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**Laurence Astruc**

## **Once upon a time in micrometres... tools, activities and living spaces during the Pre-pottery Neolithic in Cyprus**

### **Abstract**

In 1964, the English translation of Sergei Semenov's pioneering technique of analysis of the microscopic wear marks on ancient tools, first published in Russian in 1957, made the diffusion of his work extremely rapid. Since the 1980's, this technique is in the mainstream of research on prehistoric stone tools. In the past twenty-five years, studies have been carried out on lithic and bone tools from three sites in Cyprus, dated to the Pre-pottery Neolithic, from the end of the 10<sup>th</sup> millennium BC to the mid-6<sup>th</sup> millennium BC. These sites are *Ayios Tychonas-Klimonas*, *Parekklisha-Shillourokambos* and *Khirokitia-Vouni*. Use-wear studies showed that these implements were involved in a variety of subsistence and craft activities. The relations between the modes of production and the functions of the tools were also addressed. At Khirokitia, the excavation and recording methods provide an opportunity to study the spatial organization of technical activities and gain insights into Neolithic daily life.

### **Text**

Lithic tools responded to numerous needs in ancient societies, as they were employed for different activities related to subsistence and craft production. Following the English translation in 1964 of Sergei Semenov's 'Prehistoric Technology', use-wear analysis developed worldwide (Longo and Skakun 2005). Semenov's methodology is based on the observation of wear (scaling, striations, smoothing, and polish) with the naked eye and at various magnifications (up to 500X) and their interpretation in terms of cinematics and worked materials. These marks are interpreted by analogy with ethnographic examples of tool use and experiments taking into account the environmental and technological settings of the prehistoric tools studied. Physical methods (SEM, confocal microscopy, rugosimetry, tribology, etc., Anderson et al. 1998, 2006, Astruc et al. 2003, Ibáñez et al. 2016) are used to characterise tool wear. On macro- and microscopic wear, one should notably mention the studies of Keeley (1980), Anderson-Gerfaud (1981), Plisson (1985), Caspar (1988), Van Gijn (1990, 2010), González Urquijo and Ibáñez Estévez (1994), Gassin (1996), Astruc 2002, Beyries and Rots (2008). Researchers have illustrated and clarified the link between stone production and human behaviour, and the reconstruction of technological developments. Artefacts are considered to be the results of technological, economic and social choices within the frame of cultural traditions. In more recent years, several colloquia offered updates, providing a 'status quo of the discipline' (Longo

and Skakun 2008, Marreiros *et al.* 2012, 2014). Meanwhile, a special issue of the *Journal of Archaeological Science* (Evans *et al.* 2014) considers future directions in lithic microwear analysis, emphasizing the search for methodological refinements to increase the reliability of results.

The aim of this paper is to present an overview of the lithic use-wear studies conducted on several sites covering a long period, the Pre-pottery Neolithic of Cyprus (Briois and Astruc 2017 and 2019). These sites are of Klimonas (8900-8600 cal. BC, Astruc *et al.* forthcoming a), Shillourokambos (8600-6900 cal. BC, Astruc 2011, Philibert 2003, 2011, Astruc forthcoming a) and Khirokitia (7000-6000 cal. BC, Astruc 2002, Astruc forthcoming b). All three sites have provided evidence for *in situ* stone knapping, as well as for use of tools in various subsistence and craft activities.

The Amathus region is a vast territory located east of Limassol in southern Cyprus, between the foothills of the Troodos Mountains and the coastal lowlands. An intensive survey was carried out and revealed a high density of Neolithic sites (Briois *et al.* 2005). Two settlements, Shillourokambos and Klimonas, the former excavated between 1992 and 2004 and the latter under excavation since 2011, have shed light on the early stages of the Neolithic of Cyprus and its long-term developments. The very abundant lithic assemblages, collected and dated thanks to detailed chrono-stratigraphic studies, illustrate the evolution of lithic industries over more than two millennia.

Klimonas (Vigne *et al.* 2017) together with two other sites, Ayios Tychonas- *Throumbouvounos* in the Amathus region and Ayia Varvara-*Asprokremnoson* on the foothills of the central Troodos massif, define the earliest Pre-Pottery Neolithic phase, or Cypro-PPNA. The village is made of a dense network of oval houses and a communal building. So far, our sample shows no difference between the material of this building and the houses. Stone tools were used in various tasks: hunting; cereal harvesting; animal butchery; wood, plant, bone and hide scraping; wood, plant and rock cutting; and wood, stone and shell piercing (Figure 1). As regards lithic weapons, tanged pieces are of diverse forms and sizes. Since some of them bear impact fractures, they were interpreted as projectile points used for hunting. The faunal evidence has shown that the inhabitants of Klimonas hunted wild boars. They also cultivated emmer wheat harvested with stone tools. Sickle elements varied in shape and size. They were used unmodified or shaped by retouch (inverse, bifacial retouch or backs). The cutting edge tools were sometimes rejuvenated by microdenticulation. The majority of the blanks were fixed longitudinally onto a wooden haft. Butchering tools are poorly documented in our sample.

Heavy butchering tools (i.e. disarticulation and percussion) are absent. On the contrary, blanks used for meat cutting and filleting were identified. Small scale working of animal, vegetal and mineral materials are also well represented. Among them, the working of plant material is best attested, this material being used to manufacture objects. Wood, stone and shell boring are probably mostly related to the production of beads and pendants.

Three main, successive, phases of occupation were defined at Shillourokambos (Guilaine *et al.* 2011). The early phase is dated 8600-7600 cal. BC, the middle 7500-7200 cal. BC, and the late 7200-6900 cal. BC. The site is mainly characterised by hollowed structures such as a large enclosure, post-holes and wells. A well was used as a collective grave. Use-wear analysis was conducted for the early and the middle phases. A small sample of flints tools from the early phase highlights the fact they were employed in various tasks, which included cereal harvesting, hunting, plant and wood processing, butchery, hide and stone working (Philibert 2003, 2011). The importation of Anatolian obsidian is another characteristic feature of this phase. Obsidian came from the Kömürcü-Kaletepe source in Central Anatolia (Briois 2011). Analysis of use-wear traces is rarely applied to obsidian tools. At Shillourokambos, these marks showed that imported obsidian was used in longitudinal motions to cut soft materials, mainly meat and hide. It was also employed in plant processing. Transverse motions on the same materials were also identified. Two obsidian tools were used to harvest cereals. They were hafted longitudinally, just like their counterparts made from flint (Astruc 2011).

The toolkit of the middle phase consists of numerous retouched blades, end-scrapers, *pièces esquillées*, burins, backs, truncations and blades with gloss. Rare projectile points are present, including stemmed, rhombic and oval types. Arrowheads were not included in the use-wear sample, but other parts of the toolkit, both retouched and unretouched, were. The glossy pieces correspond to cereal harvesting. This activity was done with inserts hafted longitudinally and used on one, and, more rarely, two edges. Other kinds of silica-rich plants were processed using longitudinal or transverse motions. Scrapers were used to work either hide or vegetal materials, and burins to scrape and or incise plants, wood and bone. Unretouched blanks were also used for different types of activity, including vegetal and animal processing (Astruc forthcoming a).

The late phase of the Pre-pottery Neolithic in Cyprus is named Khirokitian after the site where it was identified. It is well documented by the extensive excavations conducted between 1976 and 2009 (Le Brun 1984, 1989, 1994, Le Brun *et al.* 2017, Le Brun 2017, Le Brun forthcoming).

The Neolithic village, located in the Larnaca district in the coastal lowlands, consists of circular houses built around small exterior spaces. Twelve architectural levels were identified in the main excavation area: levels G to A and levels III to I. The village was surrounded by successive walls. Lithic tools are an important component of the material culture found in all excavated spaces (Astruc 2002). These artefacts were used in various activities, mainly cereal harvesting, working wood and other plant materials, and, to a lesser extent, small butchery and skin, bone and stone working. Cereal harvesting was made using sickles composed of a wooden or antler haft and lithic elements fixed longitudinally (Figure 2). The plants were cut close to the soil, with a movement similar to the one traditionally used with metal sickles. Tools used to cut, saw or scrape wood and reeds were identified, and can be associated with the manufacture of objects such as hafts, tools, vessels, baskets and cloths. Arrowheads were not found at the site. Fallow deer was the only hunted animal and was relatively easy to tame and keep in enclosures. We have several tools used in small butchery. No large-scale butchery was identified. Several instruments used to scrape and cut bones were in all likelihood employed to manufacture tools, which represent the majority of the bone artefacts found at the site. Points, awls and needles were the most frequent bone tools. A small number of cutting-edge implements were found. They were used to work bark, wood, soft and rigid vegetal materials as well as skins and leather (Legrand 2003, 2005, 2007, Legrand-Pineau 2009, 2010, forthcoming). These tools were probably employed for basketry, and, for instance sewing and seaming clothes. We also identified tools related to an activity that is emblematic of this Neolithic period, the use of limestone, diabase and picrolite to make vessels, engraved pebbles, mace-heads, beads, pendants and figurines (Astruc *et al.* 2008, Astruc forthcoming b). A careful experimental program (Astruc 2001) was conducted to identify the wear developed on stone-working tools made from cherts at Khirokitia (Astruc 2001, Astruc 2002). Tribology (i.e. the science and engineering of interacting surfaces in relative motion, Anderson *et al.* 1998 and 2006) offers insights into the mechanisms of wear of the tools (Astruc *et al.* 2003). Using scratch tests and friction experiments in laboratory, 3D images and 3D statistical parameters, quantitative and qualitative analyses of the surface states of the cherts were carried out. The contact between the chert from the Lefkara formation, located near the Neolithic settlement, and diabase and picrolite, demonstrated two different processes of wear: adhesive wear for picrolite and abrasive wear for diabase. Moreover, the understanding of the mechanisms of wear validated the potential of standard use-wear analysis. The technical operations recognised are sawing, engraving, boring, picking and abrading of mineral materials.

At Khirokitia, the village and the excavation and recording methods permit spatial analyses of the artefact assemblages. The settlement consists in several dwellings (circular structures) erected around an external space. Circulation lanes are also apparent and a way out, set in one of the village surrounding walls, was identified. Fragmentary objects and incomplete technical sequences show that floors were frequently cleaned. Artefacts are more common in exterior spaces than in the dwellings, and the daily activities were mainly performed outdoors. Nevertheless, the interior spaces appear complementary to the external ones: their functions are similar. The same activities were identified in both interior and exterior spaces. Stone knapping and vegetal processing were the most common ones. We have fewer indications for other activities, but they do not seem to be associated with one dwelling or another, or with one external space or another. There is only one exception: the location of tools used in stone working. Tools employed to incise diabase and saw limestone and an unused picking tool were found on the floor of a house (S.122, level C). This dwelling had a long duration (level E through B) and was continuously related to stone-working, as evidenced by vessel rough-outs and tools. A cache in one of the small post-holes contained picrolite pebbles stocked for bead or pendant manufacture. Several tombs containing stone vessels were found under successive floors of the house.

The organisation of stone working, an important component of insular cultural identity, could be evidenced in 2002 by the identification of a stone vessel workshop inside the village. Stone vessels were produced in another building S.134, its small annexe S.156, and the adjoining open-air space (level B, Figure 3). The careful analysis of the macro-traces of a significant series of hammering tools, or *bouchardes*, made from chert, chalcedony, diabase and jasper (Figure 4), as well as the reconstruction of detailed *chaînes opératoires* (manufacturing sequences) of the stone objects, demonstrated that these tools were mostly used to produce vessels. The presence of a thin powder of diabase or similar igneous rocks, hammers and flakes detached during the shaping and the rejuvenation/repair of these tools, as well as fragments of vessels made from diabase and a roughed-out vessel of this material confirm this identification. Three hundred and sixty-three *bouchardes* were discovered in level B, while they do not exceed 10 specimens in the other levels. This specialized material was found in a house which is not different from the others, next to the ubiquitous lithic tools. Stone vessel production appears, therefore, to have been a specialized craft activity within daily domestic activity. It is difficult,

however, to estimate the volume of workshop production, which probably did not exceed the needs of the community or a limited group of people.

During the Pre-Pottery Neolithic, the production and use of lithic tools was a constant feature. These tools were both unretouched blanks and formal tools. The ways in which they were manufactured evolved over time. During the Cypro-PPNA and the Cypro-PPNB, tools were produced applying rules, know-how and skills seen on the mainland, namely in the Near-East. Small unipolar *débitage* was identified (Klimonas); it was replaced by bidirectional (bipolar) *débitage* (Shillourokambos). With the Khirokitian, the lithic artefacts were manufactured following simplified modes, and links with the mainland technology are no longer visible. Incidentally, the importation of obsidian is far less frequent than in Cypro-PPNB. During the Pre-Pottery Neolithic of the island, the use of local lithic raw materials evolved. When one pays attention to the flint supply, one notices a shift in the varieties mined in the Lefkara formation, from the translucent type to the opaque, and later to the granular type. Regarding stone vessels, the raw material was, during the Cypro-PPNA and PPNB, mainly limestone, and in the course of the sequence of Khirokitia it became diabase.

Hunting practices and game hunted changed over time. During the Cypro-PPNA and -PPNB, arrowheads were manufactured in the villages and repaired when hunter(s) came back from expeditions. Likewise, during the entire Pre-Pottery Neolithic, sickles were produced, repaired and stored in the settlements. The way in which the sickles were manufactured did not change significantly over time. Longitudinal hafting predominates; oblique hafting took place with very particular sickle elements only during a brief period (the early phase B/C of Shillourokambos). The evolution of sickles during the Pre-Pottery Neolithic is specific to Cyprus and does not echo the mainland (Maeda et al. 2016, Astruc and Briois 2019). Apart from hunting and harvesting, lithic tools are related to meat consumption and various handicrafts.

These were sites where knapping, subsistence and craft activities took place. When it is possible to reconstruct the function of living spaces, as is the case at Khirokitia, the tools served multiple functions. Daily activities were similar inside and outside the buildings, simply more frequent outdoors. All activities identified belonged to the domestic sphere, even more specialised ones such as stone working. Our approach, which consisted in looking at artefacts from a microscopic perspective, opens new insights on modes of manufacture and use of ancient tools made from lithic or bone, and sheds light on the organization of subsistence and craft



production. The study of the spatial distribution of the artefacts permits identification of the organisation of activities at the domestic level and is evidence for the existence of craft specialisation.

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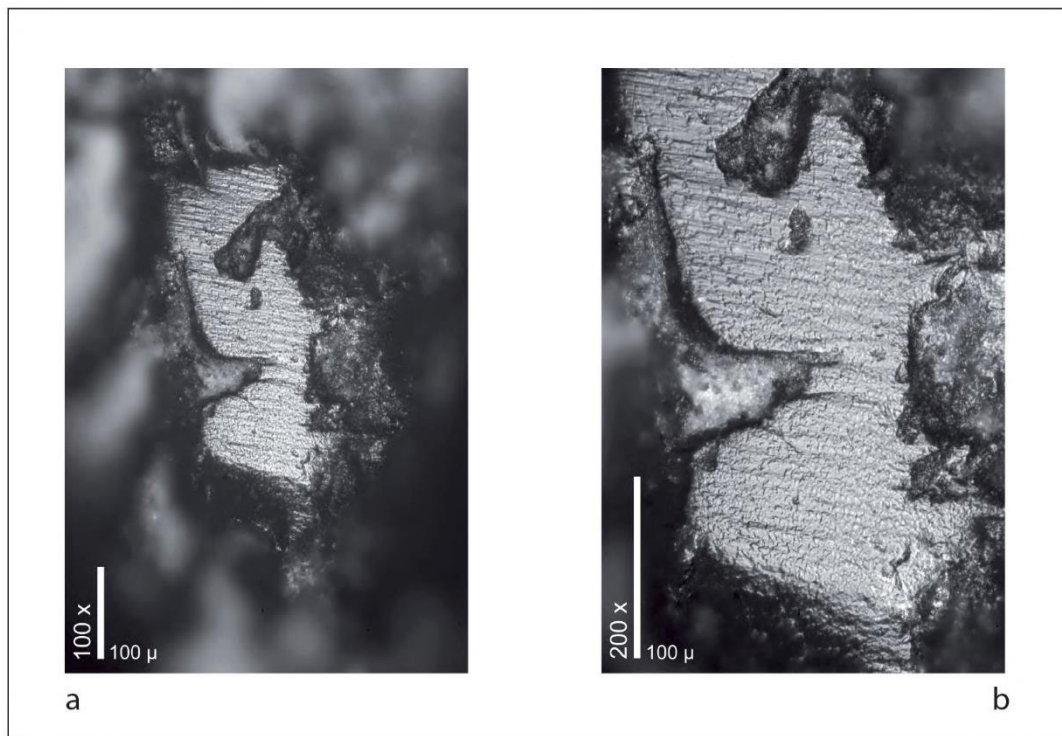
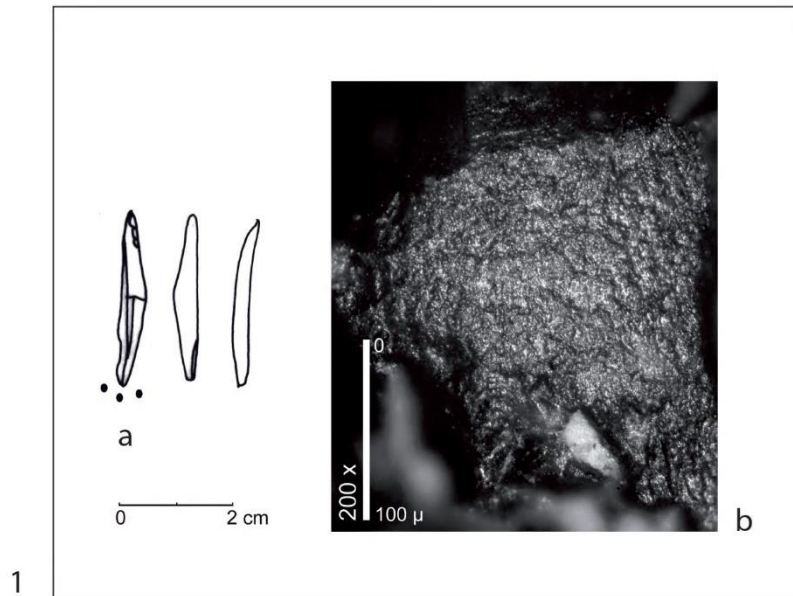
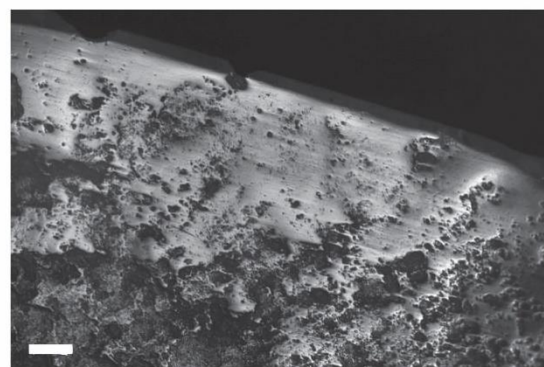
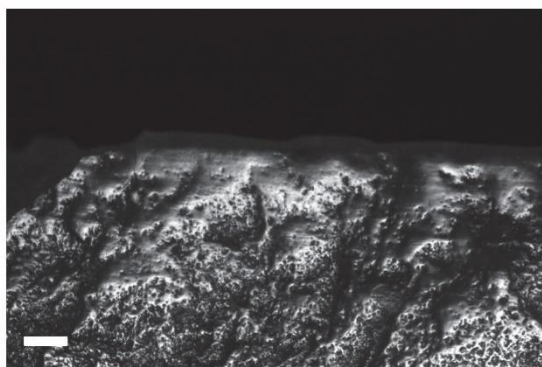
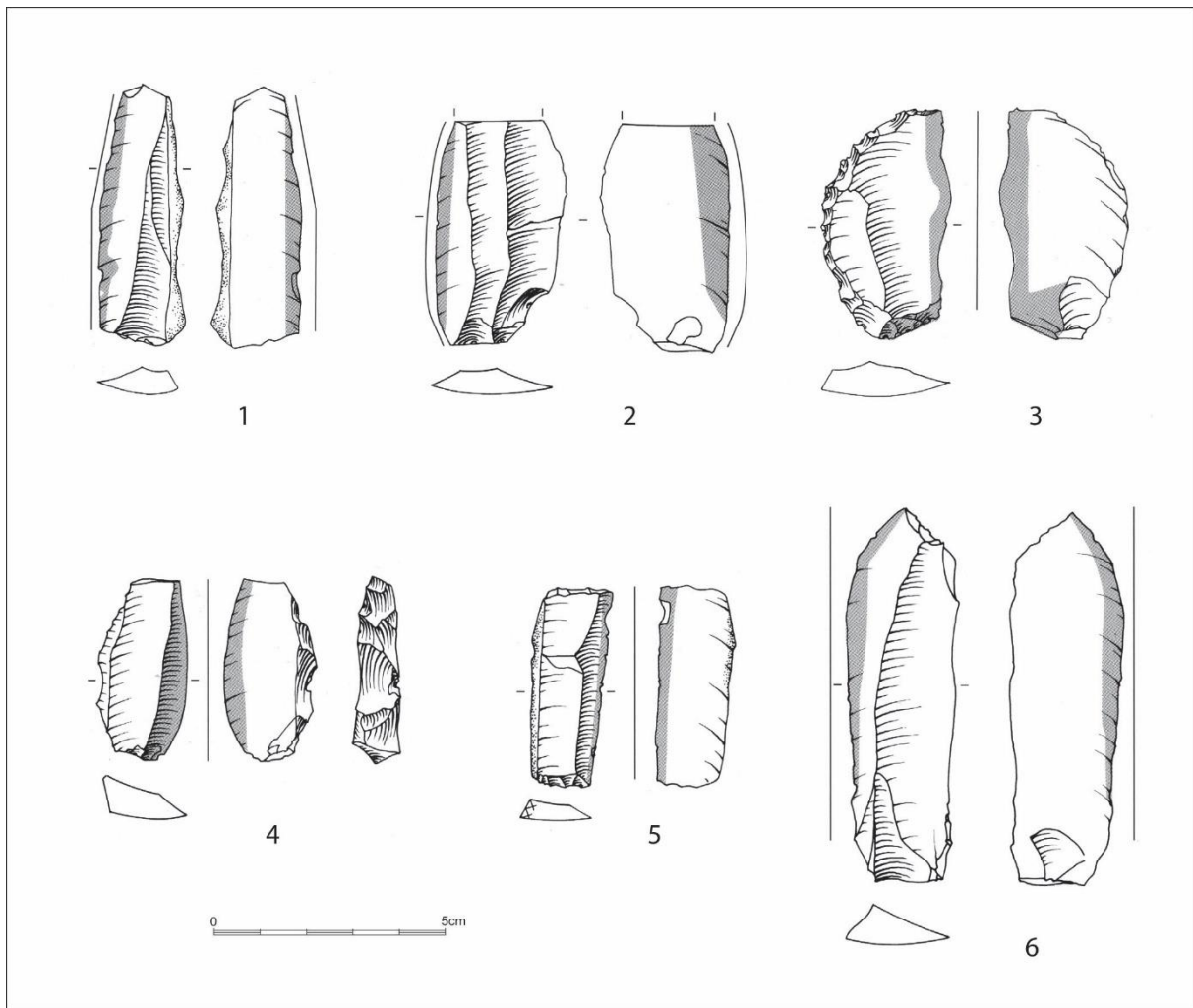


Figure 1. Klimonas. Borers. 1. Piercing of stone; a. Borer on a burin spall; b. microscope photograph showing use-wear (200x magnification): heavy abrasion of the edge of the tool and matte surface. 2. Piercing of shell; microscope photographs showing use-wear (a. 100x magnification, b. 200x magnification): heavy abrasion of the edge of the tool, flat surface with a highly developed semi-bright polish and dense striation with disrupted continuity.



a

b

Figure 2. Khirokitia (level C and III). 1-6. Sickle elements with longitudinal gloss, hafted (in parallel) on a haft; 1. Blade with a lateral cortex, 2. Blade fragment, 3-4. Backed pierces, 5. Blade with lateral cortex and truncation, 6. Truncation. a-b. Variability of use-wear due to cereal harvesting (100x magnification): the gloss is visible to the naked-eye and can be described microscopically as characterized by a well-developed and invasive polish, flat, shiny with a very thin longitudinal striation and a rounded and polished edge.

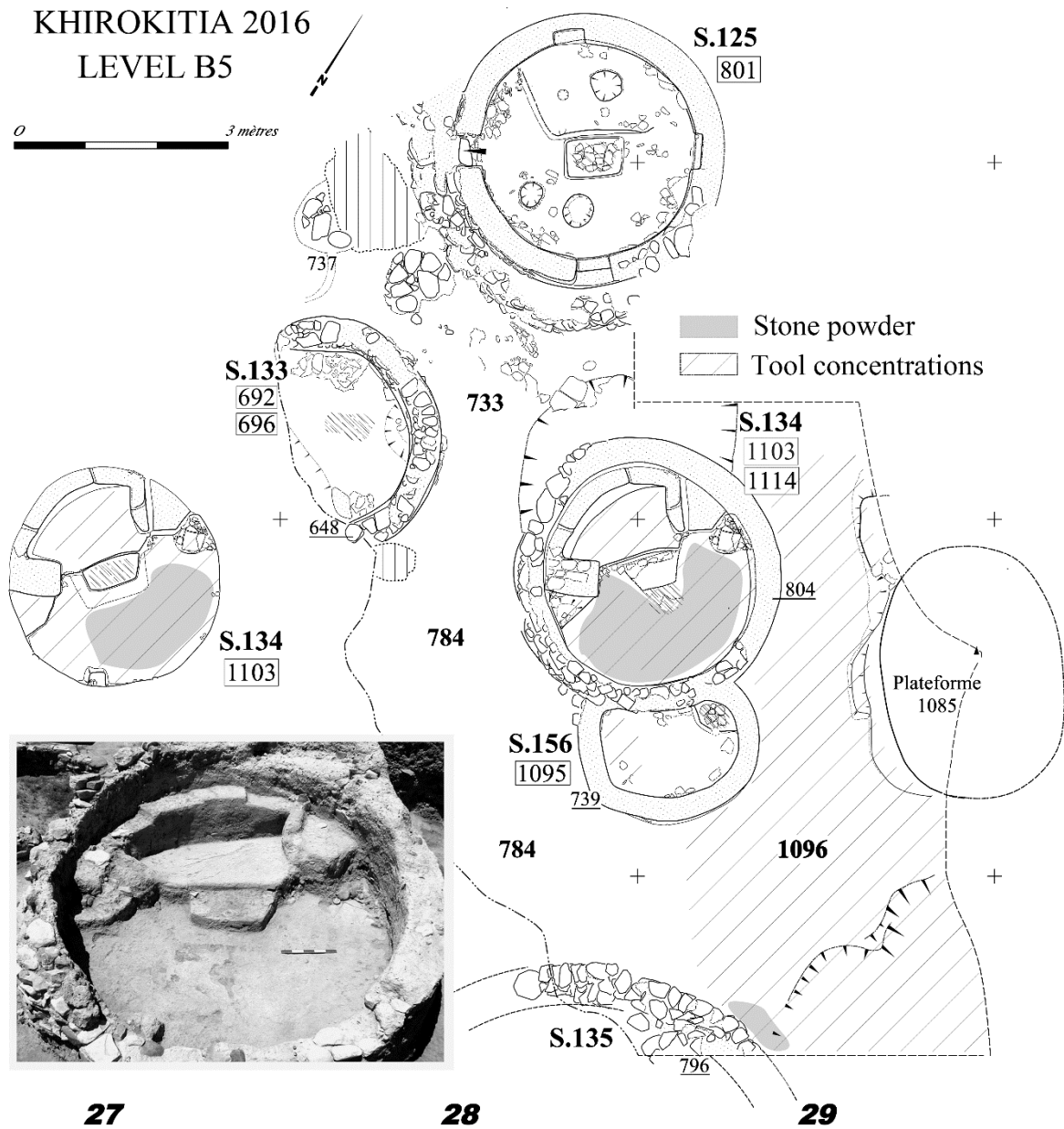


Figure 3. Khirokitia (level B5). Stone-working workshop in a domestic context (first stage). Stone powder, tools, waste from activities found inside the buildings S.134 and S.156 and on the floors of adjacent unbuilt spaces.



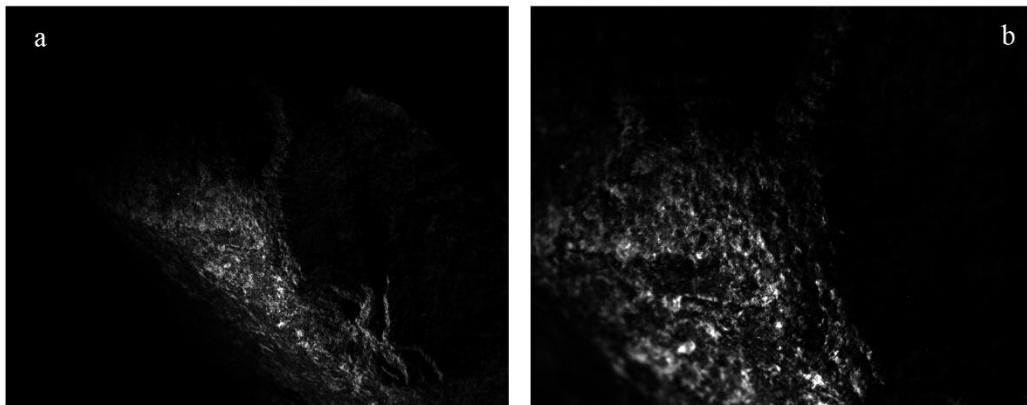
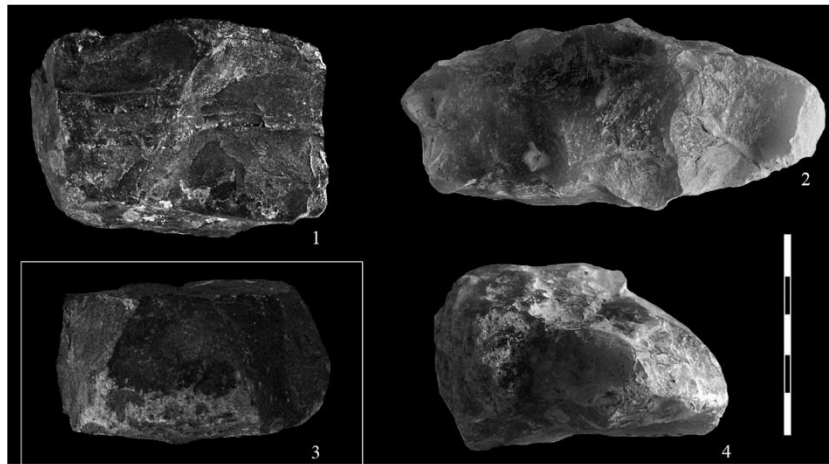


Figure 4. Khirokitia (Level B). 1-4. Heavy tools found in the workshop, used to shape stone objects, most probably vessels (1. Jasper, 2 and 4. Chalcedony, 3. Diabase). a, b. Macroscopic photographs of active areas on a picking tool made of diabase.