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# The lithic assemblages from the Palaeolithic survey research in the Megalopolis Basin, Greece

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## Abstract:

An intensive, target-oriented surface survey conducted in the Megalopolis basin during 2012-2013 led to the discovery of several Palaeolithic sites and findspots with lithics and faunal remains, including Marathousa-1, a Lower Palaeolithic open-air elephant-butcher site, dated to ca. 400-500 ka BP. This study presents the results from the techno-typological analysis of 413 lithic artefacts collected as surface or stratified finds during the survey research. The aim of the work is to evaluate the diachronic occupation of the area in relation to the lithic technologies used, the typology of the artefacts, and the raw materials exploited. It was possible to provide a chrono-cultural attribution of 167 artefacts, ranging from the Lower Palaeolithic to the Holocene, with a significant component of the collection attributed to the Middle Palaeolithic. Several diagnostic retouched tools allow us to infer that the open-air sites were occupied comparatively more intensively during the Middle Palaeolithic period. We also provide a detailed account of the lithic assemblage from Kavia cave, a previously unstudied site identified during the survey. The high frequency of artefacts pertaining to the Upper Palaeolithic in Kavia is in line with previously identified settlement and mobility patterns of the Peloponnese, where the occupation of caves becomes more intensive from the Upper Palaeolithic onward, as attested at the sites of Klissoura, Kephalaria, and Franchthi. The Upper Palaeolithic component from Kavia Cave adds new data to a meagre sample of known sites from this period. The results from the typological and technological analysis of the lithic assemblages collected during the survey in Megalopolis support the conclusions of the basin's long-term and ongoing research, indicating a relatively continuous hominin presence during the Pleistocene.

**Keywords:** Survey; Palaeolithic; Southern Balkans; Lithic technology; Megalopolis



## 1. Introduction and background

The importance of the geographical location of Greece for identifying - possibly repeated - human dispersal events is evident, as it lies at the crossroads between Europe, Africa, and the Near East. Although Palaeolithic and paleoanthropological research was neglected until recently, the last few decades have seen an increasing interest in this region's most ancient phases of human prehistory (Harvati *et al.* 2009; Harvati & Tourloukis 2013; Harvati & Roskandic 2016; Runnels 1995; Tourloukis & Harvati 2018). This new focus is reflected in recent survey campaigns and systematic excavations that have fostered an increase in knowledge about the Palaeolithic in the Southern Balkans. Prominent examples include the work conducted by joint teams from the Ephorate of Speleology and Paleoanthropology (EPS; Greek Ministry of Culture and Sports) and the University of Tübingen Paleoanthropology section, in the framework of the ERC Starting Grant PaGE (2012-2016) and the ERC Consolidator Grant CROSSROADS (2017-2022) (*e.g.*, Panagopoulou *et al.* 2015, 2018; Tourloukis *et al.* 2016; Thompson *et al.* 2018).

The Lower Palaeolithic (LP) of Greece is not well-known, and only a few sites have provided a typological and chronological context: Marathousa 1 in Megalopolis, characterized by a 'small tool' industry, dates to around 400-500 ka (Panagopoulou *et al.* 2015, 2018); Rodafnidia in Lesvos, with bifaces and industries with prepared core techniques, dates between 476 and 164 ka BP (Galanidou *et al.* 2016); Rodia in Thessaly includes a core-and-flake assemblage that dates to *ca.* 200-400 ka (Runnels & Van Andel 1993a, but see also Tourloukis 2010); and Kokkinopilos in Epirus, where bifaces have been found in *terra rossa* deposits (Runnels & van Andel, 1993b; but see also Tourloukis 2009, Tourloukis *et al.* 2015).

The Middle Palaeolithic (MP) is well-attested, with *ca.* 240 known sites associated mainly with open-air and unexcavated contexts (Elefanti & Marshall 2015; Papagianni 2000; Tourloukis & Harvati 2018). Nevertheless, it is inadequately dated and poorly understood regarding technological repertoires and hominin behaviour, as it lacks regional comparisons and synthetic studies of inter-site lithic variability. Only five excavated, sheltered sites have provided relatively high-resolution data: Asprochaliko (Epirus, Bailey *et al.* 1983); Theopetra (Thessaly, Valladas *et al.* 2007); Kalamakia (Darlás & Psathi 2016) and Lakonis (Elefanti *et al.* 2008; Panagopoulou *et al.* 2004) both in Mani peninsula; and Klissoura (Argolid, Koumouzelis *et al.* 2001). In all the aforementioned sites, the MP archaeological levels have been chronologically bracketed only very loosely between *ca.* 40 and 100 ka (Tourloukis & Harvati 2018 and references cited therein); at Theopetra, the lowest MP layers have been attributed to the transition between Marine Isotope Stage (MIS) 6 and 5 (*ca.* 130 ka; Karkanas *et al.* 2015), which makes it so far the oldest-known MP industry on the Greek peninsula from a cave or rock shelter.

The Upper Palaeolithic (UP) is mainly represented at sites in Epirus and the Peloponnese. The latter region includes assemblages from the cave sites of Klissoura, Lakonis, Kolominitsa, and Franchthi (Kaczanowska *et al.* 2010; Elefanti *et al.* 2008; Darlás & Psathi 2016; Perlès 1987), where the earliest phases of the Upper Palaeolithic and transitional industries have been identified. Outside the Peloponnese, in the Pineios River area (Thessaly), a transitional industry with foliated tools was found (Runnel 1988; Runnels & van Andel 1993a). Later UP industries occur only in a few regions of Greece, but they are best known for Epirus's cave and rock shelter sites (*e.g.*, Adam 1989: 10-254; Bailey 1997: 61-90; Elefanti *et al.* 2021).

Even though multiple Palaeolithic sites have been reported in the Peloponnese, their archaeological assemblages are often not extensively documented. Moreover, their distribution is diachronically unequal, with a more significant deficit of LP and, to a lesser degree, UP sites. This work aims to update our knowledge regarding the settlement and land-use patterns of the region by groups of hunter-gatherers, highlighting the archaeological importance of this area in

the local context. In this study, this will be achieved through the analysis of lithic assemblages compiled during surveys conducted in 2012-13 in the Megalopolis basin, including Kavia cave, the open-air sites of Isoma (*i.e.*, Isoma 1 and 2, respectively), and a cumulative group of artefacts from findspots located both inside and outside the lignite mines of the basin (see Thompson *et al.* 2018).

## 2. The Megalopolis basin

Located at an altitude of *ca.* 400-450 m above sea level (masl), the basin of Megalopolis is an intramountainous Neogene half-graben, bounded by NE-SW trending normal faults (Vinken, 1965). The bedrock of the floor and the mountains surrounding the basin consist of metamorphic rocks, limestones, and flysch of the Tripolis and Pindos geotectonic zones. From bottom to top, the Plio-Pleistocene sedimentary sequence consists of Pliocene fluvial and lacustrine deposits (Makrision and Trilofon formations), Early Pleistocene coarse-grained sediments (Apiditsa formation), followed by the Middle Pleistocene Choremi formation, which is divided into the lacustrine Marathousa Member (Mb) and the fluvial Megalopolis Mb (Becker-Platen 1964: 5-130; Vinken 1965). While the Marathousa Mb attests to the presence of a paleo-lake during most of the Middle Pleistocene (*ca.* 900-300 ky; van Vugt *et al.* 2001; Tournoukis *et al.* 2018a), the Megalopolis Mb represents fluvial input into the lake and the development of an exorheic drainage system (Vinken 1965; Tsiftsis 1987). The Marathousa Mb is composed of limnic beds intercalated with thick lignite seams, which are commercially exploited in open-cast mines. The basin is long known for its fossiliferous deposits and the rich palaeontological record (*e.g.*, Konidaris *et al.* 2018; Athanassiou *et al.* 2018, and references therein).

During two field seasons in 2012 and 2013, a target-oriented surface survey was conducted in the Megalopolis basin, whose rationale, strategy, and methods of find collection and recording stratigraphic context have been presented in detail elsewhere (Thompson *et al.* 2018).

Stratified finds were located at sites where fresh outcrops were exposed by the mining activities, as the southern edge of the Choremi mine expands to the South/South-East. At the site of Tripotamos 1, two artefacts were found together with a bone fragment inside a gravel-rich deposit that probably represents a debris flow. At the nearby site of Choremi 3, five slightly rolled flakes and flake fragments were located stratified in a fluvial deposit of sands and gravels. At the north-western edge of the Marathousa mine, lithics and faunal remains were found stratified at the site of Marathousa 1, inside a layer of silty sands that represents mudflow deposits; the subsequent discovery of more finds while cleaning the same profile made it clear that this is an important stratified site and led to rescue excavations (Panagopoulou *et al.* 2018; Harvati *et al.* 2018; see also Bludau *et al.* 2021 and references therein, for more recent investigations).

Most of the artefacts reported in this study come from surface sites and findspots, which are located outside the mines, around the periphery of the basin (Figure 1). The sites of Isoma 1 and 2 are at the western margin of the basin, at *ca.* 470-500 masl. Isoma 1 appears to be a deflated surface, where pedogenic structures and redoximorphic features indicate the presence of palaeosol remnants; some of the collected artefacts have been eroded out of the palaeosol, but we cannot exclude the possibility that other, chronologically younger specimens have been discarded on this exposed surface and are mixed with the older material. Isoma 2 lies in a fallow field to the north of Isoma 1 and yielded a mixed assemblage with artefacts from different periods (see also below).

The most significant number of finds (N = 243) were collected on the surface of a talus cone at Kavia cave, which is reported here for the first time. The cave is located on the northern side of the basin to the northwest of Karitena above the eastern bank of the Alfeios river.

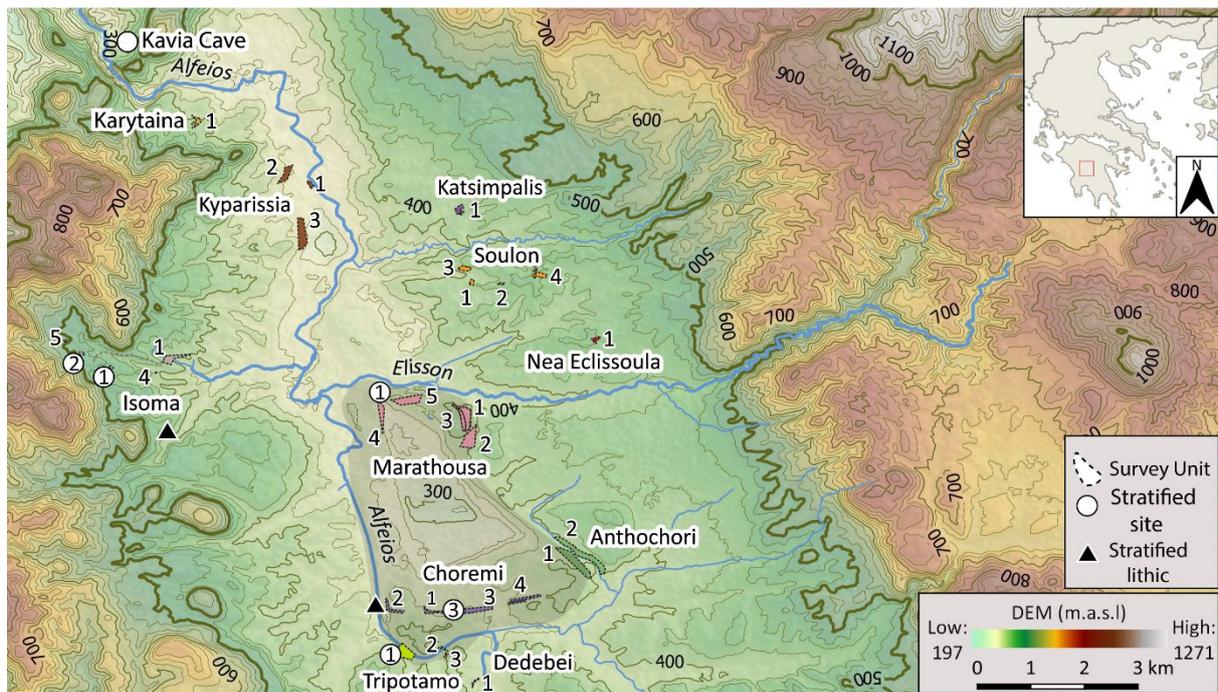


Figure 1. Topographic map of the Megalopolis basin covering the 2012 and 2013 project area where the archaeological surveys were conducted. The place names correspond to the localities inspected during the survey. Shaded polygon outlines the extent of the modern mine complex. Contour intervals every 25m. Digital Elevation Model (DEM) from the Shuttle Radar Topography Mission (SRTM) version 3 (NASA JPL 2013).

### 3. Methodology

The lithic assemblages are stored in Athens, Greece, at the Ephoreia of Palaeoanthropology-Speleology, Greece (Ministry of Culture and Sports), and were analysed following a techno-typological approach (Andrefsky 1998; Débenath & Dibble 1994), aiming to infer the type of *chaînes opératoires* (Geneste 1991; Inizan *et al.* 1999; Leroi-Gourhan 1964; Pelegrin 1995; Pelegrin *et al.* 1988; Tixier 1978), as well as the technological behaviour of the prehistoric knappers that occupied the Megalopolis basin. Flakes, blades and bladelets were distinguished based on standard metric attributes (*e.g.*, bladelets: length <50 mm, width <15 mm); debris includes pieces that lack flake traits, usually have more than four surfaces and are blocky in shape ('chunks') or they are sharp with irregular edges ('shatter'). Chips are unretouched flakes smaller than 15 mm in maximum dimension. For all specimens, the type of raw material and the Munsell colour were identified. Since most of the studied material was collected as surface finds with no association with a geological matrix, a detailed taphonomic study of post-depositional modifications was deemed unnecessary. Nevertheless, modifications due to heat, frost or rounding were recorded and apparent chemical and mechanical alterations (Inizan *et al.* 1999; Guibert-Cardin *et al.* 2022).

Regarding the tools, we have documented information on type of retouch, as well as the maximum length of the modification (retouch invasiveness), according to the typological lists of Bordes (1961: 57-162), Laplace (1974) and Débenath & Dibble (1994). For the cores, we analysed their morphology, the striking platform, and the flaking surface characteristics, according to Andrefsky (1998: 144-160), Conard *et al.* (2004) and Inizan *et al.* (1999: 59-60). The chrono-cultural attribution of the lithic assemblages is based on knapping techniques associated with specific artefacts and often by the raw materials, which tend to be more varied from the very end of the Palaeolithic with the first confirmation at Franchthi cave of Melian obsidian from the Final Palaeolithic (Perlès *et al.* 1990).

For the Lower and Middle Palaeolithic, we considered the tools, cores, and flakes obtained through direct percussion with a hard hammer. We recognized Levallois and discoid products, centripetal cores, Mousterian points, and convergent scrapers produced with the local radiolarite. For the artefacts referred to the Upper Palaeolithic, we have considered the use of direct percussion, mainly with a soft hammer, associated with laminar production (Pelegrin 2000). We included prismatic and pyramidal blade cores, formal tools, and technical pieces for the volumetric maintenance, mainly produced with the local radiolarite, of good quality. Finally, because a small number of artefacts share some techno-typological characteristics common in all the Palaeolithic periods, therefore, they are included in a separate category ("Palaeolithic (undivided)"). The same approach was followed for a part of the artefacts attributed to the Holocene: besides typologically diagnostic specimens, criteria also included technological traits such as those indicative of pressure flaking and the use of materials that are either entirely exotic (*e.g.*, obsidian) or clearly of non-local origin *and* with a homogeneity in texture that is not common in the regional types.

#### 4. Results

A total of 413 artefacts (Table 1) were collected and analysed from the Megalopolis basin survey. The assemblages consist of lithics recovered from varied geological and archaeological contexts, with the highest number of finds collected on the surface from the sites of Kavia Cave, Isoma 1 and 2 (located on the fringes of the basin). Whereas the sites of Marathousa 1, Choremi 3, Tripotamon 1 are from stratified contexts inside the mine. The low-density surface scatters and isolated stratified lithics were designated as findspots that occurred both inside the lignite mine and on the bounds of the basin.

Table 1. Composition of the lithic assemblage collected during the survey according to technological categories.

Blank type	N.	%
Flakes	185	45%
Bladelets	33	8%
Blades	20	6%
Chips	19	5%
Cores	52	11%
Debris	104	25%
Total	413	100%

We suggest a chrono-cultural attribution for 167 artefacts (*ca.* 40% of the total), ranging from the LP up to the early Holocene (Table 2), with most artefacts being attributed to the UP (31%) and MP (27%). Regarding the artefact preservation, most specimens exhibit only slight alterations (*e.g.*, Figure 2), allowing us to infer a low-energy depositional context for most of the sites and findspots.

The raw materials used are radiolarite (80%), flint (11%), quartz (4%), obsidian (1%), limestone (1%), sandstone (< 1%), mudstone (< 1%) and indeterminate (2%). The quality of the raw materials varies greatly, especially the radiolarite: as attested by our observations during experimental knapping with cobbles from fluvial sources, the homogeneity and mechanical properties may vary considerably even in the same pebble or block.

Table 2. Frequency of lithic artefacts by chrono-cultural period.

Chrono-cultural attribution	N.	%
LP	1	<1%
LP-MP	8	5%
MP	45	27%
MP-UP	24	14%
Palaeolithic (undivided)	4	2%
UP	50	31%
UP-Holocene	23	14%
Mesolithic	3	2%
Neolithic	4	2%
Holocene (undivided)	5	3%
Total	167	100%



Figure 2. Isoma, a slightly patinated flake associable with the Middle-Upper Palaeolithic.

#### 4.1. Kavia cave

Kavia (Figure 3) is a large southwest facing cave formed in Pindos limestone and is located ~10 km north as the crow flies from the site of Marathousa 1, at an elevation of 269 masl (~80 m above the Alfeios river). Even though artefacts such as burned bone and lithics were visible cemented on the walls of the cave, our survey permit prevented us from removing artefacts that were embedded in the cave walls. In total, only two lithics were recovered from the surface of the cave. Therefore, the majority of finds were collected in front of the cave mouth directly below rock fall on the surface of the talus cone where visibility alternated from moderate to high in the exposed red sediments. The density of the finds was low to medium, with a near total surface collection of finds.

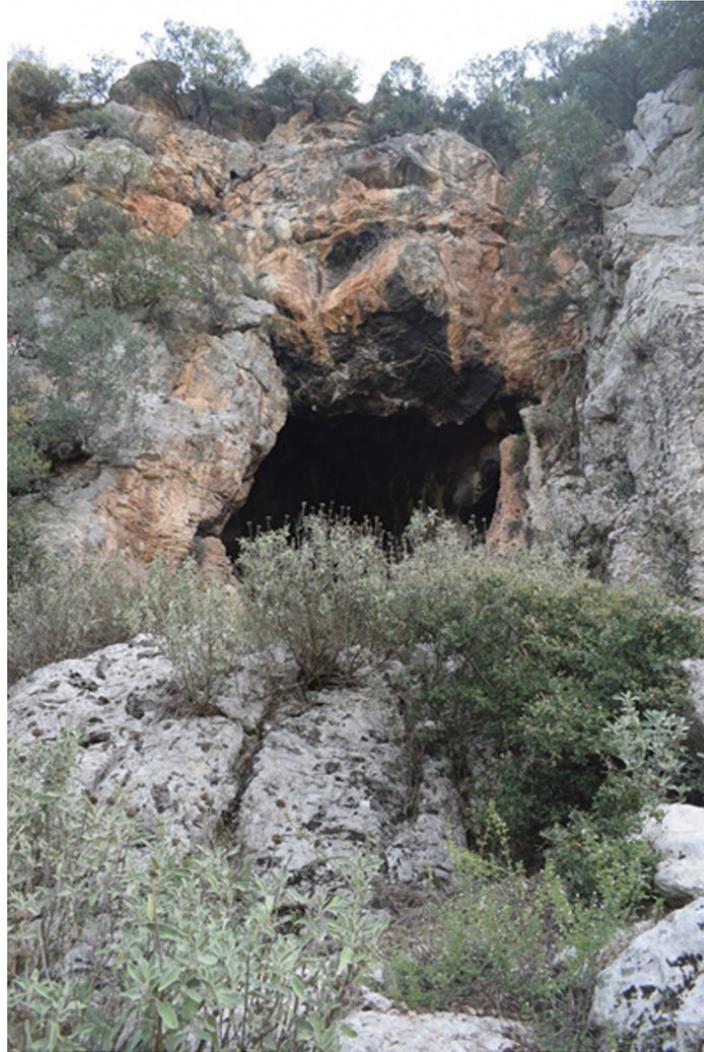


Figure 3. The entrance of Kavia Cave with black flint visible interbedded on Cretaceous limestone.

Table 3. Lithic assemblage from Kavia Cave, according to technological categories.

<b>Type</b>	<b>N.</b>	<b>%</b>
Flakes	62	26%
Bladelets	11	5%
Blades	5	2%
Cores	32	13%
Tools	64	26%
Chips	12	5%
Debris	32	13%
Slabs	9	4%
Pebble	4	2%
Blocks	5	2%
Other (blank on sub-angular pebble fragment)	1	1%
Undetermined	6	2%
<b>Total</b>	<b>243</b>	<b>100%</b>

The lithic assemblage consists of 243 specimens, as shown in Table 3: 27% of artefacts are variably patinated, 11% show neocortex on the not-knapped surfaces, and 13% have other surface alterations, such as iron oxides, manganese, and carbonates. Mechanical alterations, such as rounding (N=8), frost-derived marks (N=1), and thermal alterations (*e.g.*, potlids; N=8) often co-occur with chemical alterations on a single piece. Nevertheless, none of these alterations has severely affected the artefacts' surfaces, allowing for a precise inspection of the flaking scars.

The tools (Table 4) bear mainly scalar (N=48), marginal (N=44), lamellar, and notched retouch (N=11).

Table 4. Tool types in the Kavia Cave lithic assemblage.

<b>Tool typology</b>	<b>N.</b>	<b>%</b>
Bec	1	2%
Blades with convergent retouch	3	5%
Blades with lateral retouch	2	3%
Bladelets with lateral retouch	9	14%
Bladelets with bilateral retouch	2	3%
Scrapers	10	17%
Burins	2	3%
Denticulates	4	6%
Endscrapers	3	3%
Retouched flakes	9	14%
Microliths/Geometrics	4	6%
Composite tools	4	6%
Notches	2	3%
Perforators	3	5%
Backed points	1	2%
Splintered pieces	1	2%
Backed pieces	2	3%
Truncations	2	3%
<b>Total</b>	<b>64</b>	<b>100%</b>

The artefacts associated with the Middle Palaeolithic are mainly represented by retouched and non-retouched flakes (N=25) obtained mainly (40%) through unidirectional removals. A backed flake on bluish-grey radiolarite (Figure 4.1) has been attributed to the Lower Palaeolithic based on the quality of raw material and its techno-typological similarities with some of the artefacts discovered in the Lower Palaeolithic site of Marathousa 1, while 16 pieces, such as flakes with centripetal scar patterns, scrapers, and tools with denticulate and scalar retouch, mainly manufactured on poor and medium-quality radiolarite were considered attributable to the Middle Palaeolithic (Figure 4). Other 18 artefacts show both Middle and Upper Palaeolithic techno-typological features, like flakes with diffuse bulbs associated with the percussion through a soft hammerstone, and retouched blades associated with hard hammerstone (Figure 5).

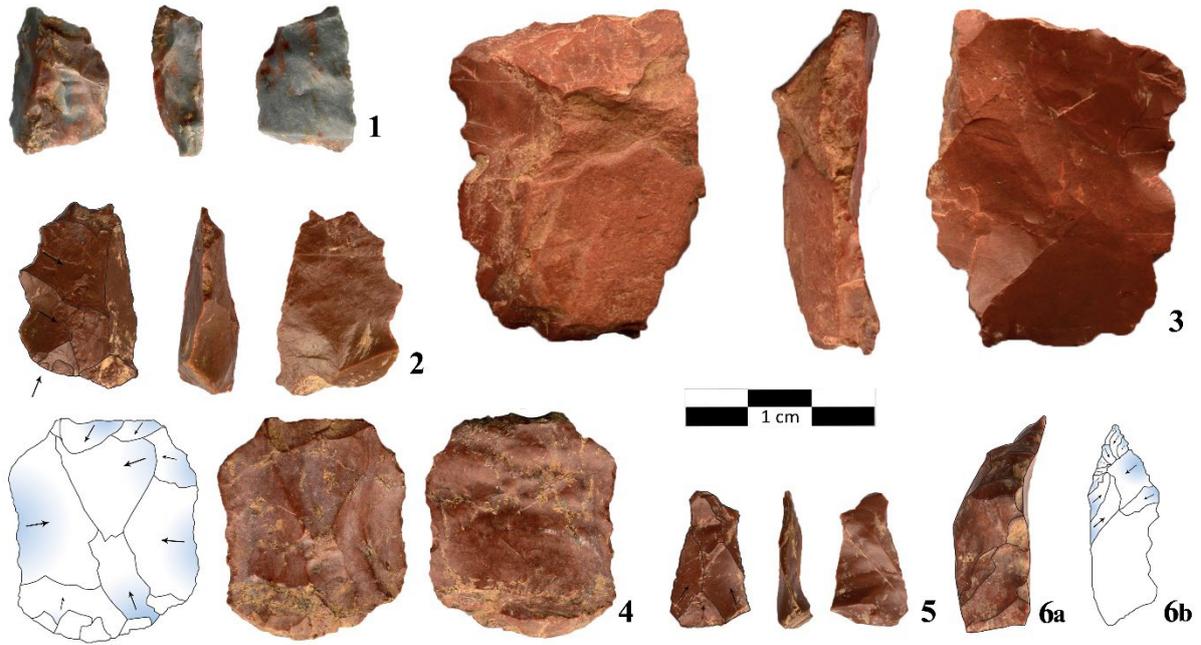


Figure 4. Kavia Cave: possible Middle Palaeolithic artefacts. 1) Backed flake. 2) Denticulate. 3) Scraper on semi-cortical flake. 4-5) Levallois flakes. 6) Two views of a borer with a prehensile area obtained by blunting retouch.

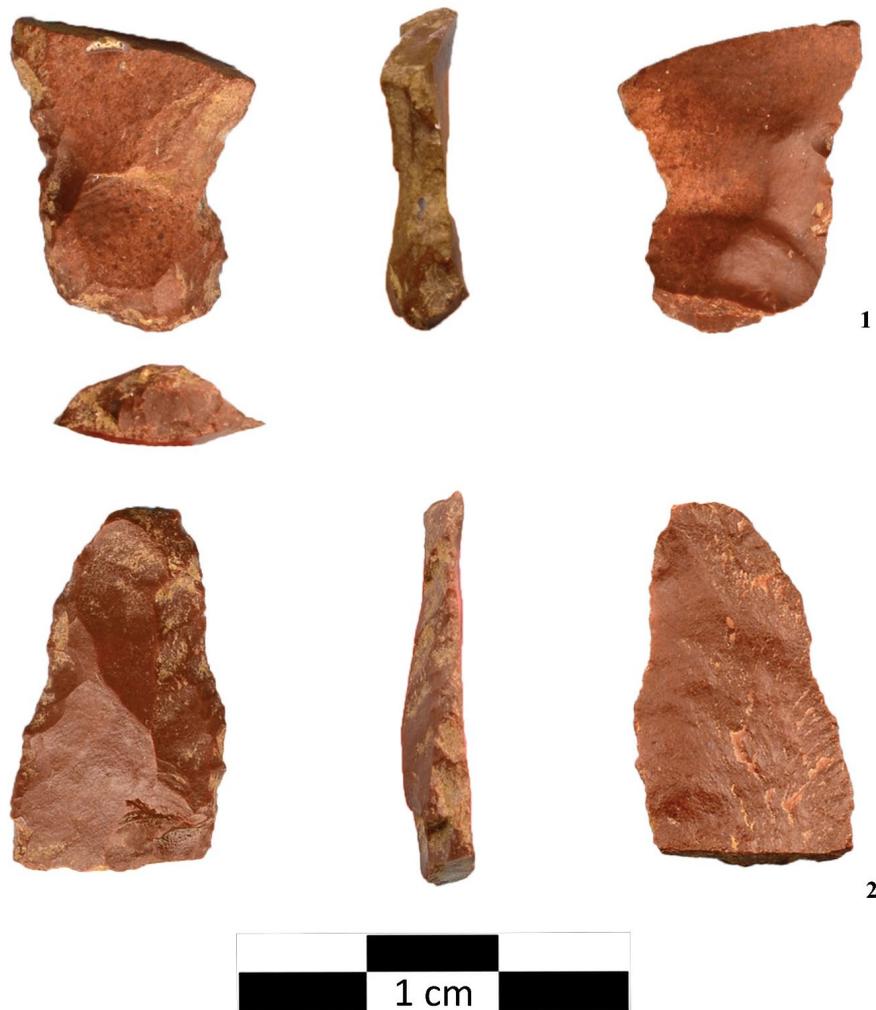


Figure 5. Kavia cave: 1) Retouched thick laminar flake. 2) Retouched blade (distal).

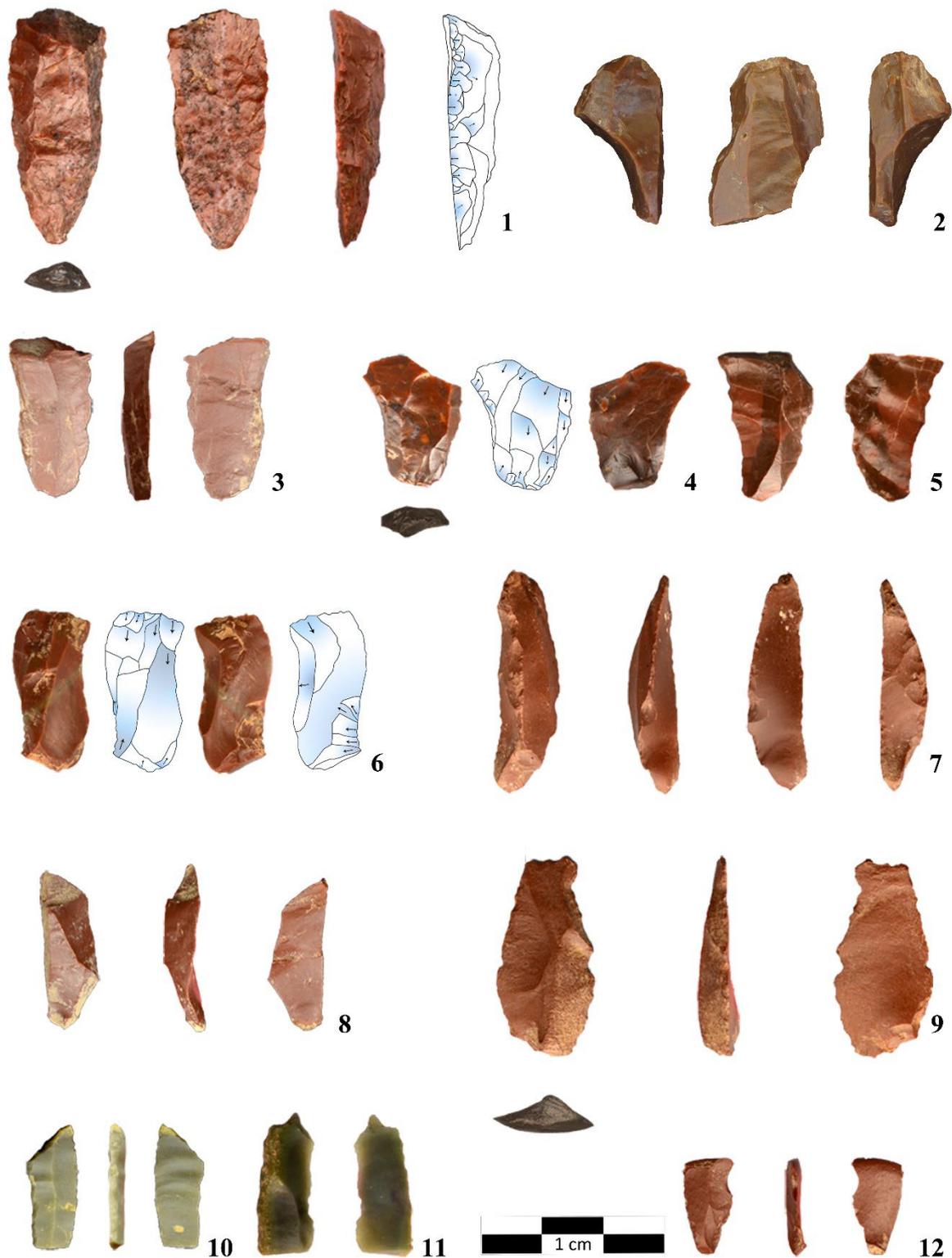


Figure 6. Kavia Cave: possible Upper Palaeolithic artefacts. 1) Endscraper on blade. The distal edge shows traces of re-sharpening, identifiable from the slightly irregular profile 2) Plunging flake. 3) Naturally backed bladelet. 4) Splintered piece. 5) Bladelet. 6) Core on a sinuous elongated retouched flake. 7-8) Initialisation bladelets. 9) Bladelet. 10) Backed truncated bladelet. 11) Perforator on bladelet. 12) Retouched microbladelet.

Radiolarite is the most common raw material, with an average artefact length of 25.4 mm. Flint was also used in artefacts with shared MP and UP features, with a mean length of 23.5 mm.

Among UP artefacts (N=34), the presence of blades with 'Aurignacian' retouch is notable, combined with carinated forms (Figure 6.1), endscrapers, pyramidal and prismatic cores (Figure 7), all implements attributable to the early phases of the Upper Palaeolithic. Artefacts related to the UP *tout court* (e.g., core-maintenance products, marginally retouched and backed flakes, burins and truncations) are also well represented (Figure 6). Another 19 pieces, produced with high-quality raw materials, exhibit typo-technological traits of the late Palaeolithic (e.g., Figures 6.10-11 and 7.1). In this chrono-cultural span (UP and UP-Holocene), the laminar products constitute 50% of the artefacts.

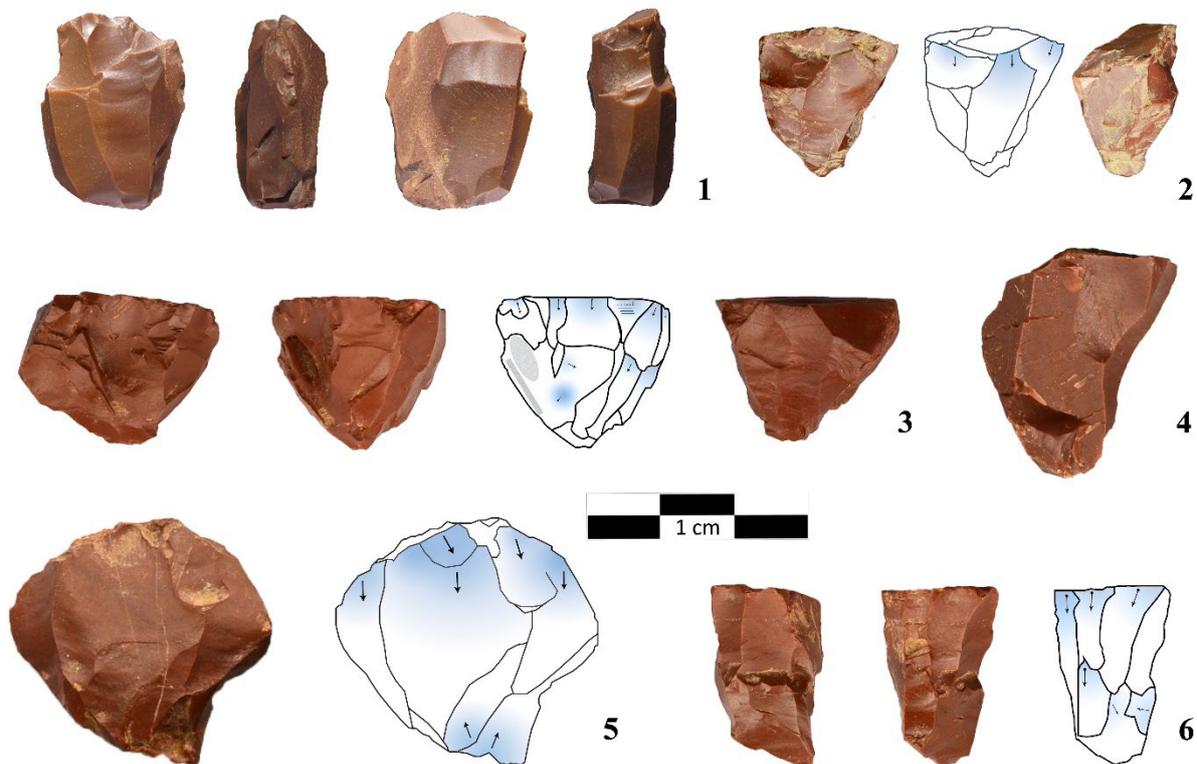


Figure 7. Kavia Cave: possible Upper Palaeolithic cores. 1) Bladelet core. 2) Prismatic core with striking platform obtained through the detachment of a flake without any further preparation. 3) Pyramidal core. 4) Prismatic core. 5) Prismatic core with convergent detachments. 6) Blade/bladelet core.

Core exploitation is characterised by a semi-circumferential scar pattern for pyramidal and prismatic cores, while the main flaking surfaces occur on the frontal part in narrow-sided cores. The striking platforms are plain, while the flaking surfaces present unidirectional scar patterns. The raw materials used are radiolarite, whereby 70% of artefacts (mean length of 23.9 mm) are produced, and the flint (28%) is associated with artefacts whose average mean length is 16.7 mm.

Only six artefacts are tentatively attributed to the Holocene, including three tools made on non-local raw materials: a translucent radiolarite point, a flint micro scraper, and an obsidian blade fragment with lateral retouch (Figure 13.2-4).

#### 4.2. Isoma

The locality of Isoma is situated on the western edge of the Megalopolis basin, where two surface lithic scatters, designated as the sites of Isoma 1, and Isoma 2, with relatively high lithic densities, were found. Overall, the lithic assemblage consists of 87 pieces (Table 5), almost 50% of which exhibit patina, 8% show traces of neocortex, and 10% exhibit traces of carbonate

and manganese; only two artefacts demonstrate heat alterations, while nine pieces are semi-cortical.

Table 5. Technological categories of lithics from Isoma.

Type	N.	%
Flakes	35	40%
Bladelets	2	2%
Blades	3	3%
Cores	12	14%
Tools	16	18%
Chips	5	6%
Debris	13	15%
Undetermined	3	3%
Total	87	100%

Most of the artefacts (N=72) are complete, unidirectional detachments (N=33) with plain (N=23) and faceted platform (N= 12) types. The tools (see Table 6) exhibit both denticulated and stepped retouch, especially those associated with the Middle Palaeolithic, to which 22 artefacts (Figure 8) were attributed.

Table 6. List of Isoma locality tool types.

Tool typology	N.	%
Blade with lateral retouch	1	6%
Bladelet with lateral retouch	1	6%
Scrapers	5	32%
Burin	1	6%
Denticulate	1	6%
Chopping tool	1	6%
Mousterian points	2	13%
Microlith/Geometric	1	6%
Groundstone axe	1	6%
Splintered pieces	2	13%
Total	16	100%

The artefacts associated with the Lower Palaeolithic consist of a pebble with bifacial removals (see Figure 8.8) and, associable with both LP and MP, a denticulate on a not homogeneous radiolarite thick flake (see Figure 8.9). The Middle Palaeolithic is represented by Levallois and discoid-type flakes, Mousterian points and a point with convergent Quina retouch (Figure 9).

The flakes are predominant in the MP lithic assemblage. Of these, 41% are tools, with either multidirectional (38%) or unidirectional scar patterns (19%). The three cores designated as LP and MP are two centripetal cores and a tested piece on pebble. Radiolarite is the preferred material at 62.5% (excluding cores) with an average length of 24.19 mm, and flint is utilized in 12.5% of the artefacts, with a mean length of 40 mm. One isolated piece was designated as undetermined raw material type.

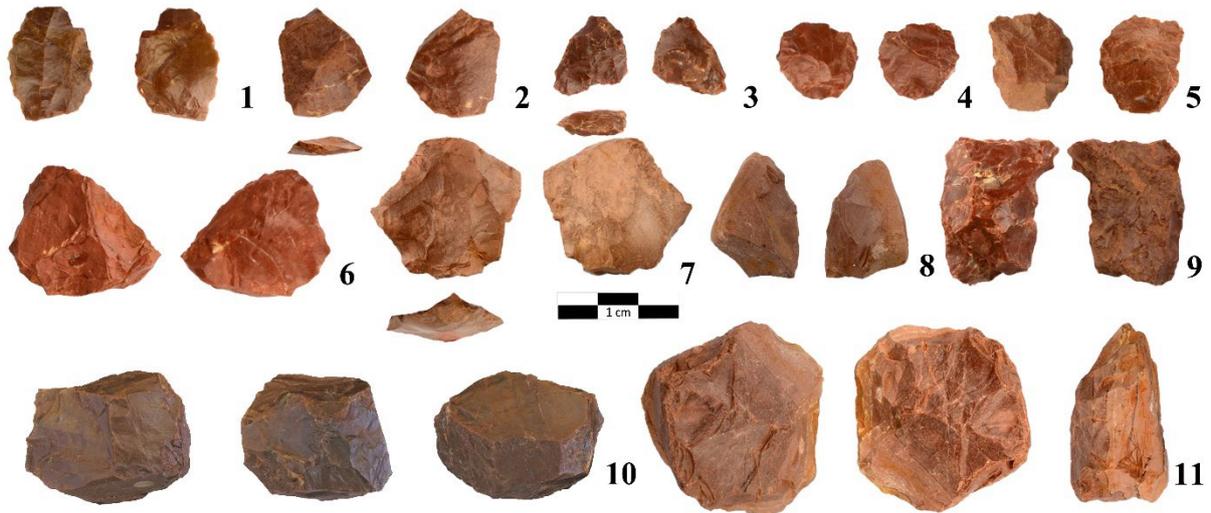


Figure 8. Isoma: possible Middle Palaeolithic artefacts. 1) Levallois flake. 2, 4, 5) Discoid flakes. 3) Splintered piece. 6) Atypical Levallois flake. Detachments are visible in the line of intersection of the two planes forming the core. 7) Pseudo-Levallois flake. 8) Pebble with flake detachments (chopping tool or tested piece). 9) Denticulate on blocky piece with Clactonian notch. 10) Flake core. 11) Centripetal flake core.



Figure 9. Isoma: 3 pointed tools. 1) Point with Quina retouch. 2) Denticulated on thick flake. 3) Mousterian point with bifacial retouch.

The artefacts attributed to the Upper Palaeolithic (Figure 10) are five, while another two are determined to be from post-Palaeolithic periods because the lithics are pressure-flaked.

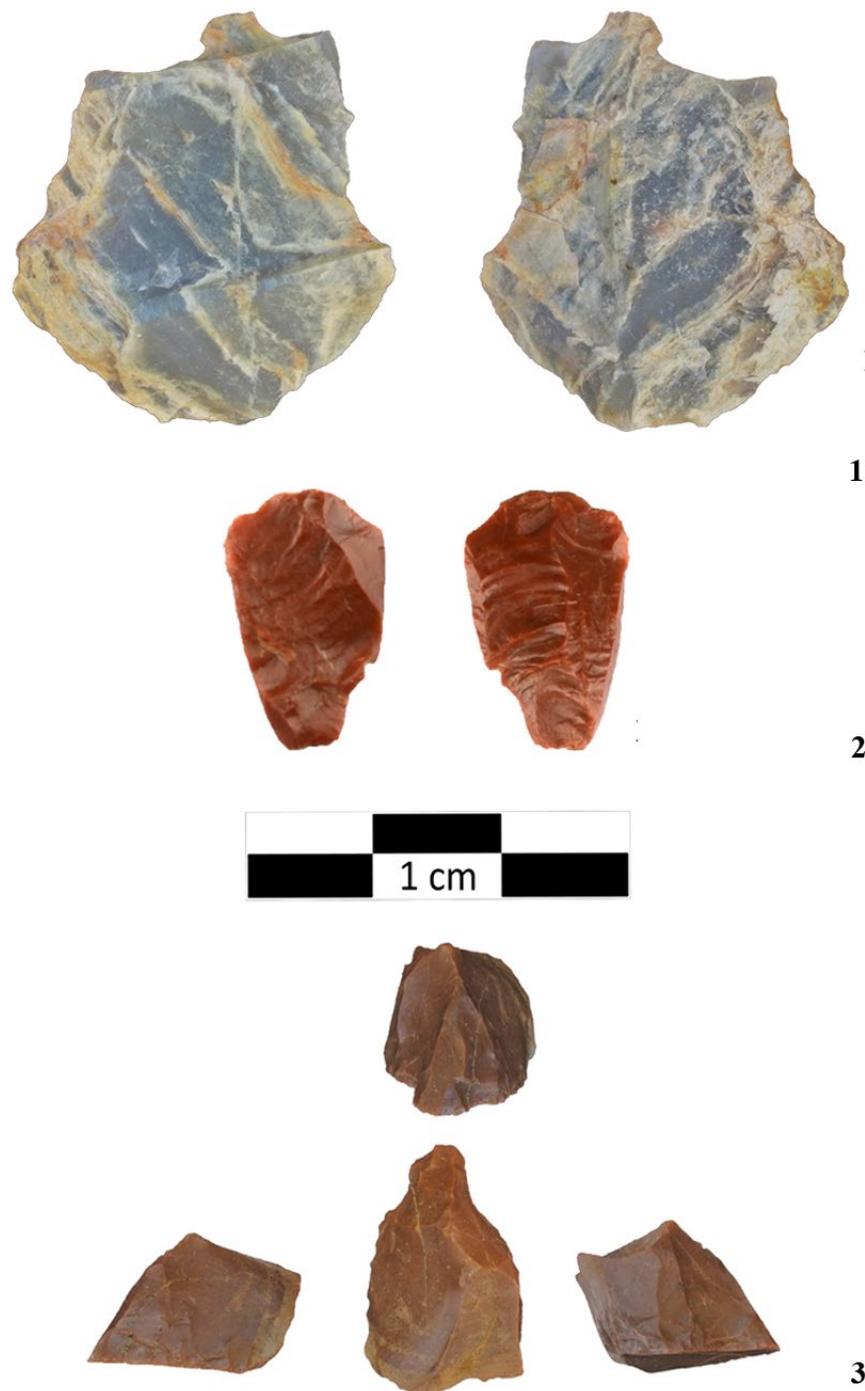


Figure 10. Isoma: possible Upper Palaeolithic artefacts. 1) Proximal fragment of a blade with *en nacelle* fracture. 2) Splintered piece. 3) Carinated nose-scraper with lamellar detachments.

Apart from a nosed endscraper (Figure 10.3), there are no other elements that typologically anchor the artefacts to this chrono-cultural unit unambiguously. Among these, we point out a splintered piece (Figure 10.2) and a core transformed into a scraper. Most of the artefacts are produced from radiolarite, with an average length of 24.5 mm, while flint was recognized only in the proximal fragment of a blade. The artefacts attributed to the Holocene (N=3) are two obsidian bladelet fragments and a broken groundstone axe with signs of use (Figure 13.1, 5).

### 4.3. Lithic artefacts from other sites and findspots in the basin

Stratified artefacts were found at the sites of Tripotamos 1 (N= 2), Choremi 3 (N=5), Choremi SU 2 (N= 3), and Marathousa 1 (N=1). For the purposes of this study, we opt to consider the small collections from those three stratified sites together with the artefacts that were found as isolated surface finds, mainly at the margins of the basin (Table 7).

Table 7. Lithic assemblage from the other minor sites and find-spots, according to technological categories.

Type	N.	%
Flakes	28	34%
Bladelets	1	1%
Cores	5	6%
Tools	31	37%
Debris	11	13%
Nodules	1	1%
Undetermined	6	7%
Total	83	100%

A small percentage of artefacts bear surface alterations such as patina (18%), neocortex (13%), and other kinds of chemical compounds, such as manganese, carbonate, or phosphate (14%), while only one artefact shows thermic alteration, four have rounded edges, and only a few specimens have cortex (N=9).

Most of the finds (N=58) are complete or nearly complete, obtained through unidirectional detachments (35%), with faceted (35%) and flat (31%) platforms. Among the tools, the retouch is largely stepped and marginal.

Table 8. List of tools recovered in the basin.

Tool typology	N.	%
Bec	1	3%
Blade with lateral retouch	3	10%
Bladelet with lateral retouch	1	3%
Scrapers	7	23%
Flake retouched	5	19%
Denticulate	1	3%
Composite tools	2	6%
Notch	1	3%
Microliths/Geometrics	4	13%
Perforators	2	6%
<i>Rabots</i>	2	6%
Tool backed	1	3%
Total	16	100%

The artefacts attributed to the Lower and Middle Palaeolithic are 21 in total and consist mainly of flakes (88%). The tools constitute 67% of the LP and MP lithic assemblage, including a Tayac point (a thick flake with two denticulated convergent edges) from the Marathousa mine (Figure 11.1), Levallois and discoid products and scrapers, and a laminar flake with Quina retouch (Figure 11.2).

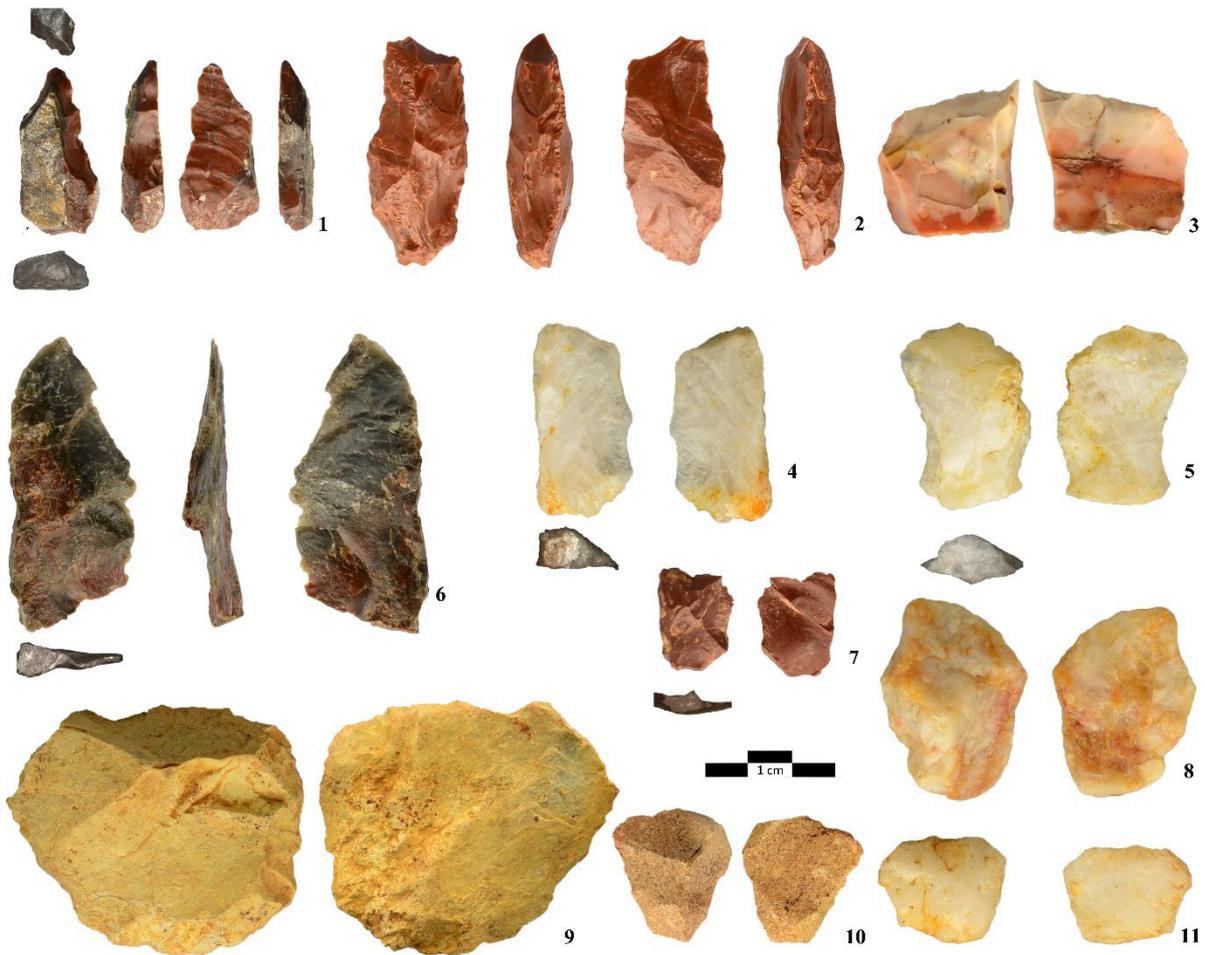


Figure 11. Artefacts attributed to the LP and MP, from other sites and findspots in the Megalopolis basin. 1) Tayac point. 2) Sidescraper with Quina retouch. 3) Flint block with a pointed distal edge obtained by the removal of a flake. 4-5) Quartz sidescrapers. 6) Backed knife. 7) Discoid flake. 8, 11) Quartz flakes. 9) Thick sandstone flake derived by a centripetal core. 10) Sandstone flake.

The raw materials used are radiolarite (70%), quartz (15%), sandstone (7%), limestone (4%) and flint (4%). The average length of radiolarite artefacts is 29.21 mm, while pieces of quartz and sandstone measure respectively 32.75 mm and 37.5 mm as mean. Moreover, we obtained 41.5 mm as the average length for limestone implements and 24 mm for flint ones.

The Upper Palaeolithic is represented by nine artefacts, adding two additional artefacts that share techno-typological characteristics associated with Holocene industries (Figure 12).



Figure 12. Artefacts attributed to the Upper Palaeolithic-Holocene, from sites and findspots located inside and outside the lignite mines. 1, 3, 6) Artefacts from the stratigraphic context of Choremi SU 2: retouched blade, core on flake, bladelet with rounded edges. 2) Bifacially retouched triangle-shaped piece with no use-wear traces could be attributed to the Late Upper Palaeolithic-Holocene. 4) Core-on-flake with lamellar detachments on the dorsal surface and a detachment of a flake on the ventral surface. 5) Retouched core tablet.

Tools represent 82% of the lithic assemblage for the UP and exhibit marginal retouch and a plain platform. There are two cores: a prismatic platform-type tested block with two lamellar detachments and a small flake core with multidirectional lamellar detachments whose edges have been retouched.

Radiolarite prevails in the lithic industry of these chrono-cultural units, with 9 out of 11 pieces, followed by two flint artefacts.

Regarding the post-Palaeolithic period, we recognized 3 microliths and one unretouched blank, probably a non-geometric microlith in radiolarite with marginal retouch that can be attributed to the Mesolithic (Galanidou & Perlès 2003). The prevailing raw material is flint, followed by radiolarite and obsidian (Figure 13.5).



Figure 13. Possible Holocene artefacts from the PaGE surveys. 1) Groundstone axe. 2, 3, 4) Pointed bladelet with triangular section, flint scraper, distal fragment of obsidian retouched blade. 5) Obsidian laminar pieces.

## 5. Discussion

Even though Megalopolis currently hosts the oldest-known Lower Palaeolithic site in Greece (Tourloukis 2021), this period is scarcely represented in the studied sample. This reflects the fact that Middle Pleistocene deposits do not crop out outside the lignite mines *i.e.*, in the margins of the basin, which is where the main survey areas targeted in 2012. Throughout the subsequent investigations in 2013, the survey began by targeting the oldest sediments of the basin in the lignite mine. At that point, the site of Marathousa 1 was located, and rescue excavations were launched at the expense of surveying further inside the mine. More recent investigations inside the mine have identified additional Lower Palaeolithic sites (currently unpublished), supporting the hypothesis of a strong human presence since the Middle Pleistocene. The lithic collections analysed in the current study, albeit small, demonstrate several Lower Palaeolithic and Lower-Middle Palaeolithic elements: aside from a notched tool on a small-sized block and a core-on-pebble (or chopping tool), we highlight the presence of some small flakes (the maximum length is of 24 mm) with functional edges, produced of low and medium quality radiolarite. The presence of possible LP artefacts, which are overall small

in size and made on radiolarite, indicates a persistent pattern that has been identified in the excavated assemblage from MAR-1 (Tourloukis *et al.* 2018b).

Most of the material presented in this study is attributed to the Middle Palaeolithic and Upper Palaeolithic, whereas there is also a significant number of lithics with typo-technological features that are common in both periods and have therefore been assigned to the 'MP-UP' (undivided). Overall, this picture is the result of several interrelated factors at play. Firstly, there is the issue of landscape taphonomy and the interplay between preservation and archaeological visibility (Tourloukis 2016): younger, Late Pleistocene sites have better chances of being preserved and accessible than Lower or Middle Pleistocene ones, especially in tectonically highly active settings and dynamic landscapes such as those of Greece (Tourloukis 2010). Secondly, hominin population densities in Eurasia were higher in the Late Pleistocene (Rodríguez *et al.* 2022 and references therein), resulting in a stronger archaeological signature and richer records. In this light, our results match the general picture in Greece and, in particular, the Peloponnese, where most known archaeological sites include mainly Middle, and to a lesser extent, Upper Palaeolithic material (*e.g.*, Perlès 1987; Reisch 1982; Koumouzelis *et al.* 2001; Panagopoulou *et al.* 2002-2004; Elefanti & Marshall 2015), a pattern that is confirmed also with data from previous survey projects (*e.g.*, Tourloukis *et al.* 2016; Parkinson & Cherry 2010).

The sample attributed to the Middle Palaeolithic includes typical prepared cores and a flake-based debitage that points to mainly Levallois and discoid reduction sequences, with toolkits that encompass primarily lateral, convergent and *déjeté* scrapers, Mousterian points, denticulates, notches and backed implements. The co-occurrence, or interchangeable use, of the Levallois and discoidal methods, found together with Mousterian tool types and a predominance of scrapers, is a common feature of the Greek MP (Panagopoulou 1999; Panagopoulou *et al.* 2002-2004; Tourloukis & Harvati 2018). The separated forms of *débitage* could be associated both with different subsistence patterns and raw material constraints. In contrast to the Levallois implements, the discoidal flakes often show evidence of retouching. Nevertheless, this trend hardly indicates a specific settlement pattern (Picin 2012). The co-presence of these implements is also a common thread for MP sites in Turkey (*e.g.*, Karain: Özçelik 2018) and the Balkans (*e.g.*, Mihailović *et al.* 2014; Borić *et al.* 2022). Bifacial shaping occurs only sporadically and true bifaces are absent in the Megalopolis basin, perhaps reflecting the relatively 'low signal' of *façonnage* lithic reduction in Greece (Runnels 1995; Tourloukis 2010), but also the scarcity of sizeable raw materials. The latter have certainly influenced the morphologies and retouch intensity identified in the MP tools, which have a mean length of 28 mm, namely comparable to the average artefact sizes reported for other sites in the region, such as Kalamakia and Lakonis in Mani (Darlás & de Lumley 1999; Panagopoulou *et al.* 2002-2004) or Klissoura in Argolid (Sitlivy *et al.* 2007). The use of relatively small-sized blanks and the selection of larger pieces for the manufacturing of retouched tools conforms to the trend observed in the LP assemblage of Marathousa 1 (Tourloukis *et al.* 2018) and seen also in other MP sites (*e.g.*, Mavri Spilia: Garefalakis *et al.* 2018).

The high percentage of Upper Palaeolithic lithics in our total sample is inflated by the material from Kavia, where the assemblage is characterized by blades and bladelets associated with lamellar cores and endscrapers. Notable is the presence of some early phases of the Upper Palaeolithic morphotypes, such as a double retouched endscraper on a blade, a nosed scraper, and laminar elements with scalar retouch; technologically, these tools are comparable to those from the Aurignacian levels of Klissoura (Kaczanowska *et al.* 2010) and the Protoaurignacian levels of Fumane in Italy (Aleo *et al.* 2021). The absence of Dufour bladelets could be due to the collection strategy or to an effective lack of them at the site. The latter option fits with the lithic assemblages from Willendorf in Germany (Teyssandier & Zilhao 2018), Mitoc-Malul Galben in Romania (Anghelinu *et al.* 2012) and Monte Avena in Italy (De Caro *et al.* 2021;

Lanziger & Cremaschi 1988). In Kavia Cave, in addition to debris and by-products of knapping, the assemblage includes cores, technical pieces, blades, and bladelets, with and without retouch. Overall, most of the assemblage is made of radiolarite, often of good quality. In particular, the vitreous and homogenous forms are preferred in the production of bladelets.

Furthermore, the presence of artefacts related to processing activities, *i.e.*, the endscrapers, the scrapers and the retouched laminar elements (see Anderson *et al.* 2015 and references therein) associated with a large number of cores, akin likely to the same cultural attribution to Aurignacian *tout court* and could suggest a residential use of the cave (*sensu* Binford 1980) during the Upper Palaeolithic. The fact that the largest -and perhaps also most conspicuous- UP component in our sample is associated with a sheltered site follows a trend, wherein open-air sites with UP material (exclusively, or not) are generally rare in Greece (*e.g.*, Runnels & van Andel 2005 and references therein). Similarly, artefacts attributed to the later or final parts of the UP are low in numbers, as in the rest of southern Greece. These include tools on backed bladelets (for comparisons see *e.g.*, Adam 1989: 54-252, 2007), which are sometimes made on non-local flint varieties and could represent (Epi?) Gravettian special-purpose localities (*e.g.*, hunting stands) or ephemeral occupations.

## 6. Conclusions

Our results confirm that hominins were present in the Megalopolis basin throughout the Palaeolithic. Nevertheless, it should be highlighted that most of our analyzed specimens could not be reliably attributed to a chrono-cultural phase because they often did not originate from stratified contexts. Despite these limitations, a large number of our finds appear to be associated with the Middle Palaeolithic (reflecting the conclusions of previous studies on this region; *e.g.*, Darlas 1994, 2007 and references therein), while Lower Palaeolithic artefacts were also identified, suggesting a more widespread human presence in the area. In Kavia cave, we recognized the maximum number of elements pertaining to the Upper Palaeolithic, and especially to the Aurignacian *sensu lato*. The rarity of preserved Early Upper Palaeolithic deposits in Greece encourages the pursuit of future systematic and intensive research in this cave. Overall, these findings are indicative of a sustained and relatively continuous Palaeolithic settlement in the Megalopolis basin, an area that may have potentially acted as a *refugium* for hominins and other mammals, due to the presence of fresh-water bodies during both glacial and interglacial periods, constituting a favourable ecosystem in times of harsher and colder climactic conditions (Bludau *et al.* 2021).

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## Data accessibility statement

The authors confirm that the data supporting the findings of this study are available within the paper. For further information, please write an email to the corresponding author.

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## Gli insiemi litici dalla ricerca archeologica sul Paleolitico nel Bacino di Megalopoli, Grecia

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### Abstract:

La posizione geografica della Grecia, significativamente sita alla confluenza tra Europa, Africa e Vicino Oriente, emerge come un elemento fondamentale nell'analisi degli eventi legati alle prime dispersioni umane. Nonostante gli studi sul Paleolitico e sulla paleoantropologia dei Balcani meridionali abbiano ricevuto scarsa considerazione in passato, gli ultimi decenni hanno per converso assistito a una crescente attenzione dedicata a questa regione.

La preistoria greca si presenta come un fenomeno complesso. Il Paleolitico inferiore è infatti caratterizzato spesso da una mancanza di contesti e indicazioni tipologiche e cronologiche. Tra i pochi depositi archeologici sistematicamente documentati, un esempio notevole è rappresentato da Marathousa 1, un sito ad alta risoluzione scoperto durante la campagna di ricognizione 2012-13 - i cui insiemi litici sono oggetto del presente studio - nel bacino di Megalopoli (Arcadia, Peloponneso) e che costituisce al contempo il più antico sito archeologico della Grecia e il più antico sito di macellazione dei Balcani meridionali (500-400 Ka BP). Il Paleolitico medio, sebbene sia meglio rappresentato, è soggetto talvolta a lacune in termini di datazione e a un'insufficiente conoscenza dei diversi repertori tecnologici, mancando di studi sintetici relativi alla variabilità tra i siti. Il Paleolitico superiore, infine, si manifesta principalmente in Epiro e nel Peloponneso, con siti come Klissoura, Lakonis, Kolominitsa e Franchthi, tutti situati in grotte.

Tuttavia, vi è una notevole disparità diacronica nella distribuzione dei siti, soprattutto per quanto riguarda quelli del Paleolitico inferiore e, in misura minore, quelli del Paleolitico superiore. Lo scopo principale del presente lavoro è stato quello di ampliare la comprensione relativa ai modelli di popolamento e uso del territorio da parte dei cacciatori-raccoglitori nel bacino di Megalopoli includendo la grotta di Kavia, i siti all'aperto nella zona di Isoma e aree minori all'interno e all'esterno della miniera.

Il bacino di Megalopoli è situato a un'altitudine di circa 400-450 metri sul livello del mare, la cui stratigrafia comprende sedimenti plio-pleistocenici, con il membro Marathousa associato a un paleo-lago risalente al Pleistocene medio.

La campagna di ricognizione nell'area ha portato alla scoperta di 413 manufatti, tra ritrovamenti di superficie e stratificati, quest'ultimi rinvenuti in depositi esposti dalle attività minerarie o provenienti da contesti geologici particolari, quali sabbie limose, depositi ricchi di ghiaia e vestigia paleo-lacustri che hanno fornito un substrato atto alla preservazione dei manufatti.

Gli insiemi litici sono stati analizzati seguendo un approccio tecno-tipologico, integrato dall'analisi macroscopica delle materie prime, al fine di comprendere le *chaînes opératoires* seguite nelle diverse aree e unità crono-culturali. Il periodo di riferimento è stato assegnato, quando possibile, sulla base delle tecniche di scheggiatura riconosciute e delle materie prime utilizzate. Per 167 manufatti, è stato determinato un range temporale che va dal Paleolitico inferiore all'inizio dell'Olocene, con una prevalenza di elementi riconducibili al Paleolitico superiore (31%) e al Paleolitico medio (27%).

Per il Paleolitico inferiore sono state riconosciute in prevalenza piccole schegge con bordi attivi in materia prima locale. Il Paleolitico medio comprende sequenze di riduzione Levallois e discoide, ma anche strumenti musteriani. I manufatti del Paleolitico superiore sono largamente caratterizzati da lame e lamelle e dall'impiego di materie autoctone e alloctone.

La radiolarite è emersa come materia prima principale (80%), a sottolineare la sua diffusione sistematica, pur con un peculiare livello qualitativo eterogeneo. La conservazione dei manufatti, caratterizzata da lievi alterazioni, ha suggerito contesti deposizionali a bassa energia per la maggior parte dei siti e dei ritrovamenti.

Nello specifico, la Grotta di Kavia, situata a nord di Marathousa 1, ha restituito un insieme litico costituito prevalentemente da manufatti attribuibili al Paleolitico superiore, in radiolarite di buona qualità, minimamente caratterizzati da patine e alterazioni superficiali, e spesso riportanti ritocchi di tipo scalariforme, marginale, lamellare e denticolato.

I siti di Isoma 1 e 2 comprendono una molteplicità differenziata di manufatti. Una parte ridotta, caratterizzata da piccole schegge, è attribuibile al Paleolitico inferiore, mentre il Paleolitico medio è rappresentato dalla confluenza dei metodi di riduzione Levallois e discoide, e dalla presenza di punte ritoccate. Il Paleolitico superiore è riscontrabile in elementi laminari, pezzi scagliati e grattatoi carenati, in materia prima locale e no.

L'insieme litico raccolto da altri siti e luoghi di ritrovamento sporadico, è composto da 21 manufatti attribuibili al Paleolitico inferiore e medio. Tra questi emerge una Punta di Tayac rinvenuta nel sito di Marathousa, nonché schegge e strumenti prodotti da diverse materie prime, tutte locali. Anche in questo caso, la presenza del Paleolitico superiore è attestata da elementi laminari e materie prime di buona qualità.

Nonostante il bacino di Megalopoli ospiti il sito archeologico più antico della Grecia (Marathousa 1), la relativa limitatezza dei manufatti rinvenuti durante le ricognizioni attribuibili al Paleolitico inferiore può essere in parte riconducibile alle difficoltà di conservazione, fenomeni tafonomici e cambiamenti del paesaggio. Gli insiemi associabili al Paleolitico medio, caratterizzati dalla coesistenza di metodi Levallois e discoide con elementi musteriani di pezzature differenti è un elemento già riscontrato durante il Paleolitico medio in diversi siti, e può rappresentare una differenziazione nei modelli di sussistenza. Il Paleolitico superiore è massimamente presente nella Grotta di Kavia dove figurano diversi elementi accostabili all'Aurignaziano.

Questo studio arricchisce la comprensione delle prime presenze umane nei Balcani meridionali, offrendo una visione dettagliata delle sequenze paleolitiche associate ai manufatti rinvenuti durante una ricognizione sistematica nel bacino di Megalopoli. Lo straordinario insieme litico rinvenuto nella grotta di Kavia, in combinazione con la rarità dei depositi Aurignaziani, incoraggia ulteriori ricerche archeologiche per chiarire le complessità temporali e spaziali relative alla presenza umana in questa regione geograficamente significativa, contribuendo in modo sostanziale a una narrativa più ampia della Grecia preistorica.

**Keywords:** Ricognizione; Paleolitico; Balcani meridionali; Tecnologia litica; Megalopoli