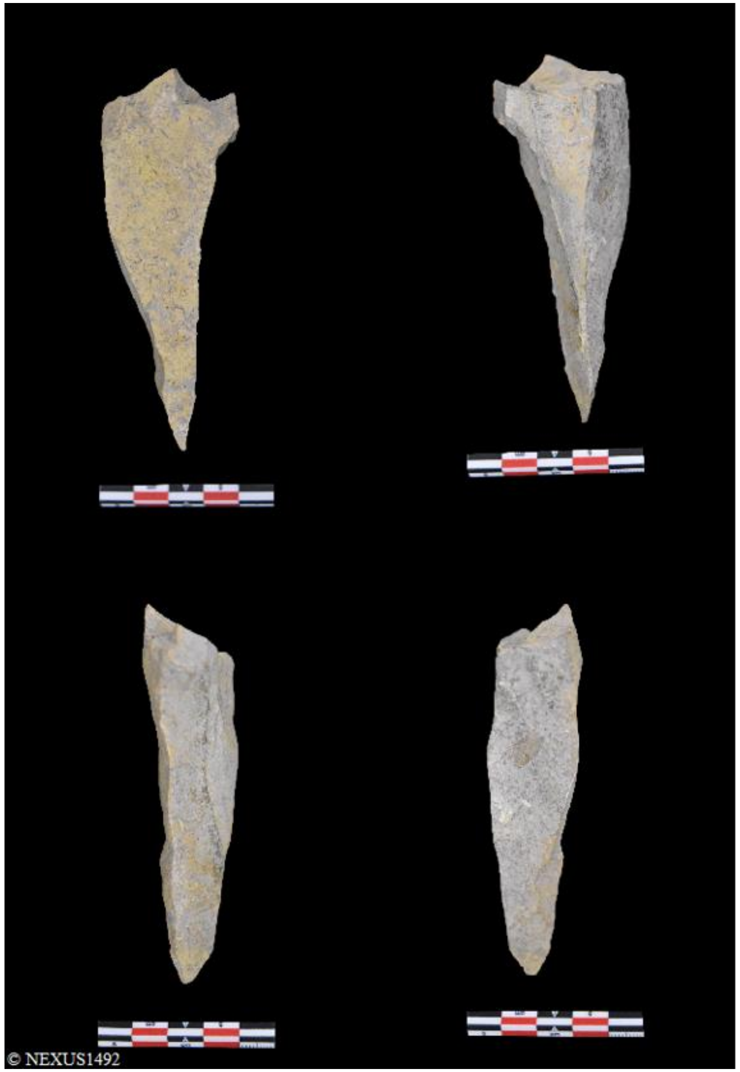

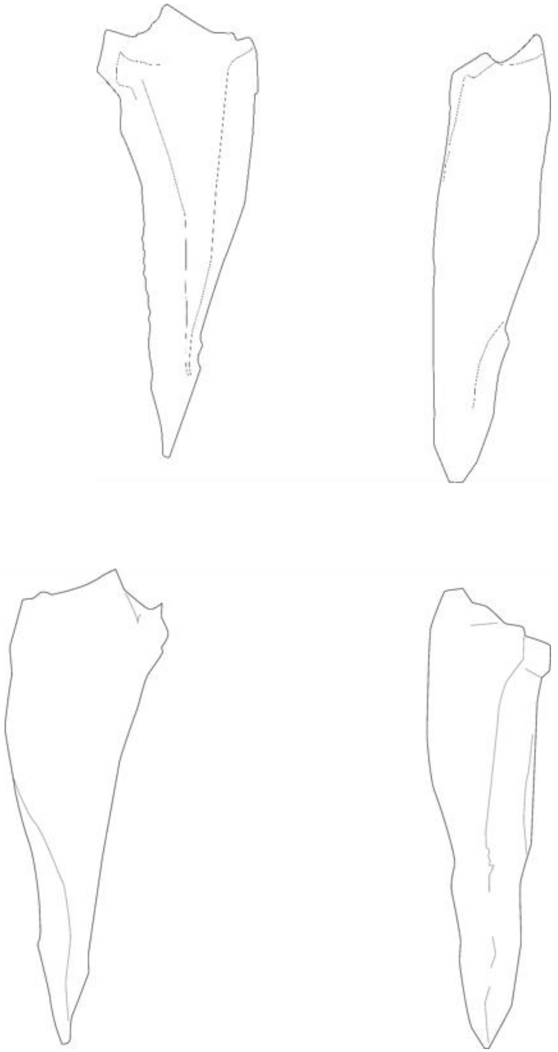

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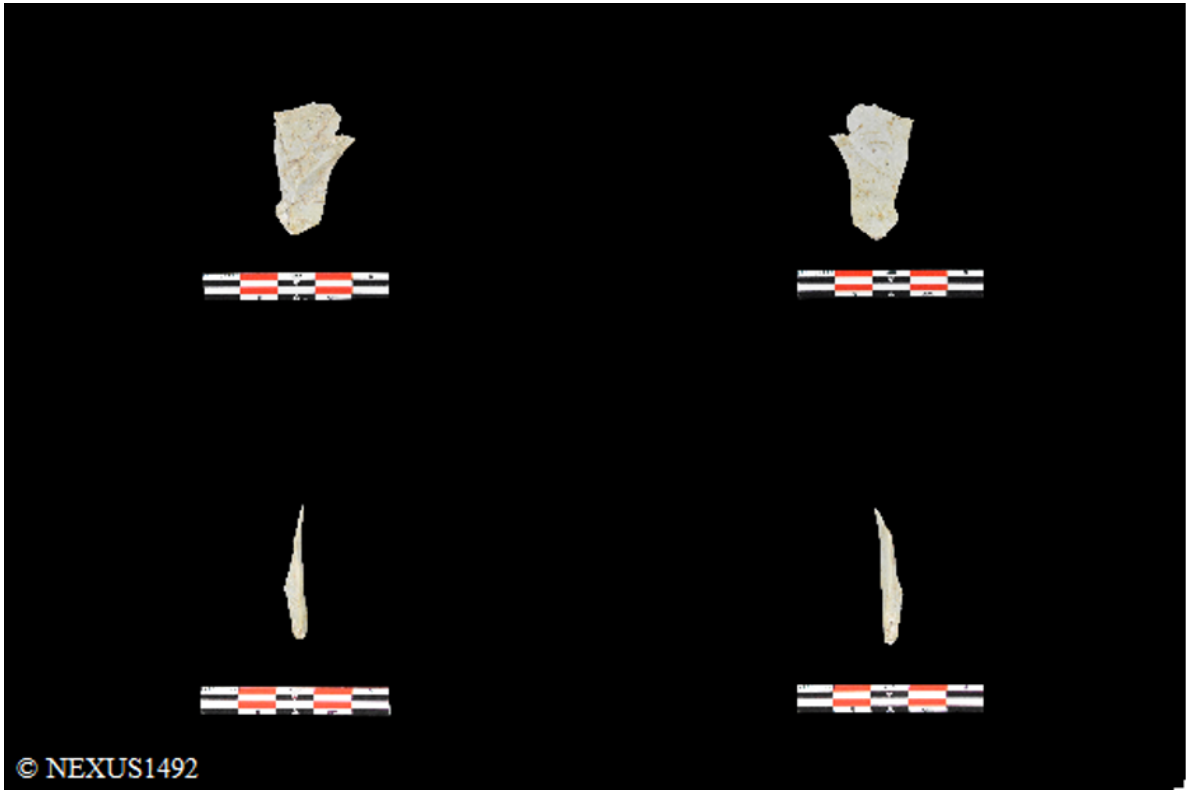

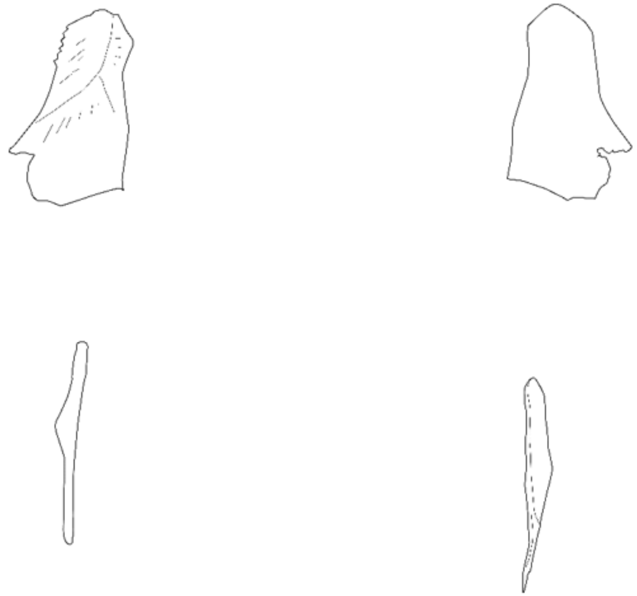

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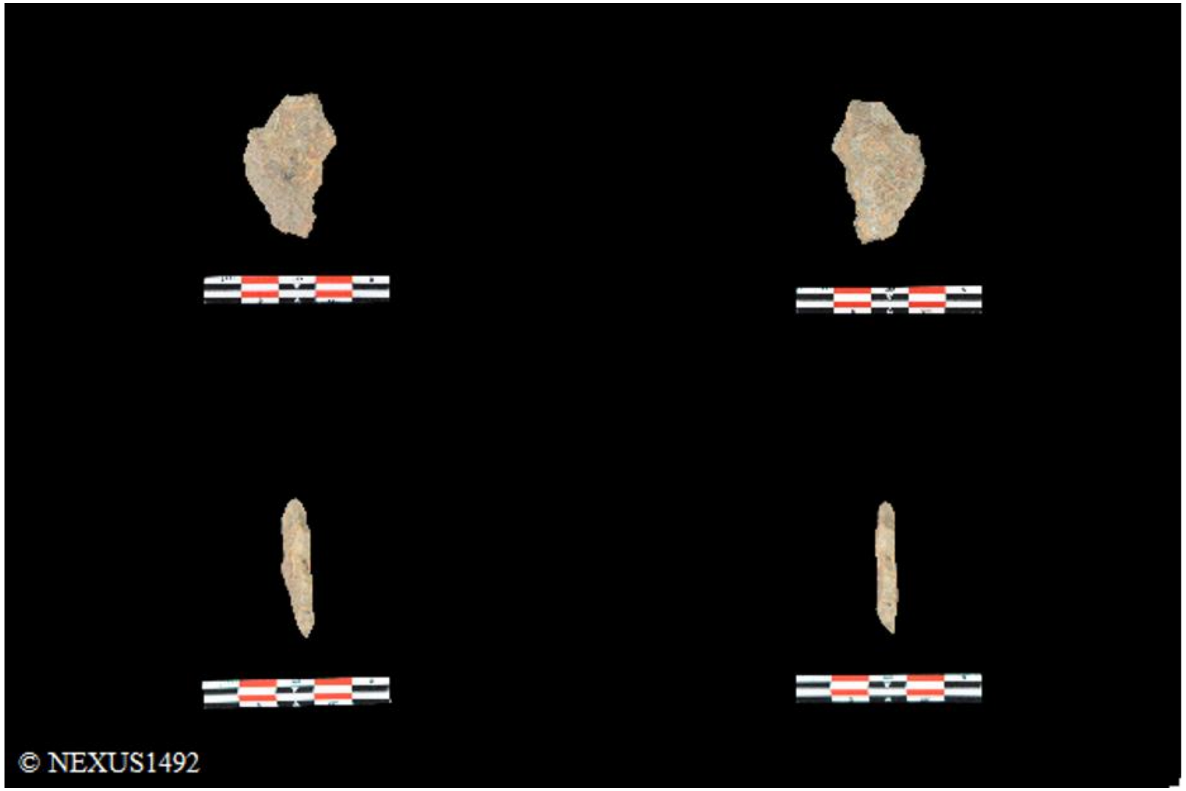

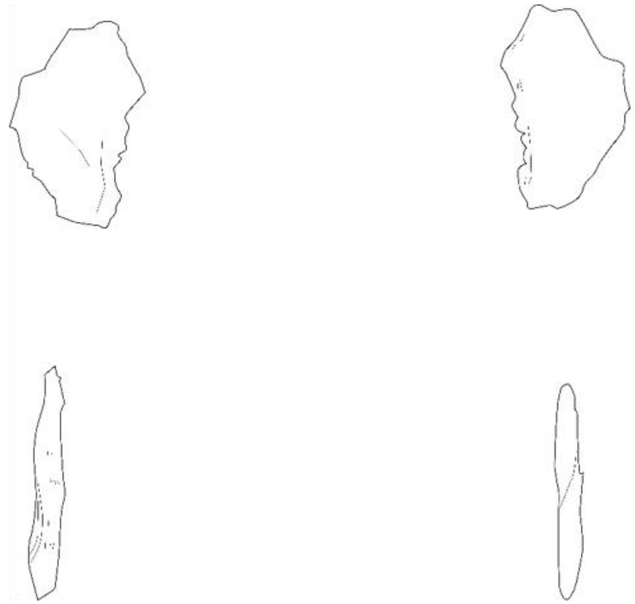

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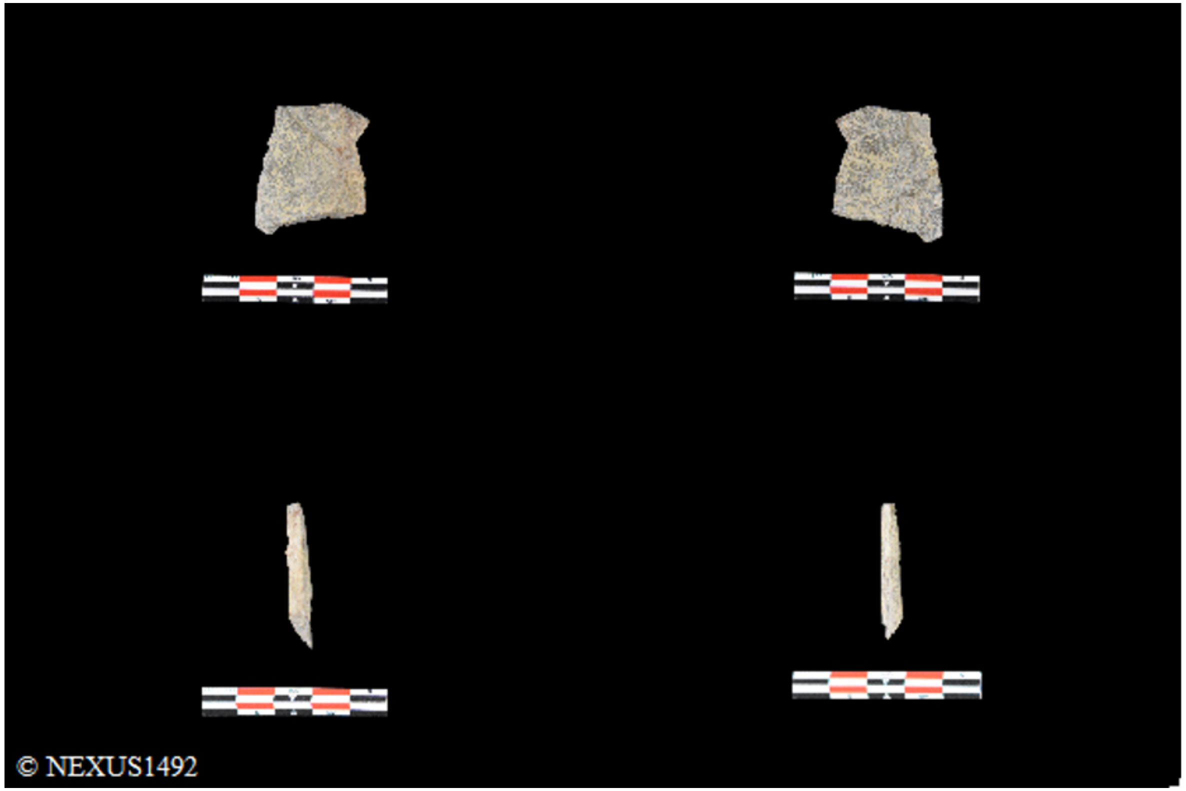

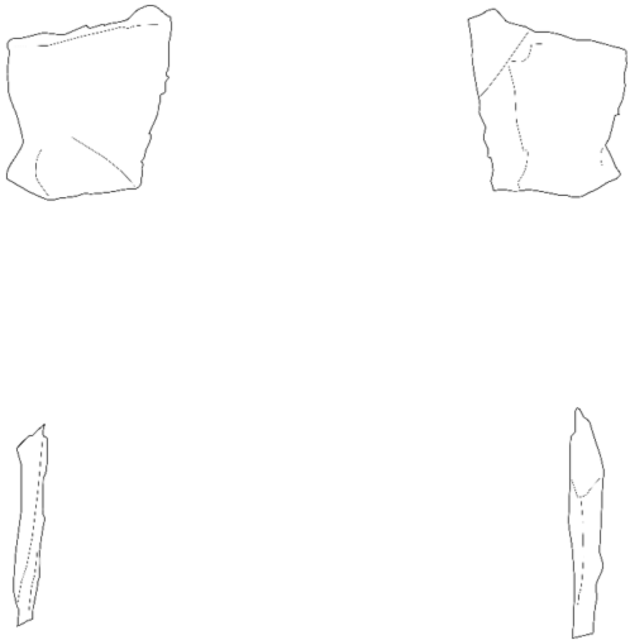

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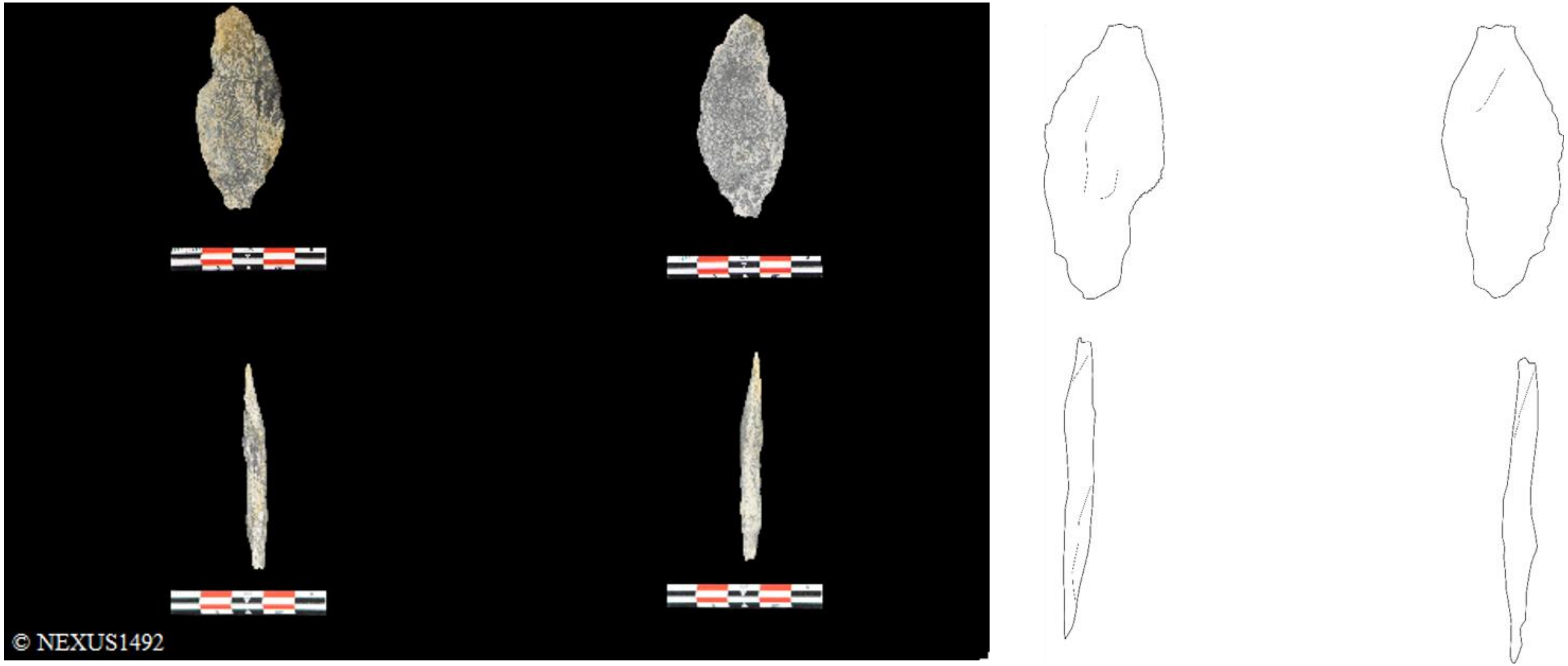

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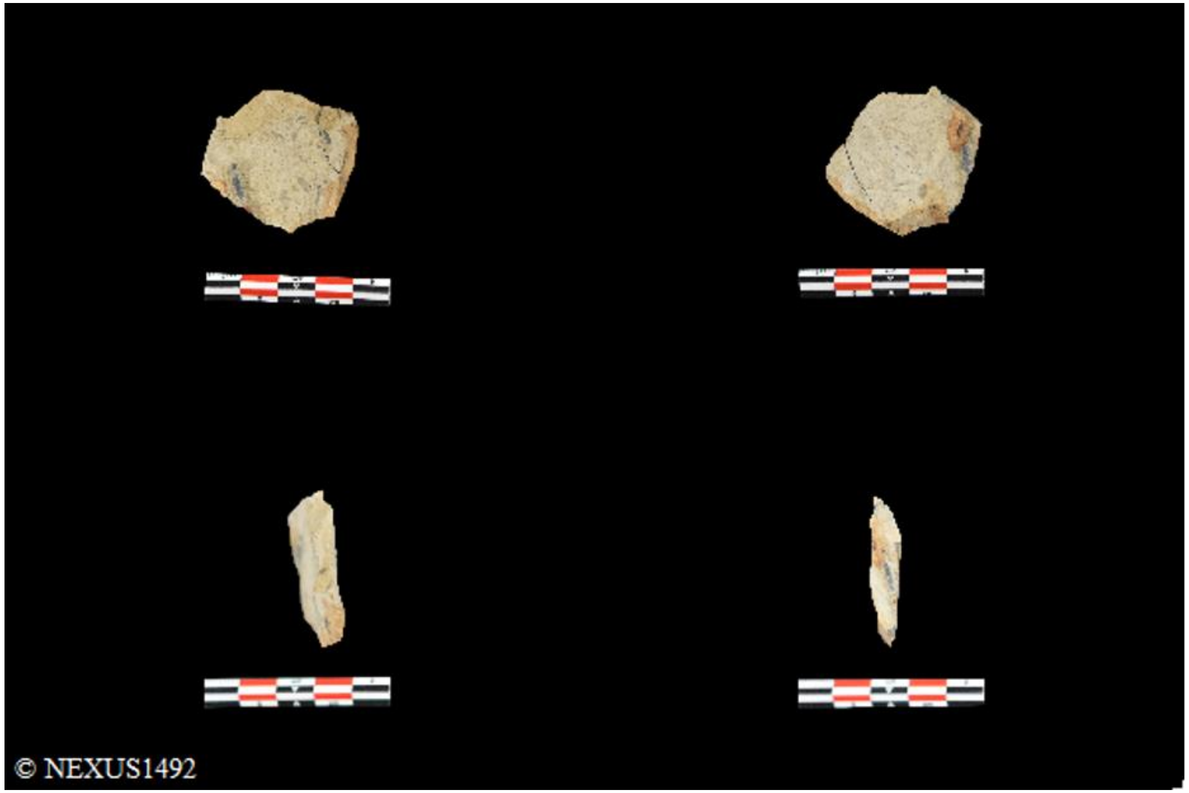

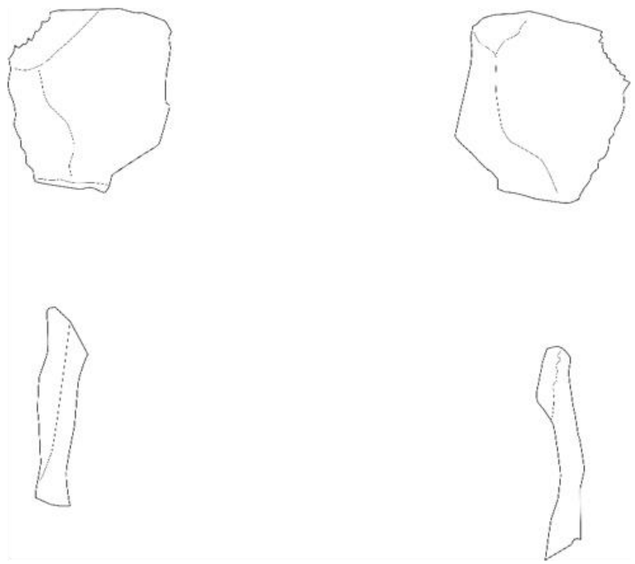

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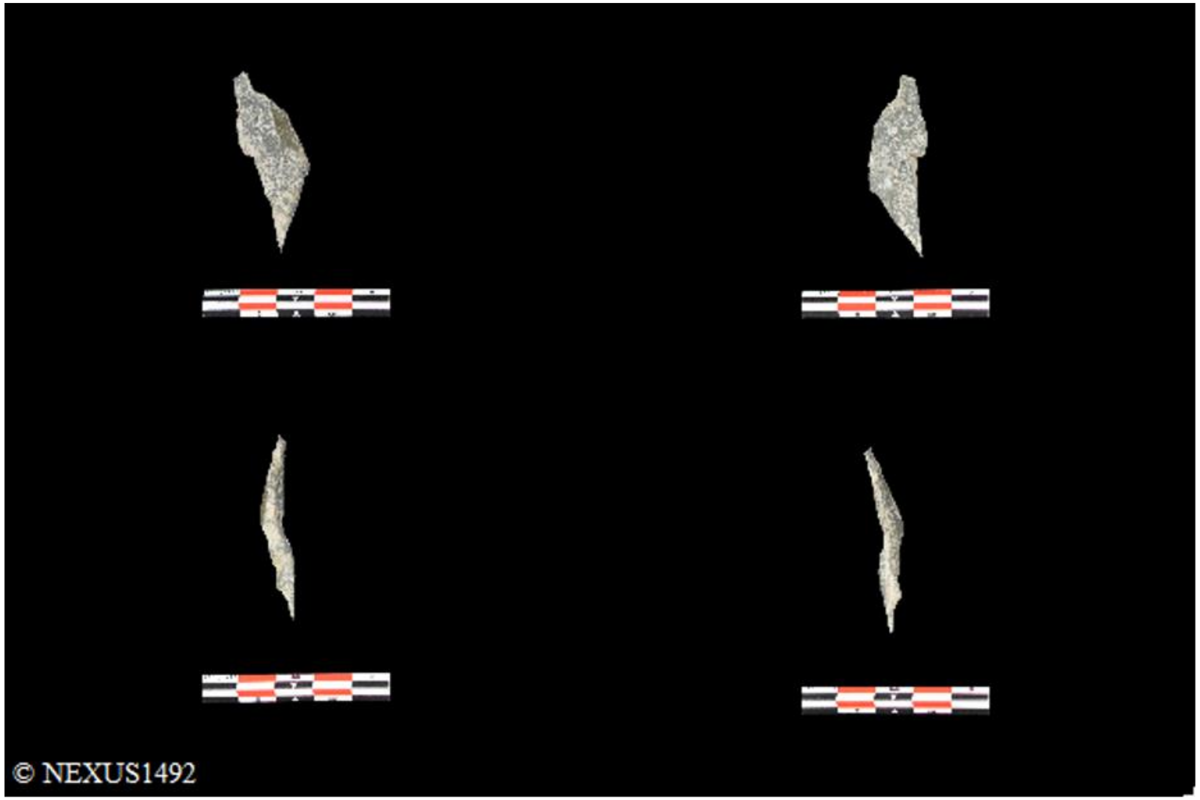

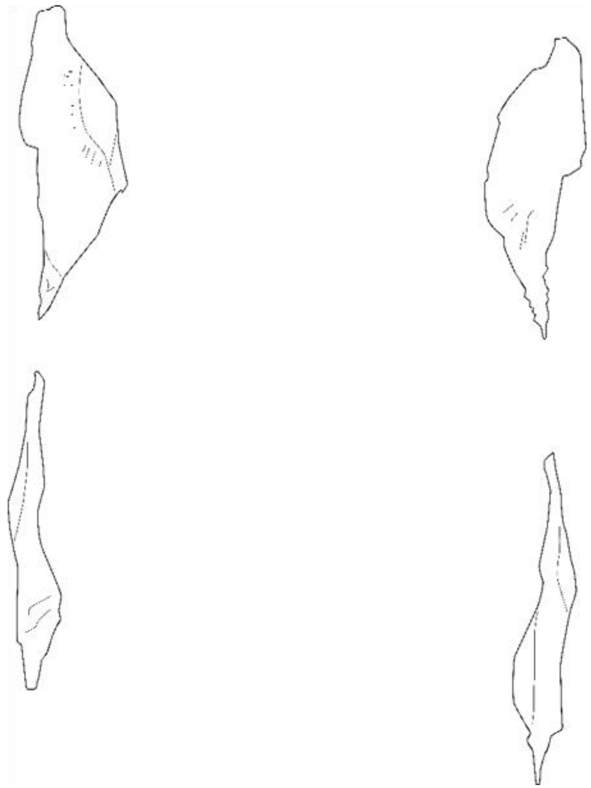

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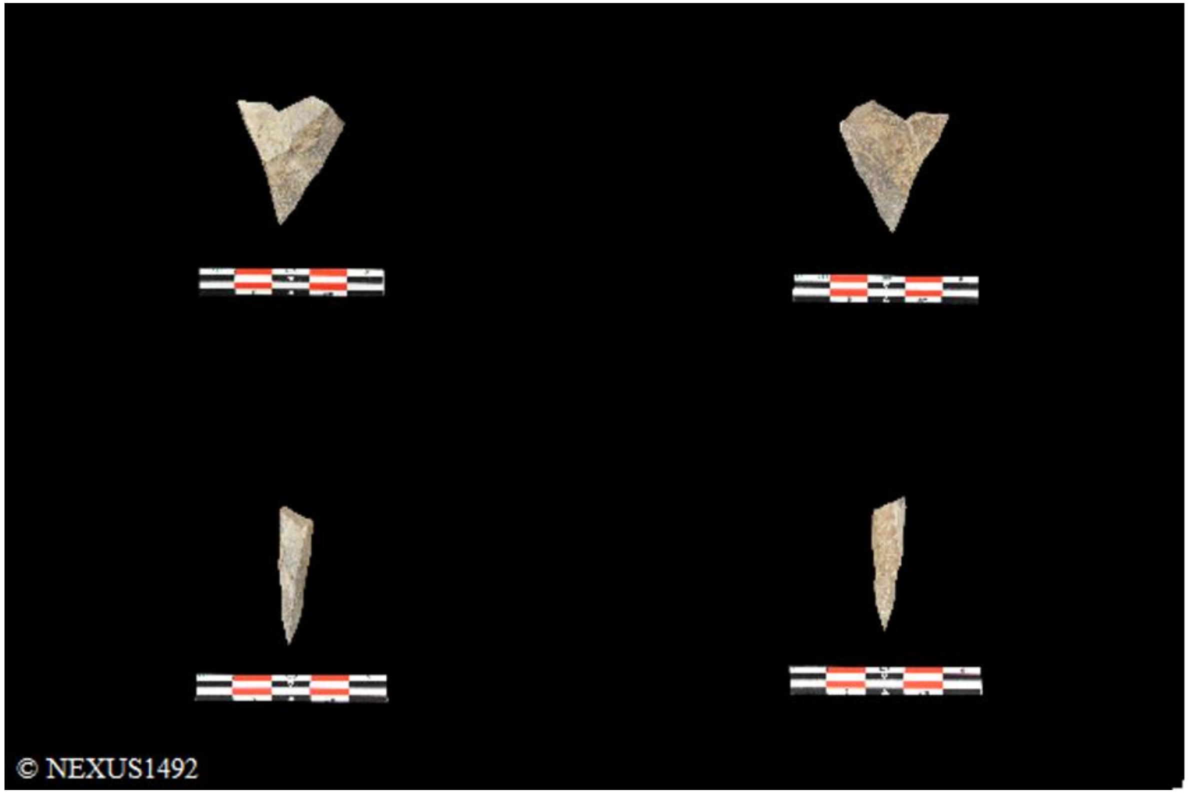

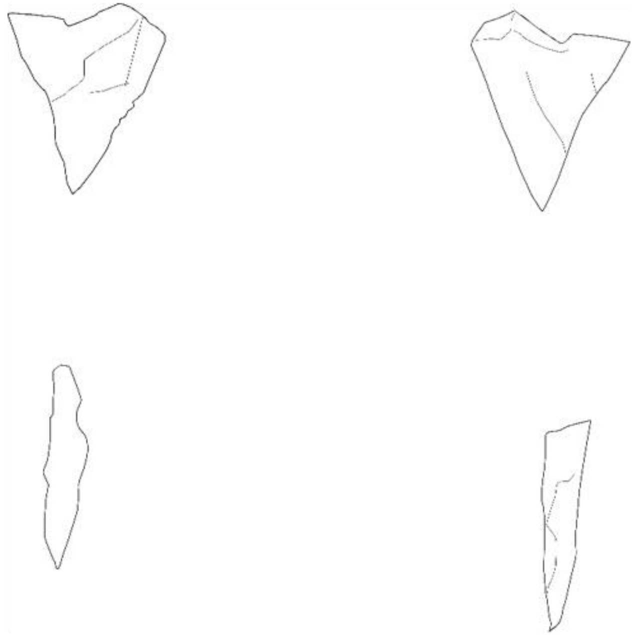

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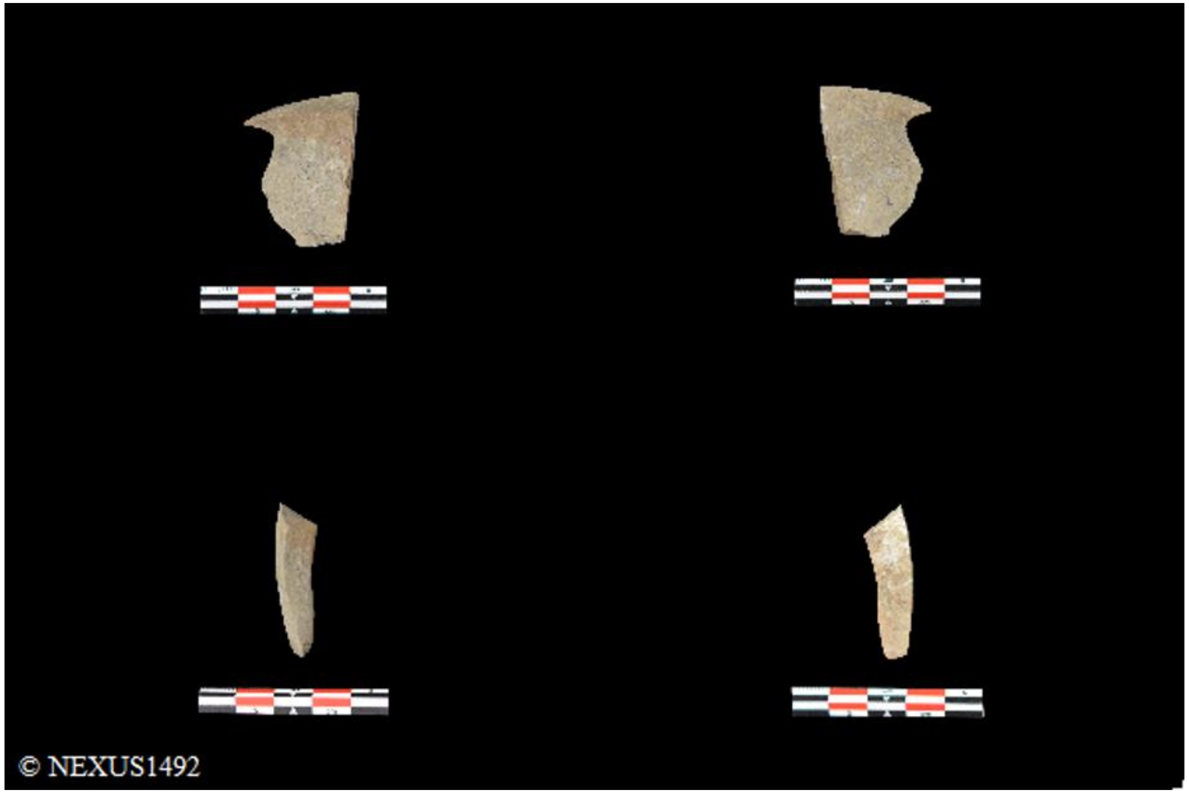

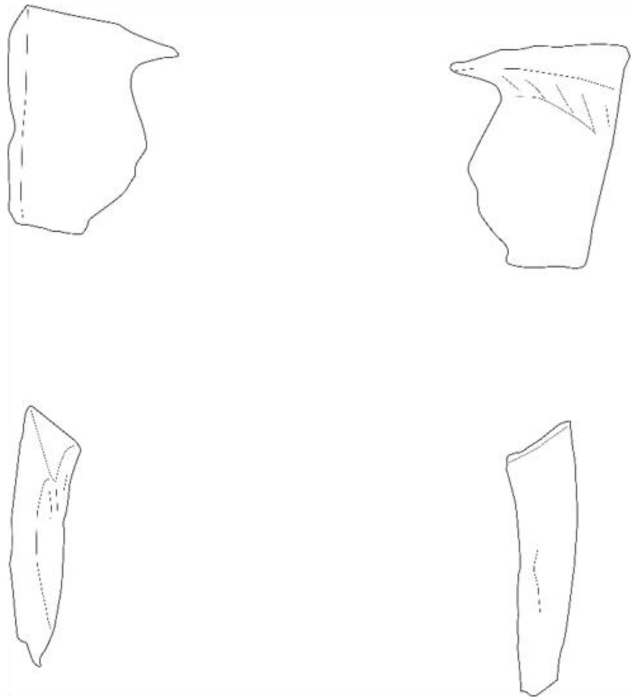

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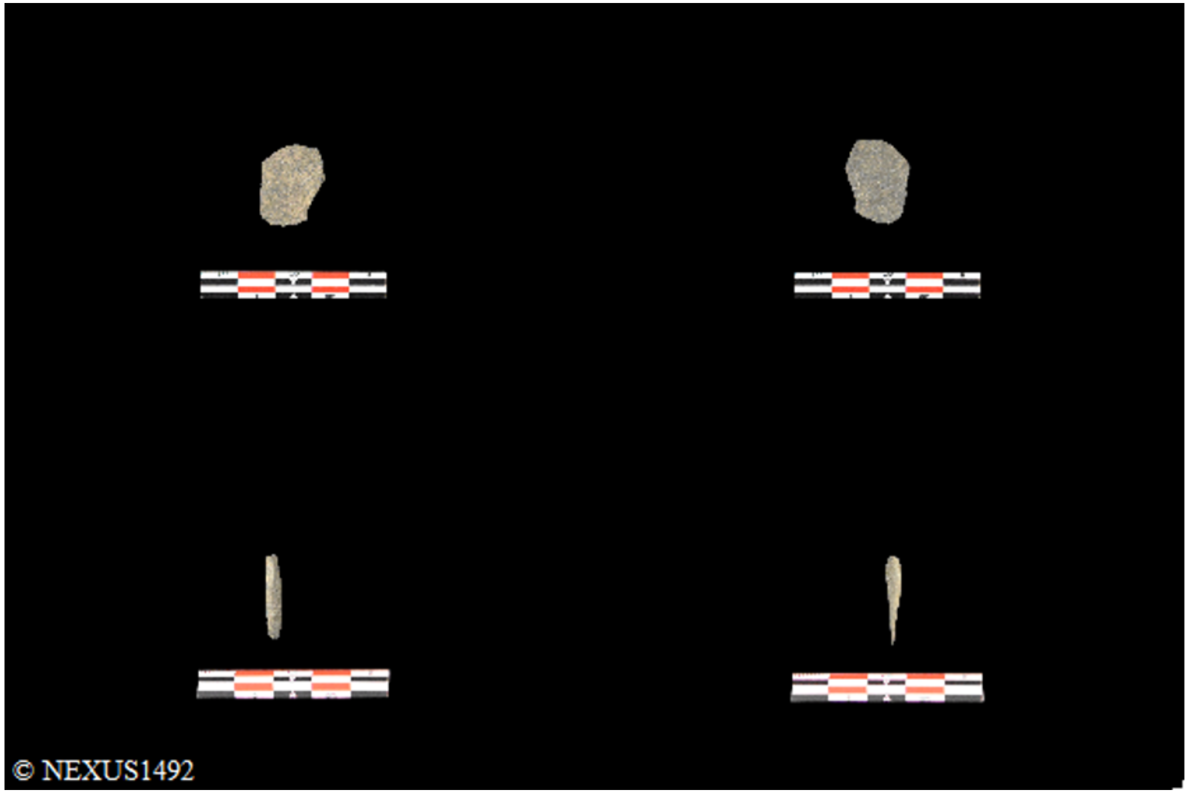

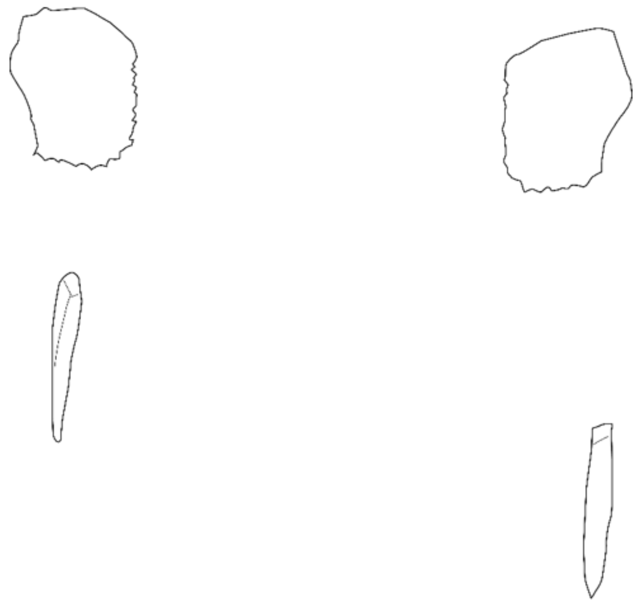

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