

TECHNICAL BEHAVIORS IN THE EARLY NORTH AFRICAN ACHEULEAN AT THOMAS QUARRY I - L1 (CASABLANCA, MOROCCO)

BY

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ABSTRACT

[EN] Thomas Quarry I – Unit L (Casablanca, Morocco), dated to ~1. million years, is a key site for understanding cultural processes that led to the first settlement of Morocco and to the Acheulean emergence in North Africa. Here, we present the technical behaviours identified in the sub-unit L1 of Thomas Quarry I (ThI-L1), which yielded one of the largest assemblages for the early North African Acheulean. ThI-L1 artefact assemblage was produced on quartzites and silicites. Two distinctive quartzite productions co-occur, one devoted to the manufacture of Large Cutting Tools (LCTs), the other focused on the extraction of small-medium sized flakes. The main technical objective of the LCT production was the manufacture of large pointed tools (handaxes and picks) and more rarely, large tools with a transversal cutting edge (beveled handaxes and cleavers). Small-medium sized flakes of quartzite were produced by a diversity of flaking methods adapted to the cobble blank morphologies and were not retouched. In addition, two different silicite productions are present, one to extract small flakes, the other to detach bladelet-like flakes. The results allow to assess that the earliest technical expressions of the Acheulean in North Africa are characterised by a high diversification of the stone working outcomes, the complexity of the mental templates and the flexible structure of the operational schemes.

KEYWORDS: Early North African Acheulean, LCTs production, Morocco, North Africa, small flaking, techno-economic systems.

[FR] COMPORTEMENTS TECHNIQUES DANS L'ACHEULEEN ANCIEN NORD-AFRICAIN DE LA CARRIERE THOMAS I - L1 (CASABLANCA, MAROC)

La Carrière Thomas I - Unité L (Casablanca, Maroc), datée d'environ 1, million d'années, est un site clé pour comprendre les processus culturels qui ont conduit au premier peuplement du Maroc et à l'émergence de l'Acheuléen en Afrique du Nord. Nous présentons ici les comportements techniques identifiés dans la sous-unité L1 de la Carrière Thomas I (ThI-L1), qui a livré l'un des plus grands

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assemblages du premier Acheuléen nord-africain. L'assemblage d'artefacts de ThI-L1 a été produit sur des quartzites et des silicites. Deux productions distinctes sur le quartzite coexistent, l'une consacrée à la fabrication de *Large Cutting Tools* (LCTs), l'autre axée sur l'extraction d'éclats de taille petite à moyenne. L'objectif technique principal de la production des LCTs était la fabrication de grands outils pointus (*handaxes* et pics) et plus rarement, de grands outils à tranchant transversal (*handaxes* à tranchant transversal et hachereaux). Les éclats de quartzite de taille petite à moyenne ont été produits par diverses méthodes de débitage adaptées aux morphologies des galets et n'ont pas été retouchés. En outre, deux productions différentes sur les silicites sont présentes, l'une pour extraire de petits éclats et l'autre pour détacher des pseudo-lamelles. Les résultats permettent d'établir que les expressions techniques acheuléennes les plus anciennes en Afrique du Nord se caractérisent par une grande diversité dans le travail de la pierre, la complexité des schémas conceptuels et la flexibilité des schémas opérationnels.

MOTS CLES: Afrique du Nord, Maroc, Premier Acheuléen nord-africain, petit débitage, production des LCTs, systèmes techno-économiques.

[AR] السلوكيات التقنية خلال الأشولي القديم لشمال إفريقيا بمقلع طوما ١ - ل ١ (الدار البيضاء، المغرب)

يعتبر مقلع طوما ١ - المستوى ل (الدار البيضاء، المغرب) المؤرخ بمليون و ٣٠٠ ألف سنة موقعا رئيسيا ومرجعيا لفهم المدارك والعمليات الثقافية التي تتعلق بأول استقرار بشري في المغرب وبزوغ الثقافة الأشولية في شمال إفريقيا. نقدم في هذا المقال السلوكيات التقنية المحددة في الوحدة الأركيولوجية الفرعية ل ١ بمقلع طوما ١، والتي مكنت من اكتشاف أحد أهم مجموعات الأدوات الحجرية المتعلقة بالأشولي الإفريقي المبكر/القديم. تم تعديل القطع الأثرية بطوما ١ - ل ١ فوق صخور الكوارتزيت (المرويت) والسيليسيت (أنواع الصوان). يتزامن إنتاجان مميزان على صخر الكوارتزيت، الأول مخصص لنحت أدوات القطع الكبيرة، والثاني يركز على استخراج شظايا صغيرة ومتوسطة الحجم. كان الهدف التقني الرئيسي لإنتاج أدوات القطع الكبيرة هو صنع أدوات كبيرة ذات رؤوس حادة (فؤوس يدوية ذات وجهين وفؤوس ذات قمم حادة) وبشكل نادر أدوات كبيرة ذات حواف قاطعة مستعرضة (فؤوس يدوية ذات حواف وسواطير). تم إنتاج الشظايا صغيرة ومتوسطة الحجم فوق الكوارتزيت عبر طرق متنوعة لاستخلاص الشظايا دون تشذيبها وكان يتم تكييف هذه الطرق مع أشكال ومورفولوجية الحصى المستعمل. بالإضافة إلى ذلك، يوجد إنتاجان مختلفان فوق الصخور السيليسية، الأول لاستخلاص شظايا صغيرة والثاني لاستخلاص شظايا صغيرة جد ممدودة ذات ميول نحو الشفيرات عن طريق "تقنية القرع ثنائية القطب على السندان". يمثل هذا الأخير أقدم نموذج لهذه التكنولوجيا (إنتاج شظايا شبيهة بالشفيرات) مؤرخ بشكل مؤكد في إفريقيا. تؤكد النتائج المحصل عليها على أن التعبيرات التقنية لأولى المجموعات البشرية الأشولية بشمال إفريقيا تشهد على مهارات وقدرات معرفية متميزة بتنوعها وتعقيدها ومرونتها. الكلمات الدالة: شمال إفريقيا، المغرب، الأشولي القديم بشمال إفريقيا، الأنظمة التقنية الاقتصادية، إنتاج الشظايا الصغيرة، إنتاج أدوات القطع الكبيرة.

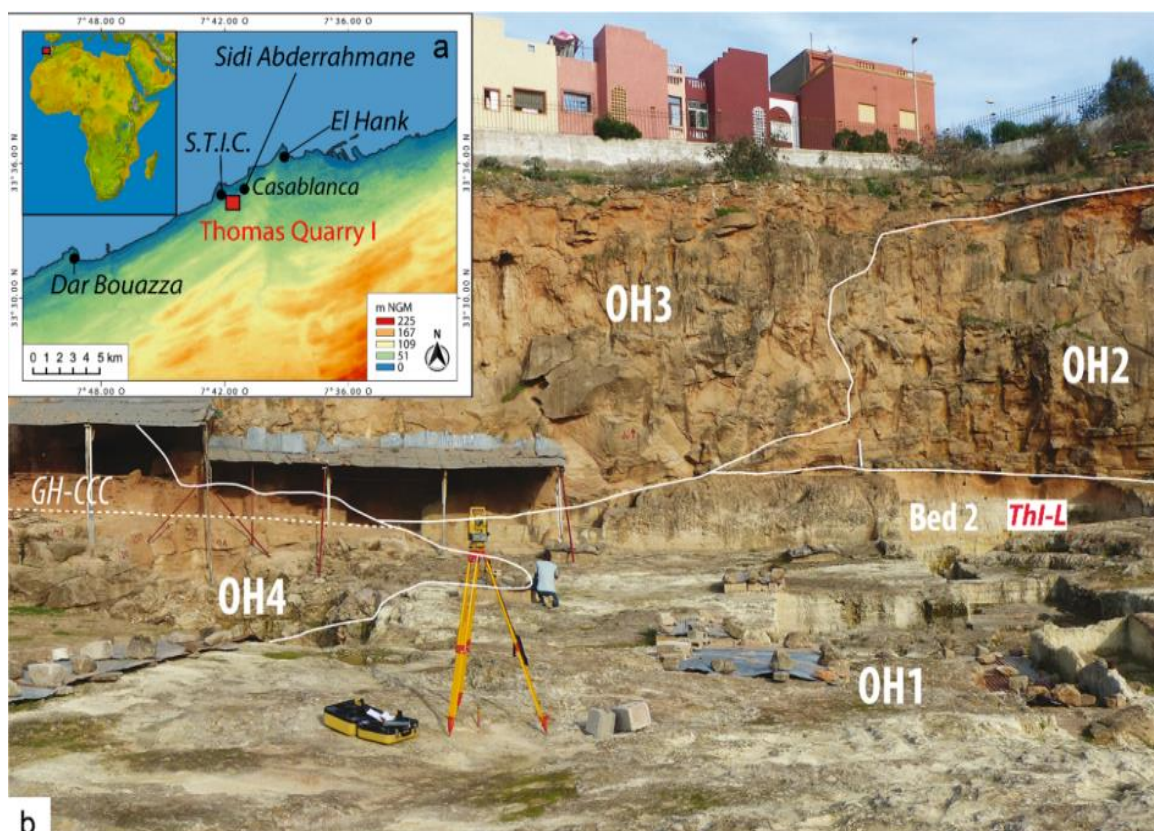
I. INTRODUCTION

Such as East and South Africa, North Africa is rich in Acheulean sites, well known since the end of the nineteenth century¹. Accordingly, the timing and mode of the Acheulean emergence and its subsequent developments are poorly understood in this part of Africa and many aspects remain open questions.

As regards the early Acheulean, Thomas Quarry I – Unit L (ThI-L1) [FIGURE 1/A] is the only North African site with a high-resolution chronostratigraphy, discovered thanks to the construction works started between the end of nineteenth century and the dawn of twentieth century².

¹ See: BLEICHER 1875; COLLIGNON 1887; PALLARY 1888; RIVIÈRE 1896; BOULE 1900; CHANTRE 1908; BREUIL 1930, but most of them lack a stratigraphic context (e.g. ALIMEN 1955; BALOUT 1955; VAUFREY 1955; BIBERSON 1961; CHAMPAULT 1966; CLARK 1992; MATTINGLY *et Al.* 2003; REYNOLDS 2006; BOUDAD & GUISLAIN 2012; PARENTI *et Al.* 2015; CANCELLIERI 2021.

² RAYNAL *et Al.* 2017; MOHIB *et Al.* 2019; RAYNAL 2021; GALLOTTI *et Al.* 2022.



[FIGURES 1/A-B]: A. Map location of the Thomas Quarry I on North Africa map: modified after NASA/JPL/NIMA, public domain, via Wikimedia Commons. Casablanca map: modified after NASA/SRTM, 1 arc second global elevation data, created using the free and open source software QGIS v3.18.2 (<http://www.qgis.org>); B. Members 1 to 4 of the Oulad Hamida Formation at ThI (photo and drawing LEFÈVRE, D.). GALLOTTI *et Al.* 2023.

Thomas Quarry I firstly investigated by Biberson and later on known for its human remains³, was re-examined in 1985 revealing the presence in stratigraphic context (Unit L) of a rich lithic assemblage of quartzites and silicites⁴, together with fauna⁵. Magnetostratigraphic and geochemical data, added to the existing lithostratigraphy of the Casablanca sequence, provided a robust chronostratigraphic framework for ThI-L establishing its age at ~1.3 Ma⁶. The large-sized mammalian assemblage comprises the genus *Hippopotamus*, bovids, an *Equus* sp. and an Elephantidae. The most significant components of the fauna from ThI-L are the presence of the suid *Kolpochoerus* and of some rodents, which are in agreement with the age of *ca.* 1 Ma⁷.

³ ENNOUCHI 1969; RAYNAL *et Al.* 2010- 2011.

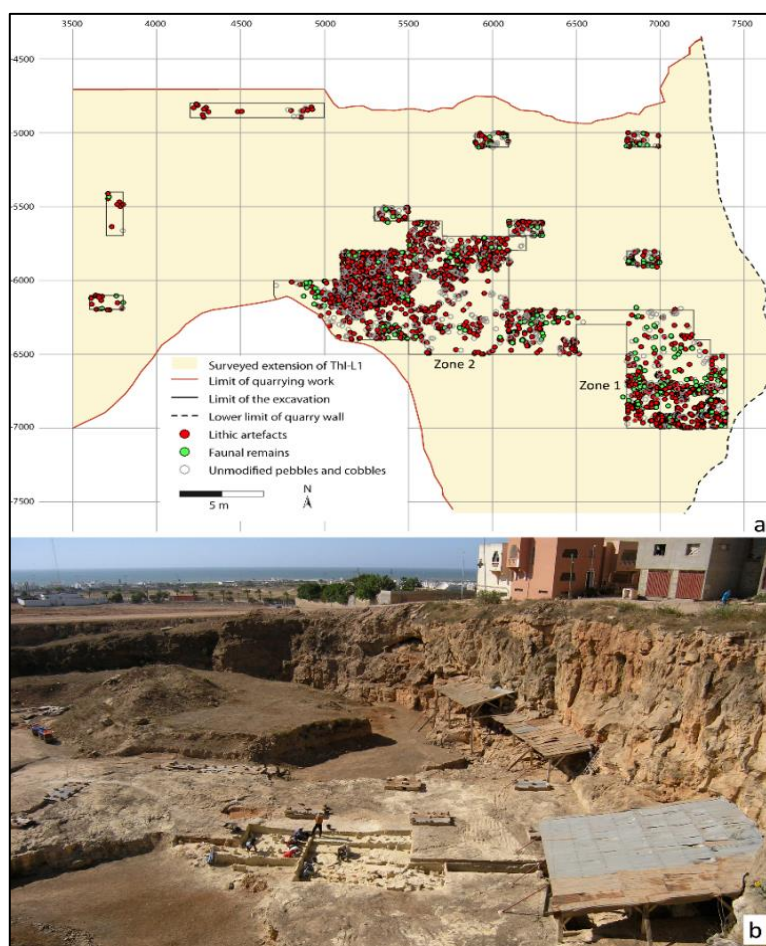
⁴ In scientific literature, the terms flint and chert are controversial depending on whether geologists, archaeologists, petrographers or sedimentologists use them. Following RAYNAL *et Al.* 2022, here we use the general term silicite for hyper-siliceous rocks including chert, flint, silcrete and hydrothermal silica.

⁵ RAYNAL & TEXIER 1989; RAYNAL *et Al.* 2023.

⁶ GALLOTTI *et Al.* 2021.

⁷ GERAADS *et Al.* 2022; RAYNAL *et Al.* 2023.

ThI-L site belongs to the Bed 2 deposit of Member 1 of the Oulad Hamida Formation [FIGURE 1/B]. The archaeology of ThI-L is limited to archaeological sub-units L1 at the base and L5 at the top. ThI-L1 has been systematically excavated in 1988-1996 and 2006-2008 in two main areas and several test trenches (Zone 1 of 68 m², Zone 2 of 75 m² and test trenches of 20 m²) [FIGURE 2/A] and surveyed on about 1000 m² [FIGURE 2/B]. ThI-L5 has been excavated only in Zone 1. Both sub-units yielded faunal remains, lithic artefacts and unmodified pebbles/cobbles⁸.



[FIGURES 2/A-B]: A. Horizontal plan with the distribution of all the mapped remains at ThI-L1. In GALLOTTI *et Al.* 2023; B. View of the ThI-L1 excavation in 2007 © RAYNAL

Here, we report the results of a detailed analysis of ThI-L1 assemblage (3845 lithic artefacts and 3677 unmodified objects) with specific research aims including the reconstruction of the *chaînes opératoires*⁹ and of the conceptual schemes and operational solutions adopted¹⁰. This study represents the first comprehensive techno-economic assessment of an early North African Acheulean lithic assemblage.

⁸ GALLOTTI *et Al.* 2023.

⁹ LEROI-GOURHAN 1964 & 1971; LEMONNIER 1976, 1986; PELEGRIN 1985; GENESTE 1989, 1991; PERLÈS 1991; INIZAN *et Al.* 1999.

¹⁰ GALLOTTI *et Al.* 2020- 2023.

II. RAW MATERIALS

The lithic assemblage of ThI-L1 is mainly composed of Palaeozoic tenacious rocks, i.e. quartzites abundantly available in local primary and secondary sources. The remaining objects are of silicites¹¹.

The term «quartzites» includes several varieties of Cambrian-Ordovician basement rocks that form the bulk of the Casablanca anticlinorium and are essentially Acadian and Arenig in age¹². The quartzites are low-porous, dense rocks with variable mechanical properties depending upon bedding, cracking, porosity, and alteration. They form the basement for the Mio-Plio-Pleistocene formations of the Casablanca sequence. They were exposed on the foreshores [FIGURE 3/A] or were locally preserved in points. Notched by the wadis and Quaternary paleo-rivers, they largely supplied the alluvial deposits of the wadis and the various ancient beaches with pebbles/cobbles of various shapes and sizes. Even today, the raw material is still available in the form of whole or naturally fractured cobbles [FIGURE 3/B]. The light grey facies, very well crystallised, with conchoidal fracture and mechanical properties very close to those of silicites and largely outcropping between El Hank and Sidi Abderrahmane [FIGURE 1/A] and [FIGURE 4/A] is the quartzite type mainly used by ThI-L1 knappers¹³.



[FIGURES 3/A-B]: A. Current quartzite outcrop and cobble beach at El Hank © LEFÈVRE, D.; B. Cobble beach at Dar Bouazza © MOHIB

¹¹ GALLOTTI *et Al.* 2020 & 2023.

¹² CAILLEUX 1994.

¹³ GALLOTTI *et Al.* 2023.



[FIGURES 4/A-B]: A. Current quartzite outcrop of El Hank type © GALLOTTI; B. silicite pebbles from ThI-L1 © GALLOTTI

Silicites derived from the phosphatic plateau in the hinterland of the Meseta and are available in secondary deposits near the site¹⁴. Four types of silicites have been identified at ThI-L1, revealing a long stage in marine environment, which has been heavily erased by posterior alteration [FIGURE 4/B]. This means 1) that pebbles derive from marine deposits very close to their final deposition place (ThI-L1 deposit) and that a successive transportation in continental waters did not leave any stigmata; 2) or that post-depositional alteration in the site erased the stigmata of this post-marine transportation; 3) or that humans collected them directly in marine beaches (not yet localized) or in slightly derived deposits (still to be identified)¹⁵.

III. QUARTZITE PRODUCTIONS

The quartzite assemblage is composed of 3373 artefacts and 3115 cobbles and pebbles [TABLE 1]. Two main quartzite productions coexisted at ThI-L1: one devoted to the production of Large Cutting Tools (LCTs), the other focused on the flaking of small to medium-sized flakes. Cobbles and rare pebbles bearing percussion marks were used as active hammerstones for knapping. Small-medium sized flakes were the intended end products of the quartzite small flaking. They were exceptionally retouched. Before flaking, or between knapping sequences, some cores were used as knapping hammerstones.

¹⁴ RAYNAL *et Al.* 2022.

¹⁵ GALLOTTI *et Al.* 2020.

Categories	Total	%
Cores	442	13.1
Core fragments	55	1.6
Whole flakes	875	25.9
Broken flakes	881	25.2
Retouched flakes	3	0.1
Large flakes	17	0.5
LCTs	219	6.5
LCT tips	15	0.4
Hammerstones	30	0.9
Debris	836	24.8
Total artefacts	3373	100.0
Pebbles	2792	89.6
Broken pebbles	45	1.4
Cobbles	275	8.8
Broken cobbles	3	0.1
Total unmodified objects	3115	100.0

[TABLE 1]: ThI-L1. Categories of the quartzite assemblage.

A.Small Flaking

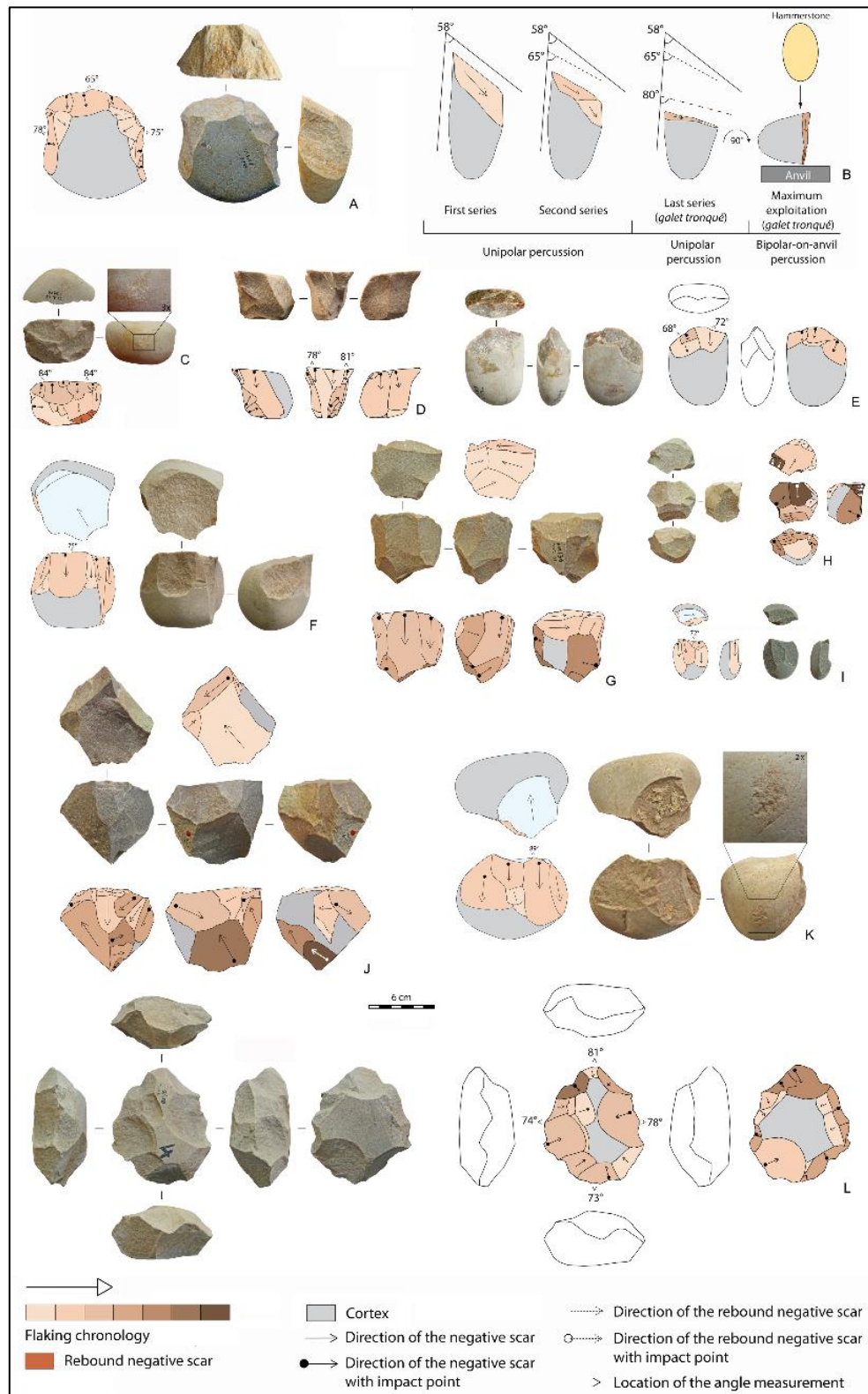
Several flaking modalities for small-medium sized flake production have been identified analysing 381 cores and 878 whole flakes. The remaining 61 cores are broken¹⁶.

- Simple exploitation (55 cores). One or two flake scars are extracted with a random distribution of distinct faces of the core;
- Unifacial unidirectional with a cortical striking platform on plano-convex cobbles (90 cores). The flaked surface of the core corresponds to the convex face of the cobble, whereas the flat natural surface is used as striking platform without rectification [FIGURE 5/A]. Negative scars of many cores show a progressive increase in the flaking angle value (from an acute angle to an abrupt angle) from the first to the last series [FIGURE 5/B], documenting a continuous reduction up to the so called *galet tronqué*. The technique adopted is the direct freehand percussion, but three overexploited *galets tronqués* show small removals with an opposite direction, typical of the bipolar axial percussion on anvil, especially of quartzite [FIGURE 5/C].
- Unifacial unidirectional with a rectified striking platform (17 cores). Flakes were extracted from a striking platform rectified by one-two removals, rarely three, to create a suitable flaking angle between 56° and 89° [FIGURE 5/F, I&K]. The blanks are bi-convex and plano-convex cobbles/pebbles.
- Bifacial partial alternating (96 cores). Unidirectional removals are present on two adjacent surfaces and each negative scar is used alternatively as a striking platform to flake the adjacent plane [FIGURE 5/E]. Knappers preferentially used biconvex cobbles/pebbles exploited on the transversal or longitudinal axis, thinner than those used for unifacial unidirectional exploitation. Neither can these cores be considered as

¹⁶ GALLOTTI *et Al.* 2023.

choppers because the edge between the two flaking surfaces shows highly variable angles and it has never been retouched after the completion of flaking activity.

- Peripheral unidirectional (8 cores). A peripheral flaking surface with unidirectional removals exploits the quasi-entire thickness of thick flat cobbles creating short and wide/thick cores. The striking platform is cortical and corresponds to one of the flat surfaces of the cobble blank [FIGURE 5/D].
- Multifacial multidirectional irregular (67 cores). Core surfaces were alternatively flaked through multidirectional removals without a clear organisation of the reduction process. No specific platform preparation was conducted insofar as each negative serves as a striking platform for the following removal on a secant face [FIGURE 5/J].
- Multifacial multidirectional orthogonal (18 cores). A multifacial exploitation is conducted respecting an orthogonal shape during flaking. In most cases blank morphology is not recognizable following the intense reduction by several removals, and because the same flaking surfaces were repeatedly flaked [FIGURE 5/G].
- Alternate flaking surface system (*Système par Surface de débitage Alternée*, SSDA, FORESTIER 1992-1993; 9 cores). Each flaking surface of the core with a unidirectional exploitation becomes a striking platform for an adjacent flaking surface always exploited with unidirectional removals. The flaking is accomplished through a continuous rotation of the core [FIGURE 5/H].
- Discoid (21 cores). Discoid cores are bifacial and exhibit two convex, usually asymmetric surfaces which are employed in alternating series of removals as a striking platform and flaking surface. Flakes are detached according to a plane that is secant to the plane of intersection of the two surfaces. The convexity of the two exploited surfaces is natural because knappers used biconvex cobbles as blanks. The peripheral convexity is acquired by a mostly centripetal flaking organisation [FIGURE 5/L].



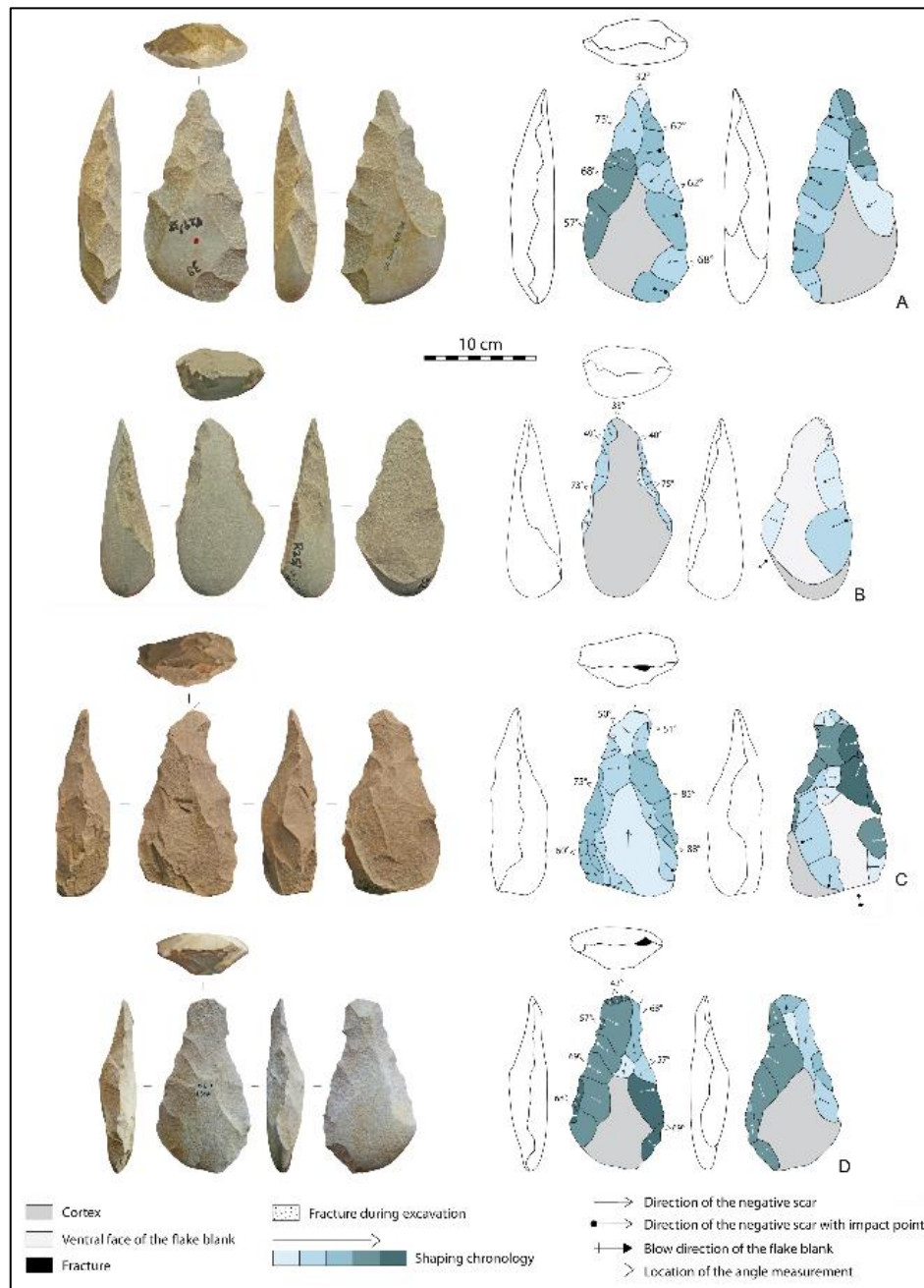
[FIGURES 5/A-J]: B. Unifacial unidirectional core with a cortical striking platform; B. operational scheme of the reduction sequence from a unifacial unidirectional core with a cortical striking platform to a *galet tronqué*; C. *galet tronqué*; D. peripheral unidirectional core; E. bifacial partial core; F, I & K unifacial unidirectional cores with a rectified striking platform. One of the cores K shows a pitted area on one extremity; G. multifacial multidirectional orthogonal core with one preferential unidirectional flaking surface; H. SSDA core; J. multifacial multidirectional irregular core; L. discoid core © Photos & drawings GALLOTTI, R., modified GALLOTTI *et Al.* 2023.

B. Large Cutting Tool Production

ThI-L1 yielded a rich LCT assemblage [TABLE I]. Twenty-two LCTs have a broken tip. The size of the missing part prevents to reconstruct the shaping process. In addition, eight specimens were retouched as massive scrapers and not shaped. The remaining 189 LCTs have been manufactured through several shaping processes repeated on several specimens that all tend towards similar morphologies¹⁷.

- Pointed handaxes ($n = 101$). Pointed handaxes represent the majority of the LCTs. Blanks are large cobbles, flakes and split cobbles. Among large cobble blanks, flat and slightly bi-convex forms dominate, followed by plano-convex and angular ones. Six of these cobbles have been used as knapping hammerstones before shaping as demonstrated by the pitted areas located at their extremity. Flake blanks are *entame* flakes and cortical flakes with an off-set axis. The first shaping phase consists of the localization of the tip through one or two longitudinal removals (one on each face), slightly oblique to the morphological axis of the cobble. The following shaping phases consist of four to six series of removals aiming to modify just the lateral edges making them convergent and to give the pointed shape to the tool. The majority of these handaxes lack all-round shaped edges and their proximal portion is usually unmodified [FIGURES 6/A-B].
- Skewed pointed handaxes ($n = 23$). This handaxe morphotype is characterized by a tip skewed with respect to the morphological axis of the tool. Blanks and shaping sequences are very similar to those of straight-pointed handaxes. Large or small notches create the skewed tip. Skewed pointed handaxes with all-round shaped edges are rare and their proximal portion remains mostly unmodified [FIGURE 6/C].
- Beveled handaxes ($n = 17$). This morphotype is characterized by a transversal cutting edge located on the apical portion (beveled tip) which is straight or slightly bi-convex. Only one of these handaxes is shaped on a large flake, while the others are on bi-convex, flat and plano-convex cobbles. The chronology and features of the shaping sequences are identical to those of the skewed pointed handaxes. The transversal cutting edge is obtained through a continuous series of marginal retouch or through a short notch during the final shaping phase. These latter operations may support the idea of a resharpening of the skewed tip after its breakage [FIGURE 6/D].

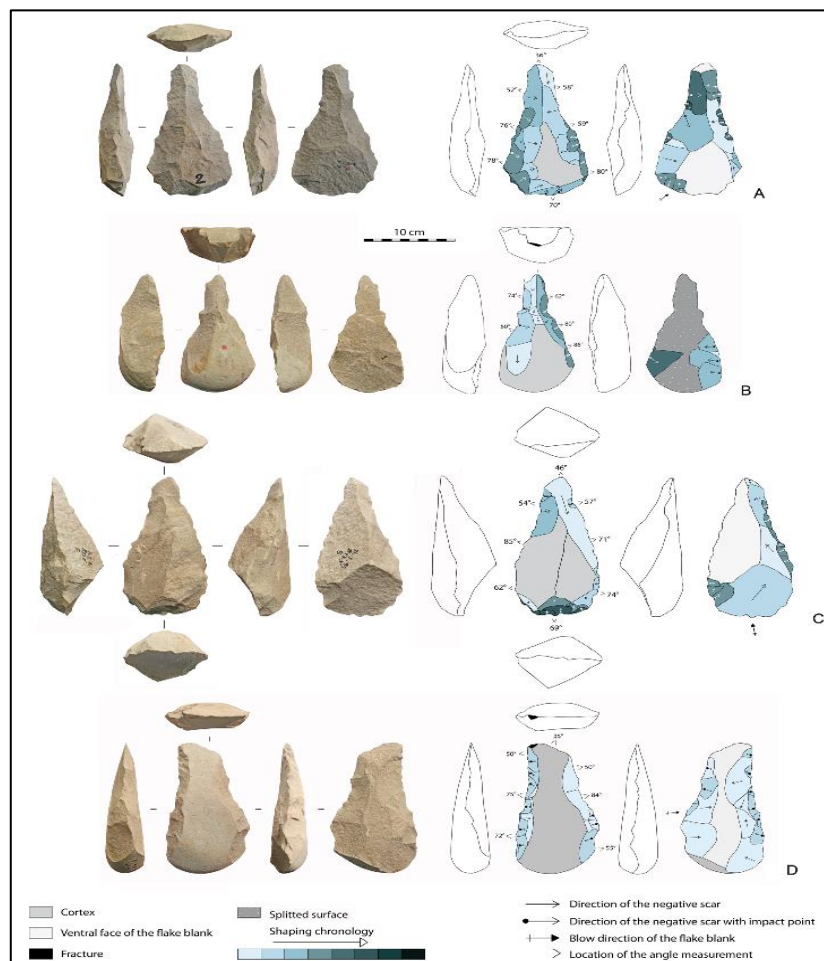
¹⁷ GALLOTTI *et Al.* 2023.



[FIGURES 6/A-D]: LCTs: A. Pointed handaxe on cobble; B. Pointed handaxe on *entame* flake; C. Pointed handaxe on flake with a skewed point; D. Beveled handaxe © Photos and drawings GALLOTTI, R., modified GALLOTTI *et Al.* 2023.

- Picks ($n = 19$). These LCTs have a tip quite distinct with respect to both the lateral edges and their overall morphology. Their blanks are cobbles, split cobbles, and flakes. Some picks show very short shaping sequences, i.e. few notches on one or both faces which taper the width of the distal half of the blank and create a pointed segment with a straight or skewed axis. The shaping sequences of the other picks are longer, distributed in five-six series of removals. The first phase always corresponds to longitudinal or slightly oblique removals on one or both faces to establish the tip location on the blank. The shaping of the lateral edges follows and for three cases that of the proximal portion [FIGURE 7/A].

- Picks with a trihedral tip ($n = 8$). They are characterized by a trihedral section at the tip area and are made on angular large cobbles and split cobbles with a triangular cross-section. Shaping follows the triangular profile of the blank without modifying the natural angles among the three surfaces [FIGURE 7/B].
- Trihedral and rhomboidal picks ($n = 10$). These LCTs are elongated and robust with a trihedral or a rhomboidal cross-section involving the (quasi)entire tool volume. These are the largest, most elongated and heaviest morphotypes among the LCTs. Blanks are large angular cobbles and large edge-core flakes. Trihedral picks are shaped from three different striking platforms, i.e. each of the three faces of the blanks is in turn both shaped surface and striking platform. The shaping sequences are very long, including seven/eight series of removals without final trimming and involve the (quasi)entire contour of the tools without modifying the original blank geometry. Rhomboidal picks are only two and are made from large flakes [FIGURE 7/C].
- Cleavers ($n = 11$). Following Tixier's (1956) classification, all the cleavers are of 'Type 0', i.e., cleavers with a cortical transverse bit created by the intersection of the ventral surface and the dorsal surface of the flake blank. Shaping sequences are very short: they involve the lateral edges, creating a slightly convergent tool shape, and also the butt portion for two specimens [FIGURE 7/D].



[FIGURES 7/A-D]: LCTs: A. Pick on flake; B. Pick on splitted cobble with a trihedral tip; C. Rhomboidal pick on flake; D. Cleaver © Photos and drawings GALLOTTI, modified GALLOTTI *et Al.* 2023.

IV.SILICITE PRODUCTIONS

The silicite assemblage is composed of 472 artefacts and 562 unmodified items [TABLE 2]. The flaked assemblage was exclusively produced from pebbles (30 to 60 mm) [FIGURE 4/B] mainly ovoid and subcircular in shape and bi-convex, plano-convex, and flat cross-sections.

Categories	N	%
Cobbles and pebbles with percussion marks	6	1.3
Cores	107	22.7
Core fragments	28	5.9
Flakes	175	37.1
Bladelet/like flakes	35	7.4
Broken flakes	46	9.7
Retouched flakes	3	0.6
Wastes	72	15.3
Total artefacts	472	100.0
Pebbles	534	95
Broken pebbles	28	5
Natural fragments	-	-
Total unmodified objects	562	100.0

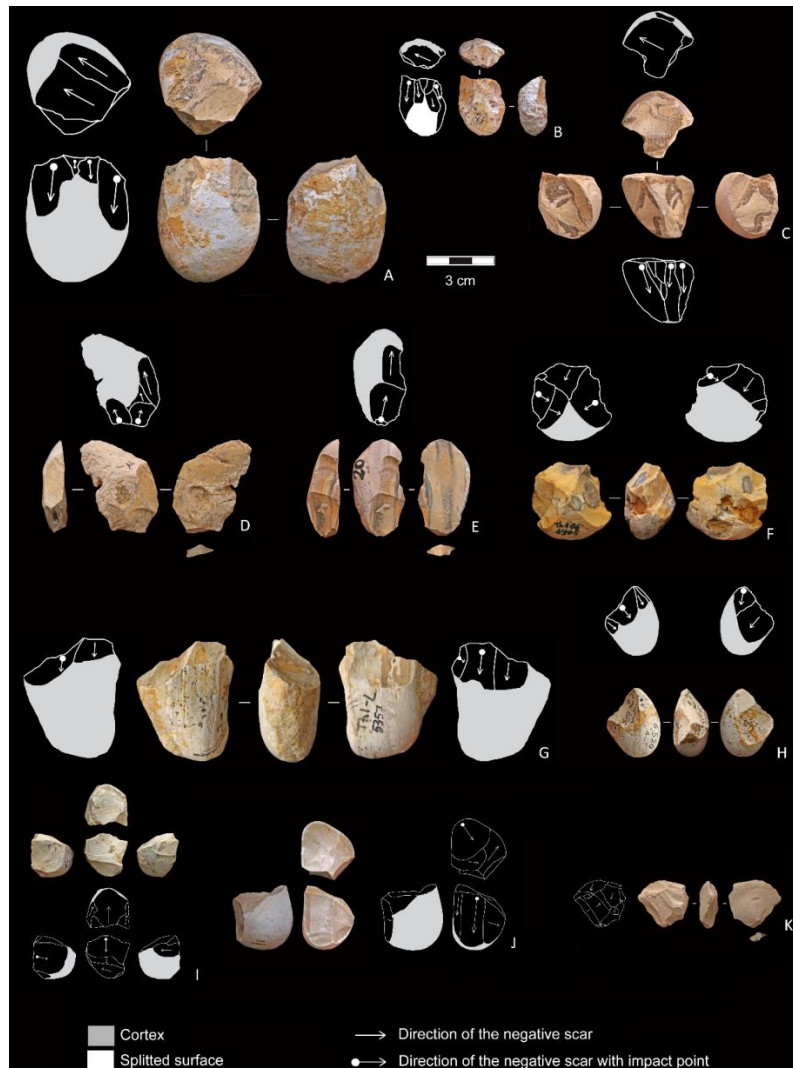
[TABLE 2]: Categories of the silicite assemblage of ThI-L1.

Silicite assemblage documents two productions, one devoted to the extraction of small flakes, the other focused on the extraction of bladelet-like flakes¹⁸. Cores for small flake production ($n = 68$) were exploited by simple ($n = 29$) and organized ($n = 39$) flaking performed using the free-hand percussion with hard hammerstones. Other seven cores have been exploited through the bipolar-on-anvil longitudinal exploitation. Among the cores flaked using a freehand percussion and organized exploitation, three flaking methods have been identified:

- Unifacial unidirectional ($n = 17$). Core blanks are mainly ovoid bi-convex and plano-convex pebbles, rarely subcircular bi-convex. The flaked surface usually corresponds to the longest natural face of the pebble, exploited to produce one to two series of three to seven elongated flakes from a striking platform rectified by one or two removals to create a suitable angle between 62° and 89° [FIGURES 8/A-E].
- Bifacial partial alternating ($n = 12$). Cores exhibit removals on two adjacent surfaces, and each negative scar is used alternatively as a striking platform to flake the adjacent plane. The blanks are bi-convex ovoid pebbles, systematically exploited on the transversal axis. Only one core shows a semi-peripheral exploitation. Angles between the two flaking surfaces vary from 45° to 70° [FIGURES 8/F-H].
- Multifacial multidirectional orthogonal ($n = 10$). These cores are overexploited (five to seven flakes on three to four surfaces) and smaller than the previous ones. Core surfaces were alternatively flaked through multidirectional removals respecting the orthogonal angles among flaking surfaces, producing undifferentiated flakes. No specific platform

¹⁸ GALLOTTI *et Al.* 2020.

rectification was conducted insofar as each negative served as a striking platform for the following removal on a secant and orthogonal face [FIGURES 8/I-K].



[FIGURES 8/A-K]: Silicite freehand exploitations. A-C. Unifacial unidirectional cores with rectified striking platform; D-E. Flakes with unidirectional negative scars on the dorsal face; F-H. Bifacial partial alternating cores; I-J. Multifacial multidirectional orthogonal cores; K. Hinged flake with multidirectional negative scars on the dorsal face © Photos and drawings by GALLOTTI, R., modified GALLOTTI R. *et al.* 2020.

Besides, there is evidence of a specific technical process hitherto unknown for these periods which is an intentional production of recurrent bladelet-like flakes exclusively through a bipolar-on-anvil semi-peripheral exploitation. Thirty-two cores [FIGURES 9/A-E] show one horizontal or slightly oblique split surface along the transversal axis of the pebble and percussion marks on the opposite side. The flat surface is appropriate to stabilize the half-pebble on the anvil (proximal portion) and strike the convex opposite surface (distal portion) with the hammerstone. The position of the striking surface (distal portion) and the split surface resting on the anvil stabilizing the core (proximal portion) remains stable during pebble exploitation. Core is rotated according to the longitudinal axis to exploit its periphery detaching bladelet-

like flakes [FIGURES 9/F-N] and no orthogonal rotation of the core is operated. This bladelet-like flake production is restricted to silicite knapping as it is not observed in the quartzite assemblage, although the knappers had a large quantity of quartzite pebbles available that could have been flaked this way¹⁹.

All cores do not bear signs of retouch or edge shaping suggesting a potential secondary use as tools and clearly fall into the category of technological waste. Some cores were abandoned after a few removals (simple cores), but there is no obvious technical reason for their discard. They may correspond to the initial flaking stage of structured cores. However, the abundance of raw materials at secondary sources in the Casablanca region may have encouraged such an underexploitation²⁰.



[FIGURES 9/A-E]: A-E. Bipolar-on-anvil semi-peripheral exploitation cores showing a split surface along the transversal axis of the pebble and elongated peripheral negative scars; F-N. Bladelet-like flakes © Photos and drawings by GALLOTTI, R., modified GALLOTTI *et Al.* 2020.

¹⁹ GALLOTTI *et Al.* 2020.

²⁰ GALLOTTI *et Al.* 2020.

V. CONCLUSIONS

This analysis of the ThI-L1 quartzite industry can be taken as a solid basis to evaluate the techno-economic strategies adopted by hominins at ~1.3 Ma in the Casablanca region. Here we discuss the technical responses to the collected raw materials, the mental templates involved in lithic production, and the relative technological skills.

LCT shaping at ThI-L1 recalls several processes that, repeated on several specimens, produced several tool-types sharing technological, morphological, and dimensional patterns. None of these tools can be defined as «biface» (*sensu* ROCHE & TEXIER 1991) because there is no bifacial and bilateral management of biconvex volumes and, even if bifacial shaping exists, it is usually restricted to the edges of the artefacts. Another common aspect of these LCTs is the conservative proximal mass, usually opposite to the tip on their major axis.

The main aim of the LCT production was to manufacture large pointed tools (handaxes and picks) and LCTs with a transversal edge (cleavers). Beveled handaxes are not a primary focus, as their transversal edge appears mostly due to the resharpening of skewed pointed handaxes after the breakage of the tip.

The production of different LCT types and the intra-type replication of morphologies reflect the existence of genuine mental templates which document a certain level of conceptual complexity. This conceptual level is expressed in the ability to discern the different elements constituting the final tool and to conceive their relationships both simultaneously (final tool) and in sequential order (the cause-effect relations among the different phases of the *chaîne opératoire*), evaluating the consequences of the programmed actions singly and globally at any given moment.

Conceptual schemes are applied through operational schemes based on the blending of LCT blank selection/production and standard shaping procedures. Knappers were able to foresee the final LCT morphometrical patterns by anticipating them through the selection of cobble blanks, directly shaped into handaxes and picks, and the production of *ad hoc* flakes²¹.

Small-medium sized flakes were the intended end product of the quartzite small flaking. Several flaking methods involving constant technical rules are documented, each of them representing the most suitable flaking solution for the original blank shape. This panoply of flaking methods is directly related to the variety of cobble/pebble blank shapes. It is difficult to establish to what extent the adaptation to the original blank shapes was imposed by raw materials constraints or was an independent choice. Most likely, the two factors played their role simultaneously, but in different ways depending on the sought outcomes. It is clear that knappers had an in-deep knowledge of the topological structure of the raw materials and of their effects on flaking. Furthermore, flaking method variation does not create a product diversity, but is essentially aimed at maximizing the production²².

²¹ GALLOTTI *et Al.* 2023.

²² GALLOTTI *et Al.* 2023.

However, when hominins needed to extract products with specific patterns, they were able to add further operational tools to the flaking level-variability. The most representative case is the production of bladelet-like flakes of silicite²³. Small flakes were produced from silicite pebbles using some of the flaking methods documented for quartzite and the same technique, i.e. free-hand percussion. Besides, there is evidence of a specific technical process hitherto unknown for these periods which is an intentional production of recurrent bladelet-like flakes exclusively through a bipolar-on-anvil technique. This bladelet-like flake production is restricted to silicite knapping as it is not observed in the quartzite assemblage, although the knappers had a large quantity of quartzite pebbles available that could have been flaked this way²⁴.

The techno-economic systems highlighted at ThI-L1 document the high diversification of the stone working outcomes, indicating different levels of knowledge and knowhow. Technical projects evidence the complexity of the mental templates involved in stone knapping as well as the flexible structure of the operational schemes.

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²³ GALLOTTI *et Al.* 2020.

²⁴ GALLOTTI *et Al.* 2020.

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