

---

# An Open-Air Site at Neshar Ramla, Israel, and New Insights into Levantine Middle Paleolithic Technology and Site Use

2

Yossi Zaidner, Laura Centi, Marion Prevost,  
Maayan Shemer, and Oz Varoner

---

## Abstract

A recently discovered site at Neshar Ramla, Israel (170–80 ka BP) is an open-air, eight-meter-thick Middle Paleolithic sequence situated in a deep karst sinkhole that acted as a sedimentary basin in which colluvial deposition was intermittent with *in situ* human activities. Presence of combustion features, excellent preservation of lithic artifacts and animal bones, and distinct concentrations of bones, lithics, and manuports point to the *in situ* human activities in the sinkhole.

The lithic assemblage from Neshar Ramla is the largest and best-preserved in the Levant dating to the latter half of MIS 6 – early MIS 5 (160–120 ka BP), offering a great opportunity to investigate changes and variations in human lifestyles and the exploitation of open landscapes for a period during which evidence for human occupation in the Levant is meager. The systematic production of naturally backed knives, the specialized tool-kit dominated by invasively and carefully retouched side-scrapers, and systematic lateral spall removal from retouched edges are unique characteristics of the Neshar Ramla industry setting it apart from other Middle Paleolithic industries in the Near East. We hypothesize that rather than a reflection of the function of the site in the land-use and mobility patterns, these features have a cultural origin and may indicate that Neshar Ramla hominins possessed discrete technological tradition that emerged in the region during late MIS 6 – early MIS 5. The unique context of the site, the size of the lithic assemblages, the excellent preservation of the finds and unique features of the lithic assemblages offer novel perspectives on various aspects of the MP hominin behavior during MIS 6–5.

---

## Keywords

Middle Paleolithic • Levant • Open-air sites • Lithic technology • Site formation processes

---

Y. Zaidner (✉)  
Institute of Archaeology, The Hebrew University,  
Jerusalem 91905, Israel

Zinman Institute of Archaeology, University of Haifa,  
Mount Carmel, Haifa 3498838, Israel  
e-mail: [yzaidner@mail.huji.ac.il](mailto:yzaidner@mail.huji.ac.il)

L. Centi • M. Prevost  
Institute of Archaeology, The Hebrew University,  
Jerusalem 91905, Israel  
e-mail: [lauracenti@hotmail.it](mailto:lauracenti@hotmail.it); [marion.prevost@mail.huji.ac.il](mailto:marion.prevost@mail.huji.ac.il)

---

M. Shemer  
Israel Antiquities Authority, P.O. Box 35, 10600 Nahlal, Israel  
e-mail: [shemerma@hotmail.com](mailto:shemerma@hotmail.com)

O. Varoner  
Department of Bible, Archaeology and the Ancient Near East,  
Ben-Gurion University of the Negev, Beer-Sheva, Israel  
e-mail: [ozvaroner@gmail.com](mailto:ozvaroner@gmail.com)

## 2.1 Introduction

Middle Paleolithic (MP) human occupation in the Levant (250–45 ka BP) is known from two major contexts: caves and open-air sites on riverbanks, small lake margins, and springs. Deeply-stratified Levantine cave sites yielded remains of both anatomically modern humans and Neanderthals together with large assemblages of lithic and faunal remains that accumulated over tens of thousands of years. The cave sites have been interpreted as repeatedly-occupied habitation localities to which lithic, faunal, and other resources were transported (Bar-Yosef and Meignen 2007; Garrod and Bate 1937; Hovers 2001, 2009; Jelinek 1977, 1982; Meignen et al. 2006; Speth 2004, 2006; Speth and Clark 2006; Stiner 2005; Yeshurun et al. 2007). Open-air sites in the Levant have been found on lake margins, flood plains, mountain/hill slopes, shallow terrestrial depressions, and karst depressions related to active springs in the Syrian Desert. Only the last type of sites was repeatedly used and preserves thick stratigraphic sequences (Boëda et al. 2001; Le Tensorer 2004; Hauck 2010, 2011). The majority of the MP open-air sites yielded shallow stratigraphic sequences and constrained lithic and faunal assemblages (Crew 1976; Fleisch 1970; Goren-Inbar 1990a; Hovers et al. 2008; Marks 1976, 1977; Munday 1977; Gilead and Grigson 1984; Ronen 1974; Sharon et al. 2010).

The open-air sites in the Levant are interpreted as either ephemeral campsites (Gilead 1980; Gilead and Grigson 1984; Hovers et al. 2014), residential camps (mostly in arid and semi-arid zones: Boëda et al. 2001; Hauck 2010, 2011; Henry 2012; Marks 1976, 1977), hunting/butchering stations (Davis et al. 1988; Hovers 1986; Goren-Inbar 1990a; Rabinovich 1990; Sharon et al. 2010; Sharon and Oron 2014), or raw material acquisition localities (Barkai and Gopher 2009; Barkai et al. 2006; Ekshtain et al. 2012; Gopher and Barkai 2011; Ronen 1974). However there are still many uncertainties in interpretation of open-air sites function (Sharon et al. 2014). For instance, three Levantine MP sites (NMO, Quneitra and Umm el Tlel VIIa0) that are interpreted as hunting/butchering localities exhibit prominent differences in the composition of lithic and faunal assemblages (Goren-Inbar 1990a; Griggo et al. 2011; Sharon and Oron 2014).

The problem of understanding the function of open-air sites and their place within land use and subsistence strategies adopted by MP hominins is further exacerbated by the shortage of published radiometric dates (e.g., Bar-Yosef 1998; Hovers 2009; Sharon et al. 2014), which are available for only a few MP open-air sites in the Levantine Mediterranean zone, all yielding ages of the later part of the MP (90–45 ka BP; Boëda et al. 2008a, b; Kalbe et al. 2014; Greenbaum et al. 2014; Schwarcz et al. 1979; Schwarcz and

Rink 1998; Ziaei et al. 1990). This is in contrast to the data from cave sites which indicate that the Levant was continuously occupied throughout the Middle Paleolithic with a possible gap between 160–120 ka BP for which we lack large and well-dated assemblages (Bar-Yosef 1998; Hovers 2009). The emerging picture of the MP open-air occupation in the Levant is thus partial and, for most of this 200,000-year-long period, is entirely missing. In particular, we know very little about the open-air adaptations of the anatomically modern humans that inhabited the Levant during the latter part of MIS 6 and MIS 5 (Mercier et al. 1993; Mercier and Valladas 2003; Stringer et al. 1989; Schwarcz et al. 1988; Valladas et al. 1988).

A recently discovered site at Neshar Ramla (170–80 ka BP) promises to fill some of these gaps in our knowledge of the MP human occupation of the Levant. It is an open-air, eight-meter-thick Middle Paleolithic sequence that is situated in a significantly different geomorphological context than the open-air sites described above. The site was found in a deep karst sinkhole that acted as a sedimentary basin in which colluvial deposition was intermittent with *in situ* human activities (Zaidner et al. 2016). Several lines of evidence point to the *in situ* human activities in this sinkhole: micromorphological study of the sediments; presence of *in situ* combustion features; excellent preservation of lithic artifacts and animal bones (often preserving anatomic articulation); and distinct concentrations (heaps) of bones, lithics, and manuports (Friesem et al. 2014; Tsatskin and Zaidner 2014; Weissbrod and Zaidner 2014; Zaidner et al. 2014). The excellent state of preservation of these finds is likely to be a consequence of the unique context of the site which, like caves, is closed and protected by surrounding walls, while at the same time not being subjected to the strong diagenesis characteristic of Levantine caves (e.g., Karkanas et al. 2000). Another probable reason for the excellent state of preservation of the site was the rapid burial of its archaeological remains (Friesem et al. 2014; Zaidner et al. 2016). The archaeological sequence of Neshar Ramla was dated by optically stimulated luminescence method (OSL) to  $170 \pm 12$ – $78 \pm 6$  ka BP, placing the Mousterian hominin occupation at Neshar Ramla to the MIS 6 and 5 (Zaidner et al. 2014).

A history of tens thousands of years of human occupation demonstrates that Neshar Ramla was an important location within the mobility system of nomadic groups that chose to return to this place time after time. Clear diachronic fluctuations in the material density, lithic and faunal characteristics, the use of fire and manuports' transport, suggest that the mode of occupation changed over time (Zaidner et al. 2014). Neshar Ramla thus offers an opportunity to investigate changes and variations in human lifestyles and the exploitation of open landscapes over a long time span, including a few tens thousands of years (ca 160–120 ka) during which

evidence for human presence in the Levant is meager. In the current paper, we will present the site, its formation processes, and discuss some of the unique features of the Neshet Ramla lithic assemblage.

## 2.2 The Neshet Ramla Site

### 2.2.1 General Description

The open-air Middle Paleolithic site of Neshet Ramla lies on the western slopes of the Judean hills bordering the Mediterranean coastal plain of Israel (Fig. 2.1). The site is located in a limestone and chalk quarry and was discovered by the Israel Antiquities Authority (IAA) in the course of preparation of the area for quarrying. During the cleaning of the chalk bedrock from the surface soils and clays, a deep depression within the chalk surface was discovered. After removal of 12 m of the clays (from ~ 120–108 masl) with heavy machinery, lithic artifacts and animal bones were discovered.

The Neshet Ramla depression has a funnel-like shape and is 34 m deep (120–86 masl) and 40–50 m wide at its top. In the upper part of the depression the slopes are relatively moderate (35–55°), but they become significantly steeper (70–90°) between 102 and 86 masl. The diameter of the depression at the level where the archaeological remains were discovered is approximately 20 m (Fig. 2.1). Neshet Ramla is one of several depressions recently discovered in the area (Fig. 2.2). These depressions have been interpreted as karst sinkholes formed by gravitational subsidence of the bedrock into underground voids (see below; Frumkin et al. 2015). Some sinkholes are relatively shallow and large in diameter (up to 200 m), while others are small (20–50 m in the diameter), with more vertical shear walls. These sinkholes are entirely filled with sediments, and were only initially revealed during preparation of the area for quarrying.

The site was excavated during 12 months of intensive salvage excavation in 2010 and 2011. In total, more than 450 m<sup>3</sup> of the sediments were excavated, representing the entire volume of the archaeological deposits at the site. The hominin occupation layers were found at an elevation of 107.5–99.5 masl, with sterile infill extending both above and below these deposits. The archaeological finds were concentrated in the center, while near the walls artifacts and bones were exceptionally rare or entirely absent.

### 2.2.2 Sediments and Stratigraphy

The eight-meter-thick archaeological sequence is composed of homogeneous brown, gravel-rich clay and can be roughly divided into Upper and Lower Sequences. The upper 5.5 m

of the deposits (the Upper Sequence) lacks clear macro- and micro-stratigraphy (Fig. 2.3). The gravels that are composed of Nari, a calcrete crust developed on chalk bedrock in the site area, comprise 30–40% of the sediment volume. The fine-grained material is apparently derived from erosion of surrounding soils and formation of pedosediments, i.e., transported soil materials (Tsatskin and Zaidner 2014). On the basis of subtle differences in the field and laboratory measurements, especially the degree of pedogenic reworking (Tsatskin and Zaidner 2014; Zaidner et al. 2014), the Upper Sequence was divided into Unit I and Unit II (Fig. 2.1). In addition, a sharp increase in the density of bones and lithics and repeated occurrences of manuports (limestone and chert pebbles and boulders) at around 104.5 masl, allowing us to subdivide Unit II into Unit IIa (105.5–104.5 masl) and Unit IIb (104.5–102.7 masl).

The lower 3 m of the deposits (the Lower Sequence) consist of similar, brown-gravelly clay; however, they are well-bedded and include two dense layers rich in artifacts, bones, manuports, and burnt materials (Units III and V; Fig. 2.1), separated by low-density bed IV. The lowermost unit VI, is another layer with low densities of artifacts and bones.

### 2.2.3 Main Archaeological Characteristics

Units IIb–V of the site are characterized by the presence of concentrations (“heaps”) composed of animal bones, limestone boulders (anvils, hammerstones, manuports) and lithics. About 60 such “heaps” were identified in Units IIb, III, and V. The heaps vary in shape, size, thickness, composition, and density, but clearly differ from the surrounding sediments in the density of finds (Fig. 2.4). The majority of the heaps are 0.5–1 m long, but there are some larger concentrations reaching lengths of 2–3 m. Manuports consist of pebbles, boulders and stone blocks of hard limestone and chert, which are absent in the vicinity of the site. More than 200 kg of stones had been transported to Unit V alone, including boulders weighing up to 16 kg.

The site shows clear diachronic changes, with pulses of intensive occupation manifested by increases in artifact density and an increase in the number of lithic-bone-limestone ‘heaps’. The lower part of the sequence includes the two most prominent phases of occupation (Units III and V). Both of these units are thin anthropogenic layers (ca 20–30 cm thick in the center of the depression) extending over an area of 50–60 m<sup>2</sup> with large numbers of lithic-bone-limestone concentrations, as well as combustion features. Two types of combustion features have been identified so far, one representing *in situ* hearths, the other ash pile/midden formed following hearth rake-out activities (Friesem et al. 2014).

Unit IIb exhibits a different intensity and organization of occupation and is characterized by the presence of small,

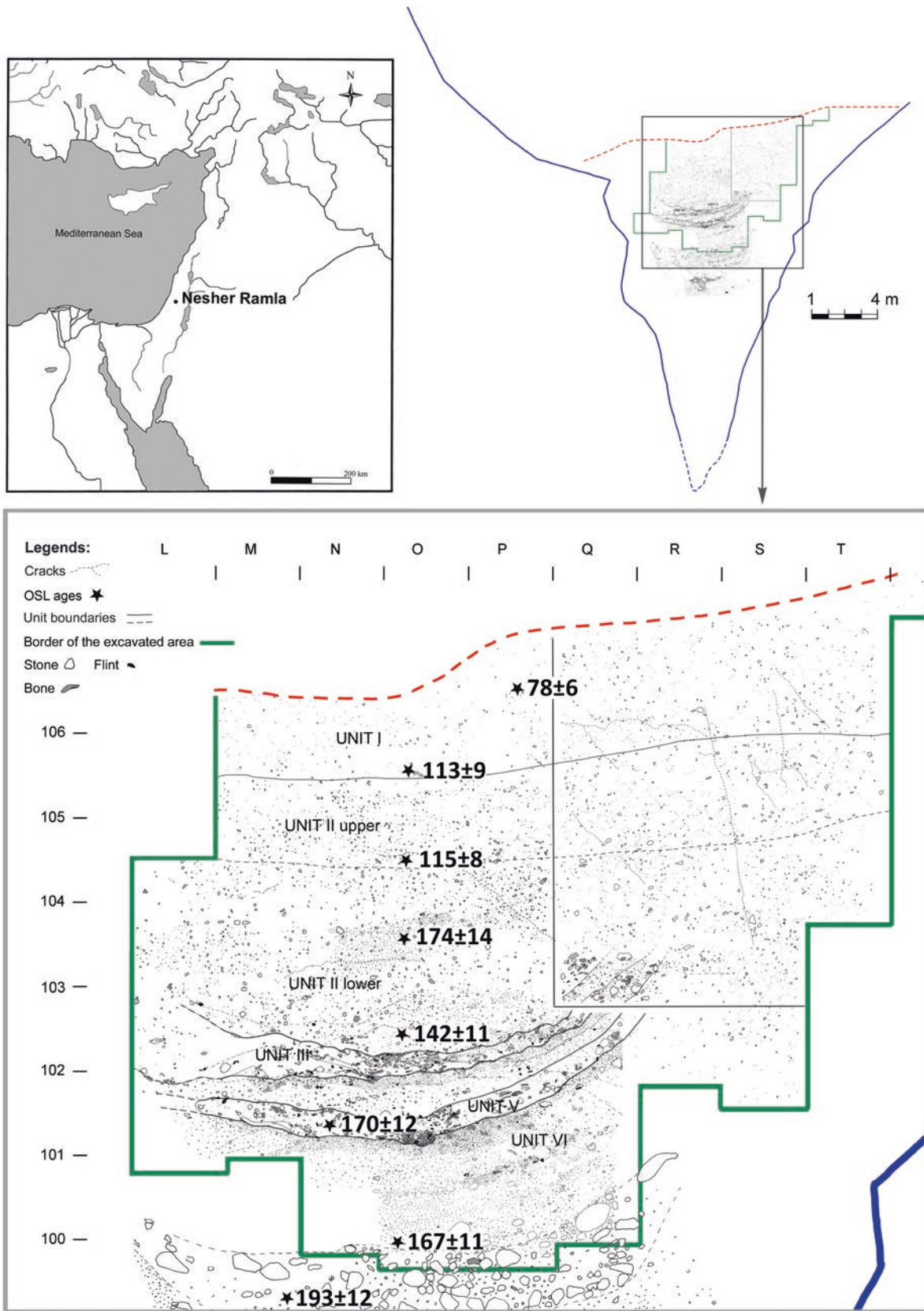


Fig. 2.1 Location of the site and composite stratigraphic section





**Fig. 2.2** Different types of surface depressions found in the site area

spatially unconnected “heaps” rather than the continuous surfaces seen in Unit III and V. The densities of the lithics suggest several occupation peaks interspersed with phases of lower occupation intensity (Zaidner et al. 2014). Units IIa and I are characterized by low densities of animal bones and lithics. No remains of combustion features or charcoal were found in Units I and IIa, although the relatively high frequency of burnt flints suggests that fire had been used.

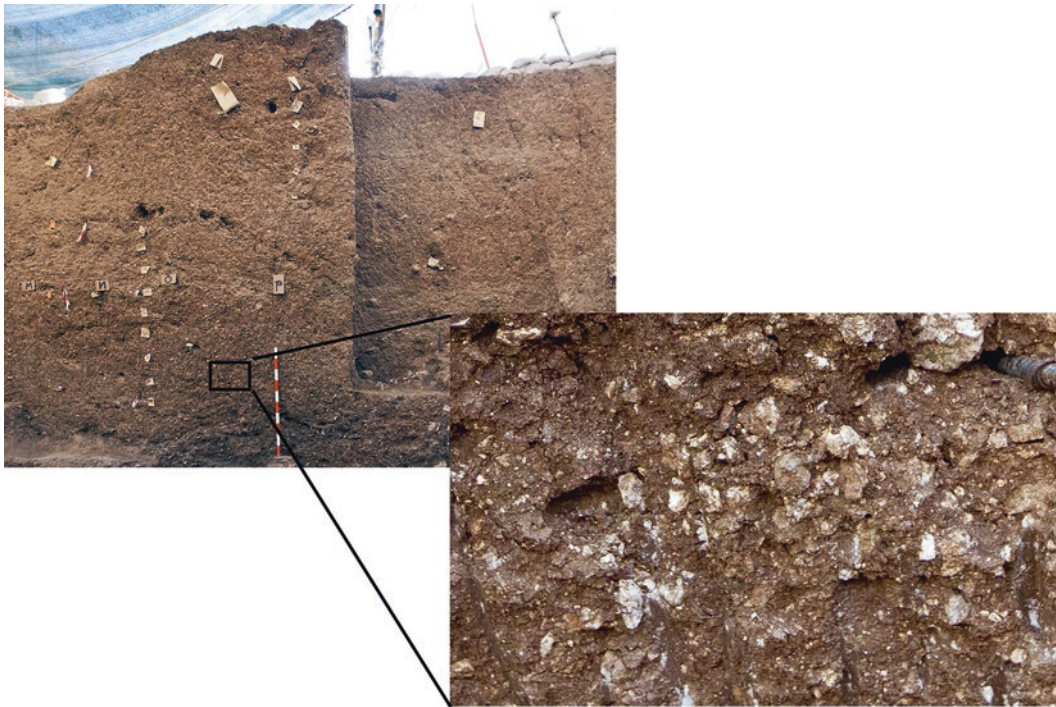
### 2.3 The Formation and Sedimentary Development of the Nesher Ramla Sinkhole

The history of the formation and sedimentary development of the sinkhole is presented in Fig. 2.5. The sinkholes are located within Late Cretaceous carbonate rocks. The surrounding bedrock is ca 40 m thick Senonian Age chalk of the ‘En Zetim Formation that is underlain by ca 100 m thick Turonian Age limestone of the B’ina Formation. The study area is located in the western basin of the Mountain Aquifer,

known as the Yarkon-Tanninim Aquifer (Frumkin and Gvirtzman 2006). The groundwater level in the aquifer fluctuated between 10 and 20 masl in course of the twentieth century. The aquifer in the study area is associated with hundreds of karstic caves extending from the low B’ina Formation to ca 60 masl in the mid-B’ina Formation (Fig. 2.5b). The morphological features of the caves are associated with dissolution under water-filled conditions by slow-moving rising hydrothermal water typical of artesian karstic system. The voids have no natural entrances and no genetic relationships to the land surface (Frumkin and Gvirtzman 2006). The sinkholes were formed due to the gravitational deformation, subsidence and collapse of the bedrock into these karstic caves (Fig. 2.5c; Frumkin et al. 2015).

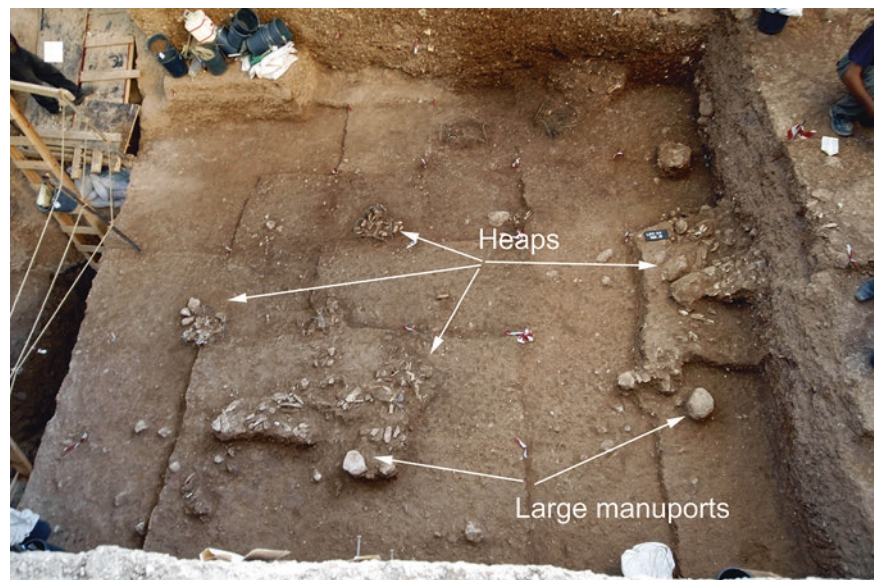
The minimum age of two sinkholes was determined by OSL dating of the sediments, placing them to the late Middle Pleistocene and Upper Pleistocene (Frumkin et al. 2015; Zaidner et al. 2014). Yet a catastrophic collapse event recorded in 1979 in the nearby village of Azarya formed a deep surface depression, indicating that similar processes still occur today (Frumkin and Gvirtzman 2006).





**Fig. 2.3** The section (southern wall, squares L–P/17, Q–T/16) and the sediments

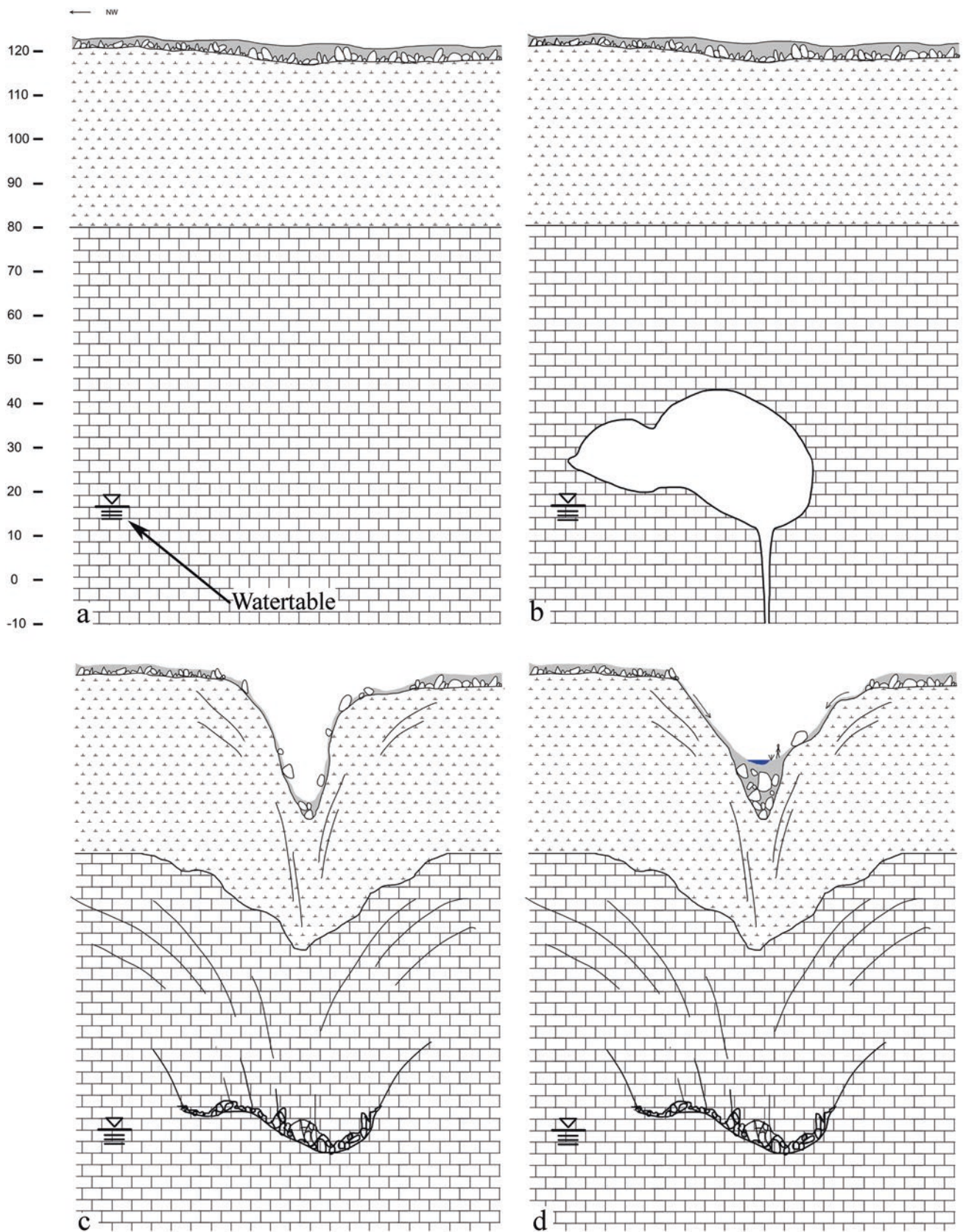
**Fig. 2.4** A surface excavated in Unit III with a number of isolated features ('heaps' of manuports, bones and lithics)



The sinkholes are closed basins that, during and after their formation, act as depositional basins, trapping sediments from the surrounding slopes (Fig. 2.5d). The initial stages of sediment accumulation in the Neshar Ramla depression could be coeval with the bedrock subsidence. The sedimentation was probably unstable and involved frequent slope failures and catastrophic collapses. In the lower part of the infill from 85 to 99.50 masl, the sediments contain numerous large blocks of chalk and Nari (up to 100 cm in size). At the

eastern wall some large blocks of Nari are found as far up as 103 masl. However, these massive slope failures are evident only in the lower part of the infill, prior to the hominin occupation of the site, while the archaeological sediments lack evidence for such catastrophic events. The lower stratigraphic units, III–V, are well-bedded and appear as continuous lens-like horizons without evidence of faults or disconformities (Fig. 2.1), suggesting that the central part of the site was not disturbed by postdepositional deformation,





**Fig. 2.5** The formation of the Neshar Ramla site. (a). The stratigraphic section of the area. (b). Dissolution and formation of the cave by slow-moving rising hydrothermal water. (c). Sagging and deformation of the bedrock and formation of surface depression. (d). During the human

occupation the sinkhole had its present-day form and served as a depositional basin. The site formation represented a continuous cycle of soil erosion, waterlogging, in situ pedogenesis and human occupation.

and that the major features of karst sinkhole were shaped prior to human occupation. Nevertheless, it is likely that during deposition, soft chalky bedrock was eroded from the edges of the sinkhole, thereby widening its upper part.

Site formation during the accumulation of the archaeological deposits was a system composed of four major processes: deposition, waterlogging, pedogenesis and human occupation (Fig. 2.5d). The depression was filled with surrounding soils eroded from hill slopes along with chalk and Nari. The pedosediments indicate that soil cover was basically similar to that of the present day, including brown Rendzina and vertisols (Tsatskin and Zaidner 2014).

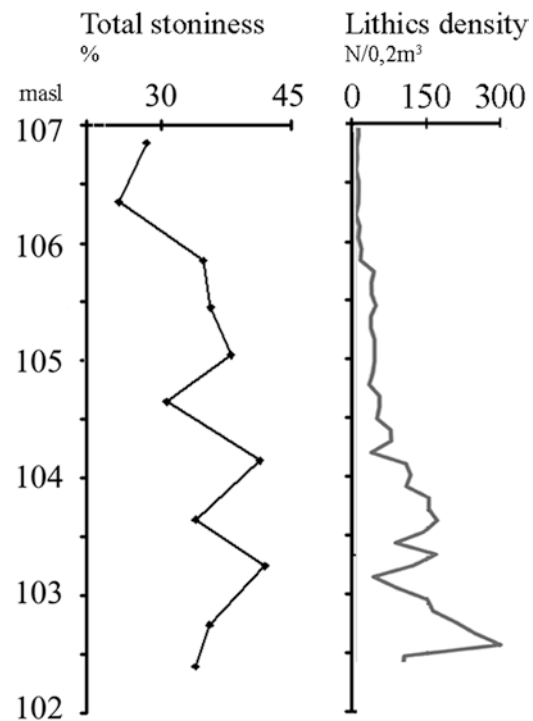
The *in situ* pedogenic processes were identified throughout the Upper Sequence (Units I–II). In the Lower Sequence (Units III–VI) traces of *in situ* pedogenesis were not found. Pedogenic processes were apparently short-lived and did not developed soil profiles with A, B, C horization. The lack of microstratigraphy in the upper 5.5 m of sequence should probably be attributed to the eradication of bedded features by post-depositional pedogenesis.

In units I and II, waterlogging is indicated by abundant tiny opaque Fe/Mn punctuations and shrink-swell processes (Tsatskin and Zaidner 2014). In particular, Unit I and Unit IIa clearly show conspicuous vertic and hydromorphic characteristics, suggesting higher seasonal waterlogging.

The evidence from the Upper Sequence indicates that accumulation of the pedosediments and Nari ceased and was followed by relatively stable episodes of low sedimentary input. This is indicated by evidence for incipient *in situ* pedogenesis, fluctuations in stoniness, skeletal fraction, magnetic susceptibility, and soil microfabric. Such indicators are expected only if the deposition and site formation were not uniform, but rather were characterized by episodes of higher and lower sediments input (Tsatskin and Zaidner 2014). This system of deposition and site formation at Neshar Ramla was consistent throughout the accumulation of the Upper Sequence, while lack of evidence for pedogenesis in the Lower Sequence may indicate some change at the boundary between Units III–II that is not yet fully comprehended.

## 2.4 Lithic Assemblages

The lithic industry of Neshar Ramla exhibits noticeable variations in the quantity of artifacts and in the presence of different technological and typological groups throughout the stratigraphy of the site (Fig. 2.6; Table 2.1). In general, the number of artifacts clearly increases with depth, from 10 to 20 artifacts per 0.1 m<sup>3</sup> in Unit I to 200–250 per 0.1 m<sup>3</sup> in Unit III (the lithic assemblages from units IV–VI are still under study). The density curve in Fig. 2.6 indicates that the increase in the quantity of artifacts is characterized by several peaks followed by drops in artifact densities. Some of these density peaks correlate



**Fig. 2.6** Total stoniness and lithic density curves. Density of artifacts shows inverse correlation with frequency of gravel. When frequency of gravel drops, density of the artifacts increases indicating changes in the rate and intensity of deposition

with reduced stoniness of the sediments. For example, between the depths of 106–105 masl in Unit IIa, gravel constitutes about 40% of the total volume of sediments, but at a depth of 104.8 masl it drops to less than 30%. The amount of Mousterian artifacts nearly doubles at this depth (Fig. 2.6). A similar inverse correlation was also recorded at depths of 103.60–80 masl and ca 102.50 masl. The decreased amount of gravel washed into the sinkhole may indicate changes in the depositional regime towards lower energy erosion and slower sediment accumulation, thereby providing better conditions for use of the sinkhole by hominins.

Hierarchical core reduction strategies in which a surface, rather than a volume of the core was exploited, dominate the lithic assemblages of Neshar Ramla. These include classical Levallois methods, a specific method for production of naturally-backed knives and methods of core-on-flake reduction, which are quite reminiscent to the Levallois reduction strategy. The industry lacks true laminar and elongated Levallois components and is dominated by short and broad Levallois flakes. The assemblages studied for this publication (27,185 artifacts representing six assemblages from stratigraphic Units III, IIb, IIa and I) show that the frequencies of Levallois products are generally low, fluctuating between 8.8 and 18% (Table 2.1). In contrast, Levallois cores dominate all the studied assemblages except that of Unit III (Fig. 2.7). Levallois cores were knapped using both recurrent



**Table 2.1** General breakdown of the studied assemblages

Blanks	III		II B 102.5–103		II B 103.4–103.9		II B/II A 104.3–104.6		II A Rino layer		I 105.8–105.95		I Vertebra layer	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<i>Débitage</i>														
Levallois products	641	8%	509	12%	774	12%	348	16%	185	11%	48	18%	55	9%
Levallois points	73	1%	12	0%	49	1%	22	1%	23	1%	8	3%	4	1%
Flakes	2900	34%	1058	26%	1818	29%	628	29%	590	36%	70	27%	240	37%
Blades	160	2%	61	1%	89	1%	31	1%	23	1%	1	0%	26	4%
Naturally backed knives	720	8%	272	7%	396	6%	126	6%	171	10%	24	9%	53	8%
CTE	687	8%	345	8%	677	11%	149	7%	45	3%	19	7%	21	3%
Kombewa flakes	124	1%	90	2%	141	2%	60	3%	21	1%	2	1%	11	2%
Pseudo-Levallois points	12	0%	13	0%	30	0%	1	0%	1	0%	0	0%	0	0%
Primary elements	1300	15%	833	20%	1307	21%	462	22%	316	19%	41	16%	104	16%
Lateral spalls	237	3%	85	2%	67	1%	1	0%	3	0%				
<i>Cores</i>														
Levallois cores	146	2%	85	2%	62	1%	31	1%	22	1%	2	1%	7	1%
Cores	139	2%	35	1%	50	1%	12	1%	12	1%	0	0%	6	1%
Preferential surface cores	42	0%	16	0%	13	0%	8	0%	4	0%	1	0%	4	1%
Cores on flakes	87	1%	27	1%	45	1%	18	1%	16	1%	1	0%	4	1%
Nahr Ibrahim	77	1%	20	0%	13	0%	2	0%	1	0%	0	0%	0	0%
		0%						0%		0%		0%		0%
Retouched pieces	815	10%	549	13%	632	10%	212	10%	120	7%	35	13%	47	7%
Chunk	314	4%	112	3%	167	3%	26	1%	87	5%	12	5%	60	9%
Total studied sample	<b>8474</b>	<b>100%</b>	<b>4122</b>	<b>100%</b>	<b>6330</b>	<b>100%</b>	<b>2137</b>	<b>100%</b>	<b>1640</b>	<b>100%</b>	<b>264</b>	<b>100%</b>	<b>642</b>	<b>100%</b>

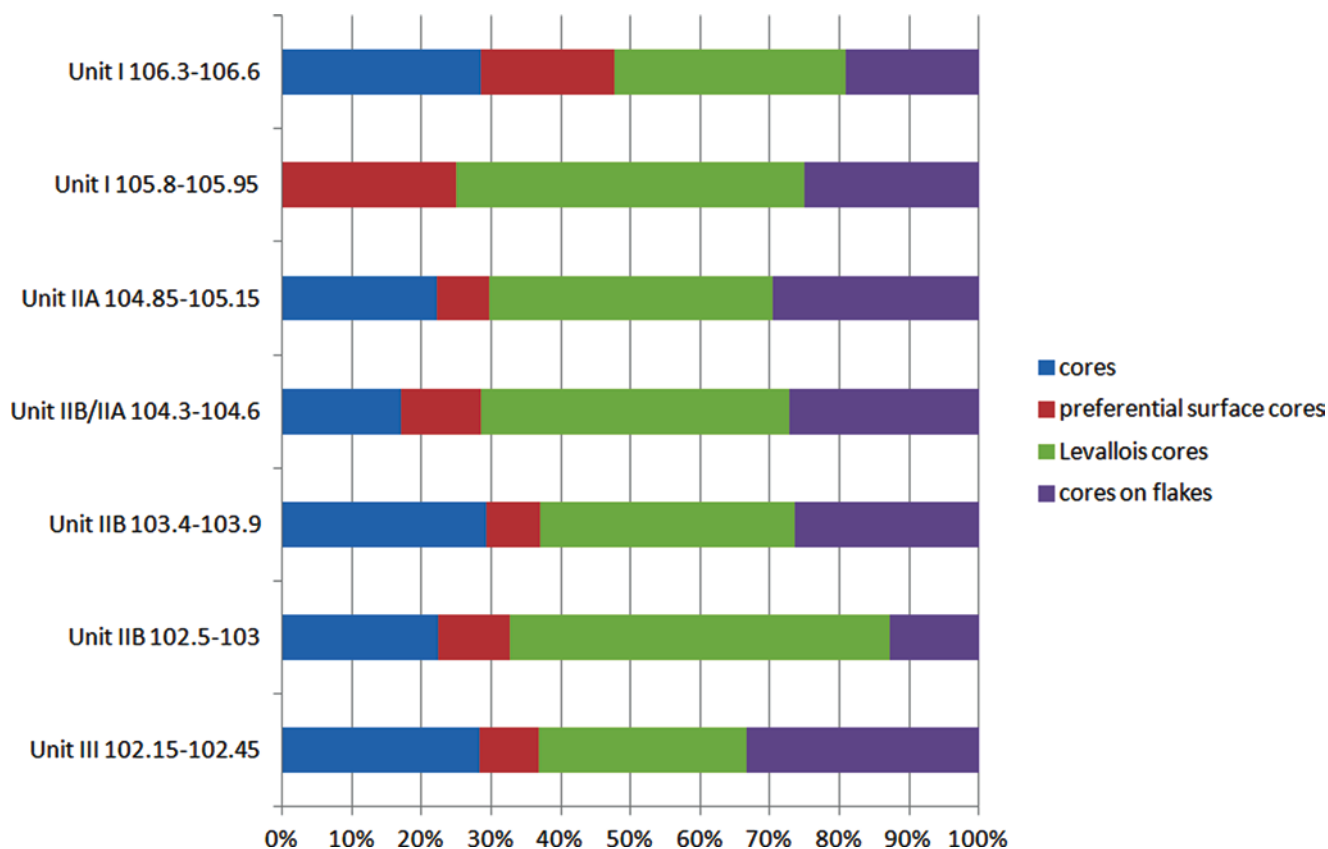
and preferential methods. The cores are small and exhibit a low degree of standardization and poor preparation (Figs. 2.8: 2; 2.9: 2; 2.11:1, 4). The tools were made using the largest and most regular Levallois blanks (Figs. 2.9: 4, 5; 2.10: 4, 5; 2.12: 3, 5–7, 9; 2.13: 6, 7). Scar patterns on the dorsal faces of Levallois flakes and points indicate that both unipolar convergent and centripetal methods were used (Figs. 2.9: 8, 9; 2.10: 2, 3, 6; 2.12: 1, 2, 8; 2.13: 2, 5). The majority of core trimming elements (CTEs) fall into a category of Levallois preparation flakes, including *débordant* flakes and some platform and debitage surface rejuvenation flakes.

Hierarchical core reduction strategy was also employed for production of naturally-backed knives (NBK). NBKs make up between 6 and 12% of the lithic assemblages (Table 2.1; Fig. 2.14; Fig. 2.9: 3; 2.10: 1; 2.13: 1). At Neshet Ramla, NBK's occur throughout the archaeological sequence, always in substantial numbers regardless the size of the assemblage. NBK's often exhibit signs of edge damage that could be a result of use. In addition, use of NBK's as blanks for production of side-scrapers is also quite common. The NBK's were struck from specific type of cores (hence-

forth preferential-surface cores; Figs. 2.8: 1, 3, 4; 2.11: 2). Preferential-surface cores were identified in all studied assemblages (Fig. 2.7).

The preferential-surface cores exhibit Levallois-like volumetric conception with two hierarchical surfaces, one used for flaking and other as a striking platform. The fracture plane of the flakes detached from the debitage surface is parallel to the plane of intersection between debitage and striking surfaces. However, the evidence for predetermination and preparation of the debitage surface is dubious, and this seems to be the major deviation of the preferential-surface cores from the Levallois concept. The detached flakes usually removed the lateral, cortical edges of the core. Only rarely were flakes removed from the center of the debitage surface. The cores do not exhibit signs of the preparation of convexities. The striking surface exhibits only minimal and discontinuous preparation on the limited area from which the flakes were removed.

No other organized reduction methods were systematically used at Neshet Ramla. The category of cores (Table 2.1; Fig. 2.7) is composed of indeterminate core



**Fig. 2.7** Frequencies of the core types in studied assemblages

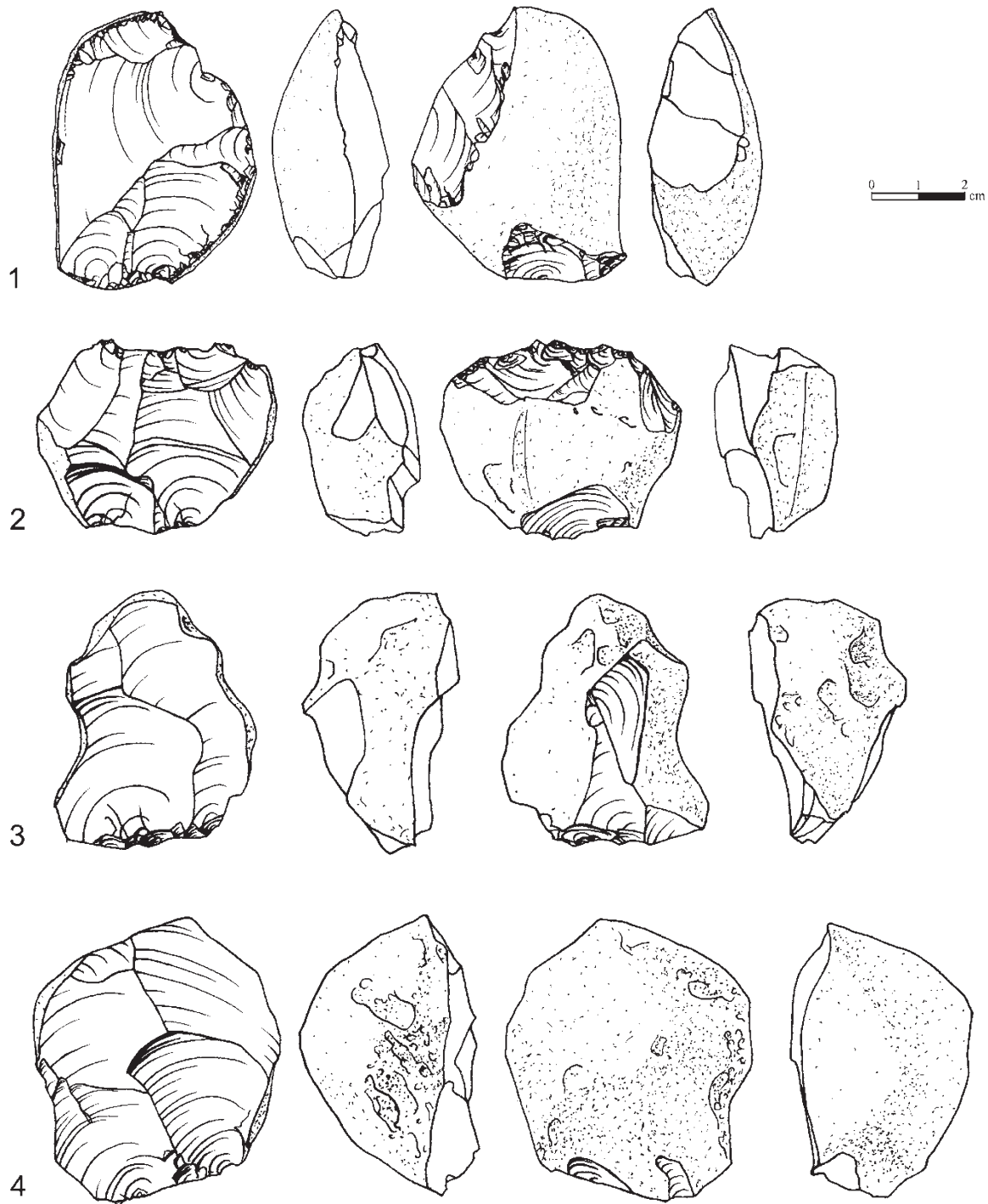
fragments, single platform cores, globular cores, cores with a few removals, and a very few discoidal cores. Cores-on-flake are the second largest group within the core assemblages, except for Unit III where they are the dominant category (Table 2.1; Fig. 2.7). Cores-on-flake exhibit Levallois-like hierarchical surfaces morphology, with convex ventral faces of the flakes used as debitage surfaces and striking platforms shaped on the dorsal faces (Fig. 2.9: 1; 2.11: 3).

Apart from NBKs production, the other distinctive feature of the Neshet Ramla lithic industry is highly specialized toolkit dominated by carefully and intensively retouched side-scrapers and side-scrapers shaped by removal of lateral longitudinal spall from retouched edge (long sharpening flakes, or “*coup de tranchet lateral*”; Zaidner et al. 2014; Zaidner and Grosman 2015). The side-scrapers were made on the largest, most regular and carefully prepared blanks, and were retouched by an intensive, regular and invasive retouch, mostly along the entire length of the edge (Figs. 2.9: 6, 7; 2.10: 4, 5, 7; 2.12: 3, 4, 7, 9; 2.13: 3, 4, 6). There seems to be a chronological trend in the proportion of side-scrapers among the artifacts, from almost 80% in Unit III to 30–50% in the

upper assemblages (Fig. 2.15). In the upper units, the importance of the expediently retouched flakes and types 42–46 of Bordes’ typology rises considerably. Among other tool types, the most interesting category is that of the retouched points which are almost entirely absent from Unit III, but are relatively abundant in other assemblages.

The removal of a lateral longitudinal spall from the retouched edge of the scraper at Neshet Ramla (Fig. 2.13: 8, 9) is technically similar to “long sharpening flakes removal” (LSF; Cornford 1986), “*coup de tranchet lateral*” (Bourguignon 1992), or Prądnick technique common in Keilmesser group of the central Europe (Jöris 2006). The process started with the preparation of a small truncation on the ventral surface. The truncation served as striking platform for the spall removal. An initial analysis of the spalls and parent scrapers demonstrates that the angle of the edge formed by spall removal is significantly sharper than that of the original (Zaidner and Grosman 2015). This was achieved by directing and angling the blow so that it removed a higher volume of material from the dorsal surface compared to that removed from the ventral surface of the parent tool.

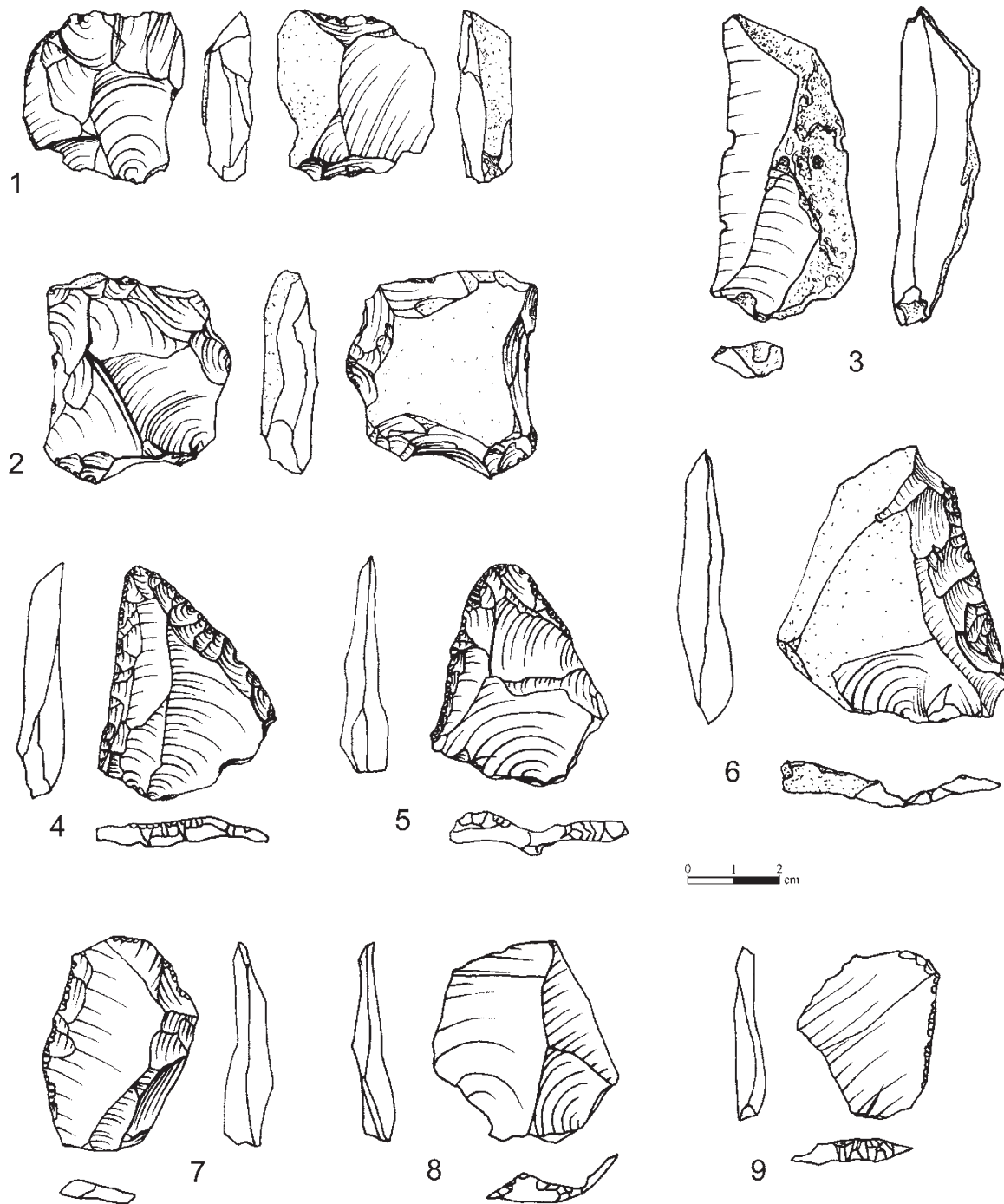




**Fig. 2.8** ‘Preferential-surface cores’ – 1, 3, 4; Levallois core – 2

Both tools with the scar of the spall removal and spalls are abundant throughout the Neshar Ramla sequence, providing a rare opportunity to reconstruct the life history of these specific tools. The spalls often removed relatively sharp, regular and lightly retouched edges. The scar of the spall removal usually extends over a part of the retouched edge, forming an edge that is partially retouched and par-

tially not. A majority of the parent tools (73%; Zaidner and Grosman 2015) were not retouched after a spall was removed. Therefore, it is likely that the main goal in removing a spall was formation of an edge that is partially retouched and partially raw. The spall removal, thus, was probably employed as technique for the edge finishing and manufacture of a specific tool-type.



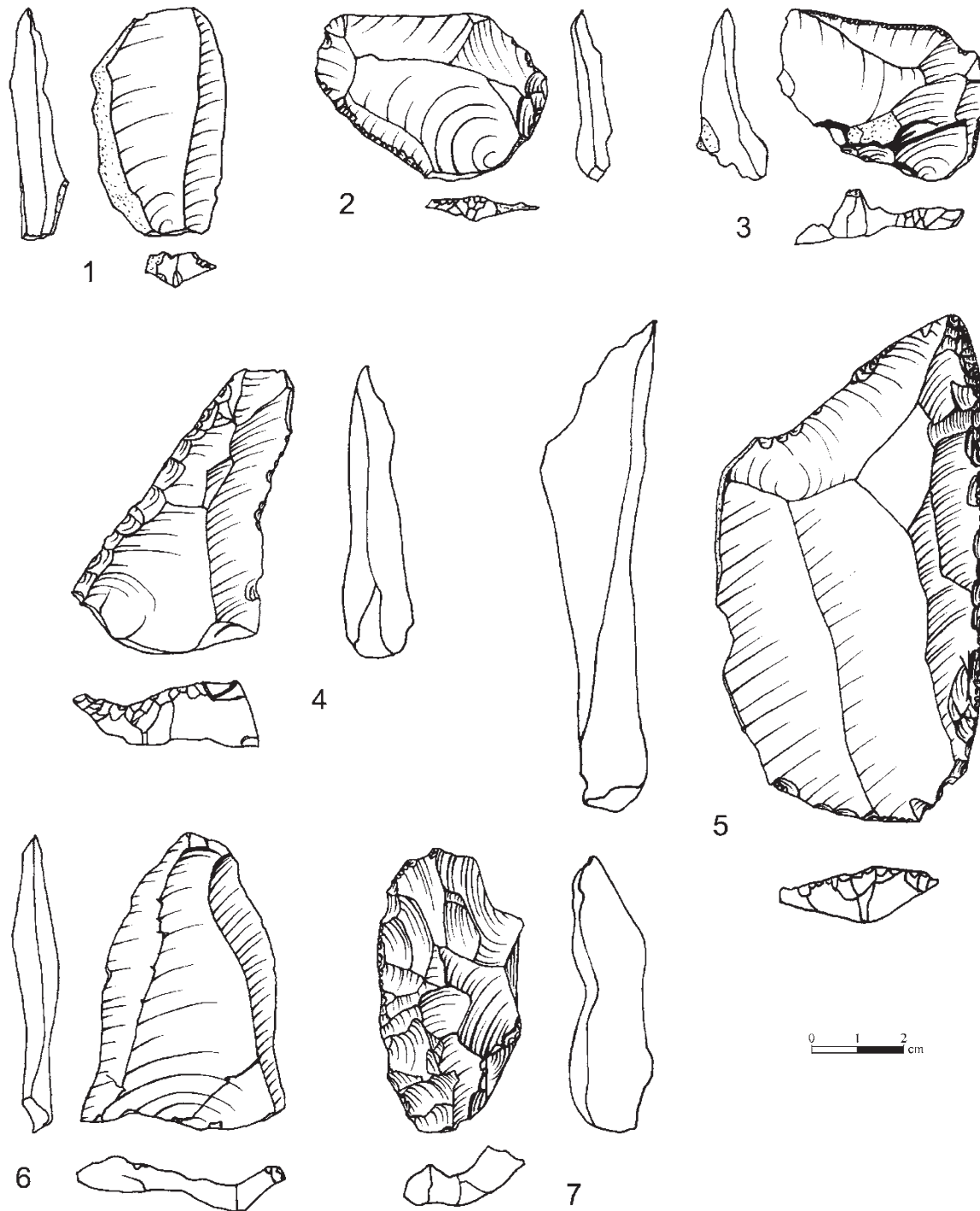
**Fig. 2.9** Core-on-flake – 1; Levallois core – 2; Naturally backed knife – 3; Retouched points – 4, 5; Side-scrapers – 6, 7; Levallois flake – 8; Raclette – 9

## 2.5 Discussion

The 200,000 year-long sequence of the Levantine MP is generally characterized by the dominance of the Levallois technology, relatively frequent occurrences of core-on-flakes, and a scarcity of heavily-retouched scrapers (Bar-Yosef 1998, 2000; Hovers 2009; Shea 2003). The presence of

Levallois products is often high in cave sites (20–60% of the assemblage) but low in open-air sites (5–20%). The lithic assemblages of open-air sites also notable for their high typological diversity and more expedient tool production in comparison to the caves (Gilead 1995; Gilead and Grigson 1984; Goren-Inbar 1990b; Hovers et al. 2008; Hovers 2009; Munday 1977; Ronen 1974). It has been suggested that these



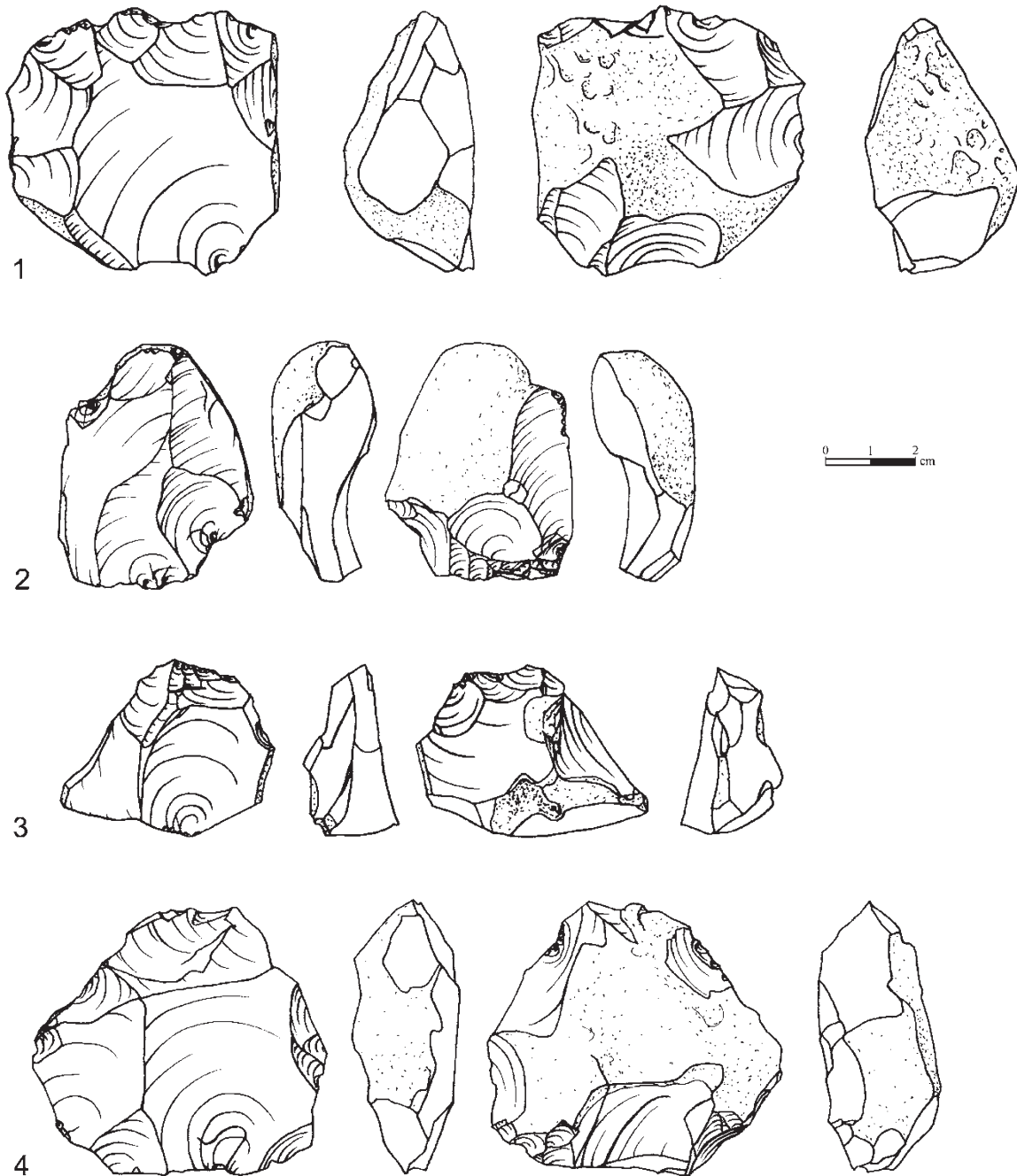


**Fig. 2.10** Naturally backed knife – 1; Raclette – 2, 3; Side-scrapers – 4, 5, 7; Levallois point – 6

differences are the result of specific site functions, more intensive lithic reduction, and the higher expediency of the lithic technology in open-air sites (Gilead 1995; Hover 1990, 2009; Jelinek 1982; Meignen et al. 2006; Ronen 1974; Sharon et al. 2010).

Neshet Ramla shares some general characteristics with other Levantine sites, especially the use of the Levallois

method for production of flakes, use of core-on-flakes and production of the Levallois points. However, it should be noted that these characteristics are universal and occur in many MSA and MP contexts throughout Africa, Europe and Asia (e.g. Douze and Delagnes 2016; Groucutt et al. 2015; Moncel et al. 2009; Petraglia et al. 2010). Along with these classic MP features, a number of distinctive traits were



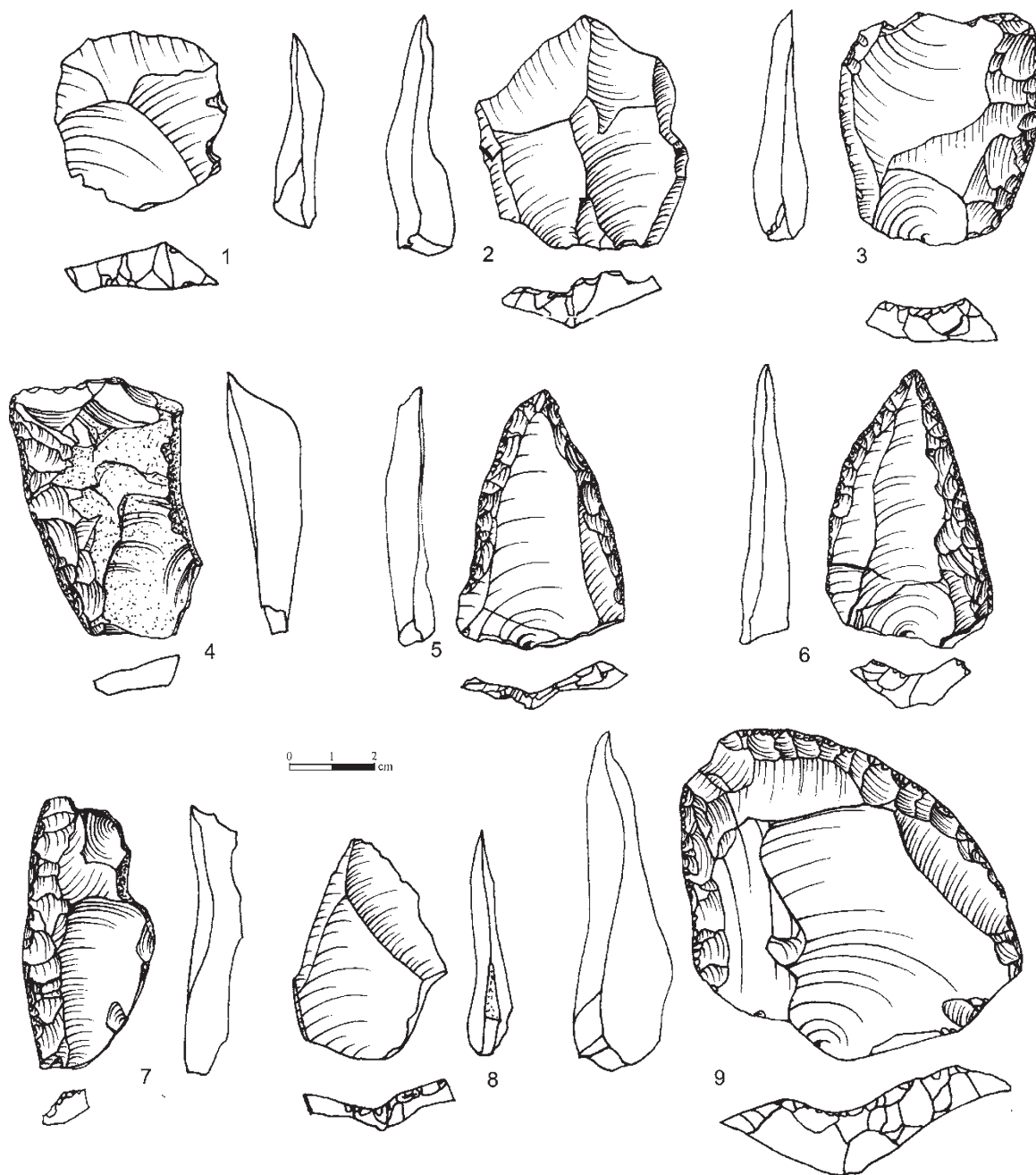
**Fig. 2.11** Levallois cores – 1, 4; ‘Preferential-surface core’ – 2; Core-on-flake – 3

recorded. One of these is the specific reduction sequence for NBKs production. None of the Levantine sites yielded NBKs in high numbers like those at Neshar Ramla, and a specific reduction sequence for NBK production has never been identified. In general, NBK’s in the Levantine MP sites rarely exceed 2–3% of the total assemblage (Table 2.2) and they are usually interpreted as CTEs removed for shaping the core and maintaining lateral (and sometimes distal) convexities (Henry 2003; Hovers 2009; Meignen 1995; Pagli 2013). The only case in which NBKs are considered as end-

products is the site of Nahal Mahanayeem Outlet (Sharon and Oron 2014).

The retouched toolkits of the Levantine MP are usually quite heterogeneous and include a variety of tool types, with side-scrapers often contributing a substantial portion, but rarely exceeding 30–35% of the assemblage. The assemblages from the lower part of the stratigraphic sequence at Neshar Ramla exhibit an unprecedented predominance of side-scrapers and scrapers with lateral spall removal (Fig. 2.15). Intensive and invasive retouch is also an uncom-



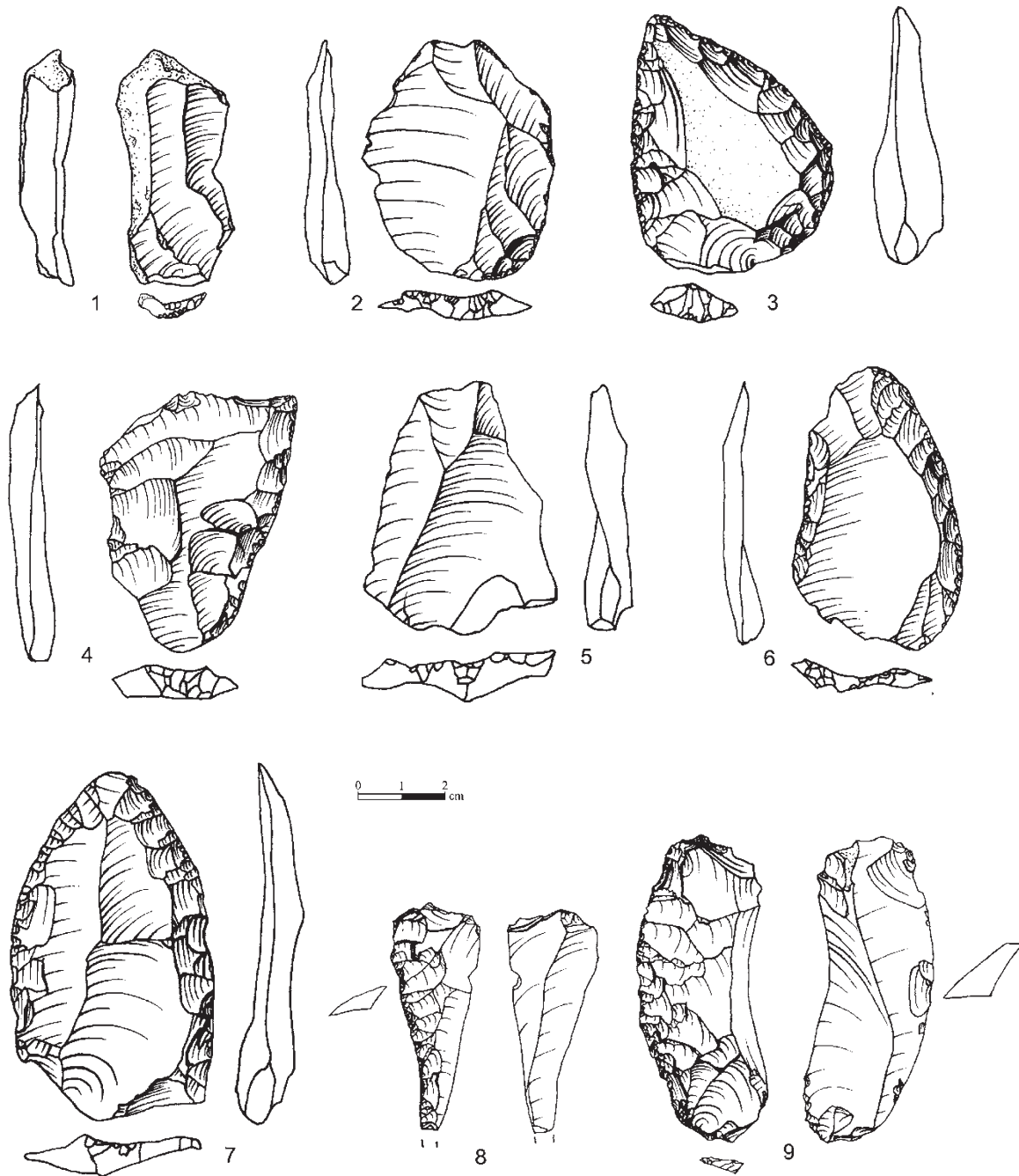


**Fig. 2.12** Levallois flakes – 1, 2; Side-scrapers – 3, 4, 7, 9; Retouched Levallois point – 5; Mousterian point – 6; Levallois point – 8

mon feature at MP sites, as the majority of the Levantine side-scrapers were only lightly retouched (Hovers 2009). The upper assemblages of Nesher Ramla display slightly different picture, with lower occurrences of side-scrapers in conjunction with the presence of lightly-retouched flakes, notches, and denticulates, making them more similar to other Levantine sites. The most interesting assemblage in the Upper Sequence derives from Unit I (105.95–105.8 masl). This is the only assemblage to have been studied thus far which is dominated by retouched Levallois and Mousterian

points. The varying prevalence of different technological and typological types identified along the Nesher Ramla stratigraphy probably indicates changes in the site's mode of occupation. This impression is reinforced by the varying investment in the transport of large and heavy manuports, and the varying densities and taphonomic characteristics of faunal remains along the site's stratigraphy (Friesem et al. 2014; Zaidner 2014; Zaidner et al. 2014).

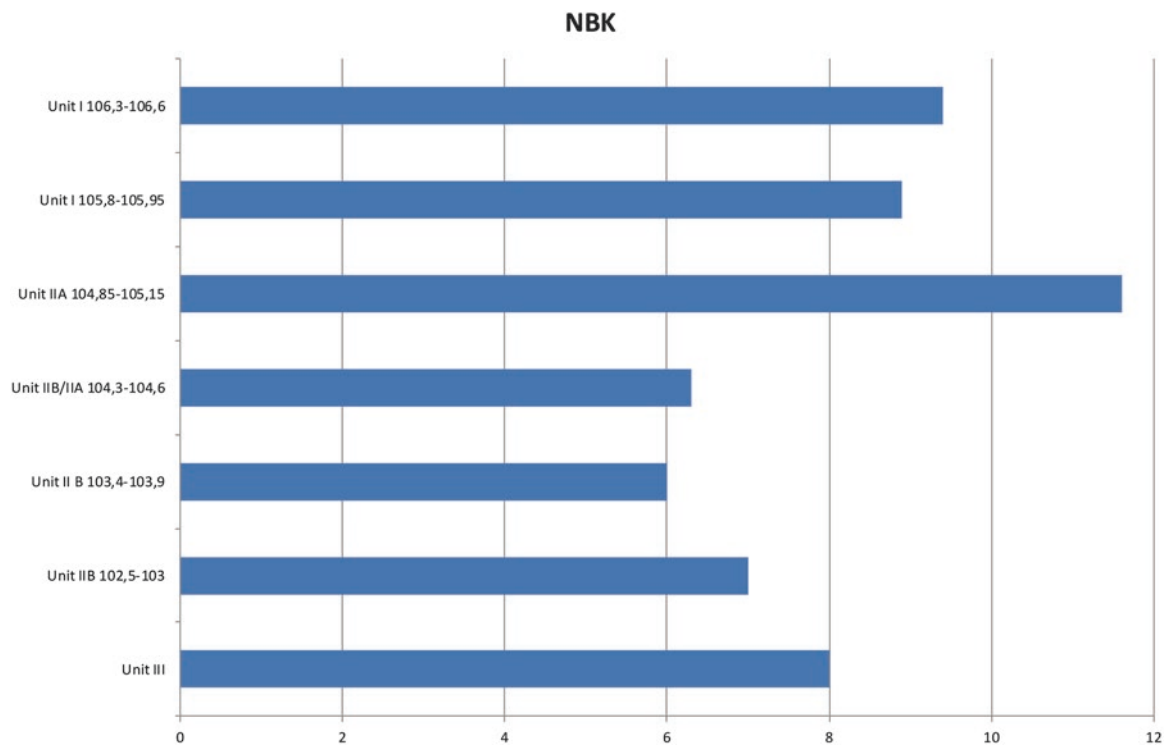
The systematic lateral spall removal from scraper-like retouched edges further distances Nesher Ramla assem-



**Fig. 2.13** Naturally backed knife – 1; Levallois flakes – 2, 5; Side scrapers - 3, 4, 6, 7; Long sharpening flakes – 8, 9

blages from the general technological trends in the Levant. The removal of lateral spalls is a rare phenomenon, having been reported from the late Lower and Middle Paleolithic in Europe and from Middle Stone Age in Africa (e.g. Bourguignon 1992; Cornford 1986; Douze 2014; Jöris 2006; Roebroeks et al. 1997), but not from Middle Paleolithic assemblages in the Near East. Although sparsely interspersed across broad chronological and geographical ranges, the lateral spall removal technique represents a singular, well-structured technical process. In Central and Eastern Europe,

this technical process became a cultural marker that defines the Prądnick and the Keilmesser group of sites (Jöris 2006). The spalls were removed from the variety of retouched tools including side-scrapers, points, bifacial tools and backed knives. The aim of the removal ranges from primary finishing and shaping of the edge to tool maintenance, re-sharpening and recycling. The site of La Cotte de Saint Brelade, British Isles, is one of the few localities in which lateral spall removal was systematically employed. Cornford (1986) has suggested that spalls were removed in order to



**Fig. 2.14** Frequencies of naturally backed knives (NBK) in the studied assemblages

produce raw sharp edges. Her view was based on the assumptions that butchering was one of the main activities at La Cotte de Saint Brelade and that raw edges are most appropriate for butchering and meat cutting. Cornford also suggested that the increased occurrence of spalls in some layers of La Cotte de Saint Brelade correlates with diminishing supply of flint at the site. In other words, the growing shortage of fresh blanks with suitably long edges resulted in the need to reuse existing retouched tools for making these edges. This, however, is an unlikely explanation for Neshar Ramla, given that sources of raw material were readily available in the close vicinity of the site. Alternatively, the goal of the spall removal in Neshar Ramla is more likely to be a manufacture of a specific tool type, making it more similar to the Central European MP Keilmesser group, where the spall removal was embedded within the original sequence of the tool manufacture and aimed at finishing the working edge (Jöris 2006).

A technique similar to that used at Neshar Ramla for the lateral edge spall removal was occasionally employed in other Middle Paleolithic sites for the preparation of truncated-faceted pieces (Schroeder 1969, 2007; or Nahr Ibrahim technique, Solecki and Solecki 1970). In rare cases, the removal of a lateral spall at Neshar Ramla is also associated with additional ‘truncated-faceted’-like removals on the dorsal surface (Prevost and Zaidner 2016). In case of Neshar Ramla the ‘truncated-faceted’-like removals assisted in preparation of the edge, either by serving as a “guide” for following

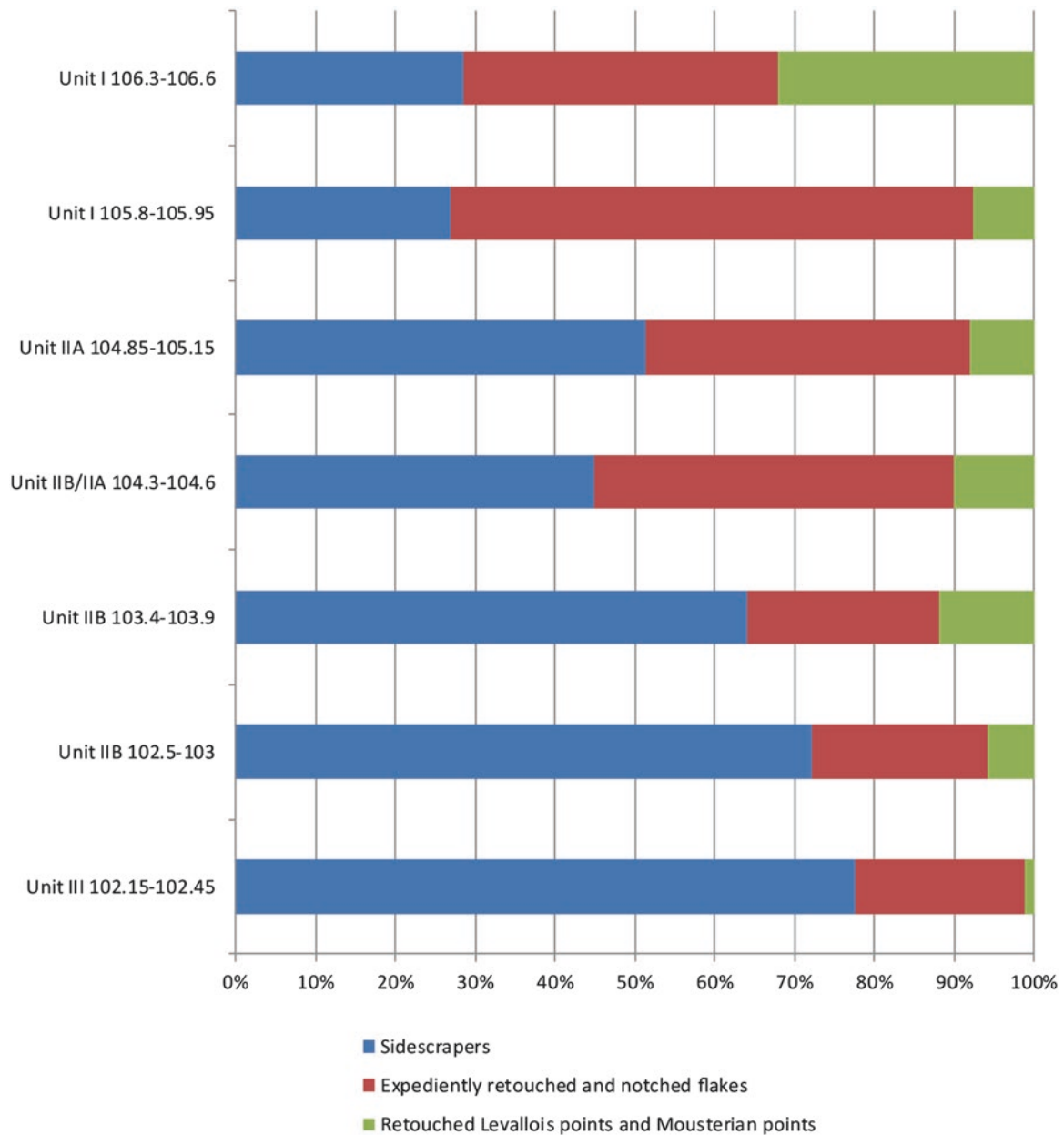
removal of the lateral spall, or by flattening the convex dorsal surface and improving the edge angle after the spall removal.

Other artifact types shaped by a similar technique are sinew frayers from Upper Paleolithic assemblages of Gamble’s cave in Kenya (Leakey 1931), and European Kostienki knives that occur in a number of Middle and Upper Paleolithic European sites (e.g. Delagnes 1992; Efimienko 1958; Escutenaire 1997; Otte 1980; Turq and Marcillaud 1976). Along with dorsal scars similar to the Nahr Ibrahim technique, Kostienki knives sometimes exhibit the scar of a lateral spall removal (*coup de tranchet lateral*; Bourguignon 1992). The most common interpretation for the dorsal removals on Kostienki knives is thinning of the blank as part of the tool preparation (Delagnes 1992; Turq and Marcillaud 1976). At Neshar Ramla the phenomenon of lateral spall removal is almost exclusively associated with removing the scraper-like retouched edge, which is not the case for Kostienki knives or truncated-faceted pieces.

## 2.6 Conclusions

The Neshar Ramla MP open-air site is located in a karst sink-hole that was largely formed prior to its MP hominin occupation and acted as closed depositional basin. The site formation during the accumulation of the archaeological deposits consisted of four major processes: deposition of eroded soils,





**Fig. 2.15** Frequencies of the main retouched tool categories in the studied assemblages

waterlogging, pedogenesis and human occupation. It is likely that these processes often acted quasi-simultaneously, but the evidence suggests that some of them were more dominant than others during different stages of the site formation. The periods of intensive human use of the site were likely to be associated with stable episodes of low sedimentary input, which provided better conditions for exploitation of the sinkhole by hominins. The intensity and mode of the occupation fluctuated throughout the use of the site as attested by sharp changes in the densities of lithics, bones, anvils, hammerstones and manuports; changes in composition of the lithic assemblages and varying degree of fragmentation of the animal bones.

The lithic assemblage of Nesher Ramla is the largest and best-preserved excavated so far in the Near East dating to the latter half of MIS 6 (160–130 ka BP). The layers dated to MIS 6 contain evidence for intensive human use (combustion features, large faunal and lithic assemblages, lithic-bone-limestone concentrations, large occupation surfaces) comparable with much later Middle Paleolithic cave sites (e.g., Kebara Cave, Amud Cave, the upper levels of Qafzeh Cave), or with some rare occurrences in the Early Middle Paleolithic (250–160 ka BP; e.g., Misliya Cave; Weinstein-Evron and Zaidner 2017; Zaidner and Weinstein-Evron 2014). Nesher Ramla, thus, filling the gap between Early Middle Paleolithic and later sites

**Table 2.2** NBK and side-scrapers in different MP sites in the Levant

Type of site	Site	Layer	Total assemblage	NBK %	Total retouched tools (restricted)	Sidescrapers (%)	References
	Neshet Ramla	I 106.6–106.3	642	8	47	17	
		I 105.95–105.8	264	9	35	20	
Open-air -		IIa 105.15–104.85	1640	10	120	31.7	
Karst sinkhole		IIb/a 104.6–104.3	2137	6	212	31.6	
		IIb 103.9–103.4	6330	6	632	55.4	
		IIb 103–102.5	4122	7	549	64.5	
		III 102.45–102.15	8474	8	618	68	
	Amud Cave	B2	1253	1.7	58	20.7	Akazawa and Ohnuma (1998)
		B4	418	1.9	11	0	
	Qafzeh Cave	III	198	6.6	8	25	Hovers (2009)
		IV	218	2.8	13	23	
		V	657	1.5	14	21.4	
		VI	433	1.6	30	43.3	
		VII	354	1.9	31	19.3	
		VIIa	599	5	48	22.9	
		VIIb	313	1.9	35	11.4	
		VIII	101	1	11	27.3	
		IX	1123	2.3	94	30.8	
		X	606	1.6	60	28.3	
		XI	846	3	77	37.7	
		XII	498	1.8	86	24.4	
		XIII	2243	2.5	231	36.8	
	XIV	495	1.4	84	3.6		
Caves and rock-shelters		XV	6109	3.7	342	13.1	
		Xva	1602	2.7	66	18.2	
Mediterranean zone		XVb	311	5.1	10	10	
		XVf	1572	3.2	31	6.5	
		XVII	867	1.3	109	18.3	
		XIX	515	1	55	16.4	
		XXI	309	1.3	38	7.9	
		XXII	182	1.6	20	10	
	Emanuel cave	II–VII	503	0.6	20	40	Goder-Goldberger et al. (2012)
		VIII–X	323	0.6	27	37	
	Yabrud I	6	632	7.4	159		Pagli (2013)
		5	998	6.6	131		
	4	1102	7.7	295			
	3	692	9.7	137			
	2	547		118			
Ksar' Akil	XXVIII	605	8.8	70		Pagli (2013)	
	XXVIII A	717	6.1	125			
	XXVIII B	785	5.2	165			
	XXVII A	359	1.4	58			

(continued)

**Table 2.2** (continued)

Type of site	Site	Layer	Total assemblage	NBK %	Total retouched tools (restricted)	Sidescrapers (%)	References
		XXVIB	439	4.6	88		
		XXVIA	275	1.8	120		
Rock-shelter	Ain Difla		1562	1.3	55	0	Lindly and Clark (1987)
arid and semi-arid zone	Tor Faraj	floor 1	1223		123	3.2	Henry (2003)
		floor 2	1903		225	4	
	Quneitra	AREA A	2330	0.2	964	23.4	Goren Inbar (1990b)
Open-air sites		AREA B	5868	0.4	2269	32.1	
Mediterranean zone	NMO		694	4.7	172	9.3	Sharon and Oron (2014)
	EinQashish		2265	0.3	189	20.6	Malinsky-Buller et al. (2014)
	NahalAqev	1	840	2.1	34	20.6	Munday (1977)
		2	448	1.6	15	13.3	
		3a	1107	0.2	43	11.6	
		3b	913	1.2	28	17.9	
		3c	946	0.5	33	15.1	
Open-air sites		3d	1286	0.5	64	9.4	
arid and semi-arid zone		3e	1510	1	96	21.8	
		3f	742	0.5	37	8.1	
		3g	875	1.2	41	2.4	
	Rosh EinMor		44,460	0.7	2667	8.2	Crew (1976)
	Hummal	5AII	138	2.9	13	30.8	Hauck (2010)
		5AIV	384	2	19	36.8	
		5a1	684	0.1	9	33.3	
		5a2	584	0.3	27	48.1	
		5a3	518	1	27	37	
		5a4	269	1.1	14	50	
		5b1	107	0	10	60	
		5b2	149	0.7	10	30	
		5b3	679	0.6	43	18.6	
		5b5	345	0.6	7	14.3	
		5b7	107	0	4	25	
		5E	211	0.5	14	42.9	
	Umm El Tlel	V2 π b	1348	6.5	117		Pagli (2013)
		V2 π a	175	13.7	10		
		V2 Δ a patinated	746	3.6	37		
		V2 Δ a non patinated	361	3.3	40		

Only assemblages with more than 100 artifacts are included in the list

dated to late MIS 5 and 4. This is important for understanding cultural and technological development during the Middle Paleolithic, especially in light of the disappearance of Early Middle Paleolithic laminar technologies during MIS 6.

The systematic production of NBKs, a specialized tool-kit dominated by invasively and carefully retouched side-

scrapers and modification of scraper-like edge by lateral spall removal are unique characteristics of the Neshet Ramla industry, setting it apart from other Middle Paleolithic industries in the Near East. On the background of constant changes in the intensity and modes of occupation, the recurrent and systematic occurrence of distinctive technological and typo-



logical features throughout the site's stratigraphy is striking. We hypothesize that rather than a reflection of the function of the site in the land-use and mobility patterns, these features have a cultural origin and may indicate that Neshet Ramla hominins possessed discrete technological tradition that emerged in the region during late MIS 6 – early MIS 5.

**Acknowledgments** We would like to thank the organizers for inviting us to submit this paper. This research was supported by Israel Science Foundation (grant number 1773/15). The archaeological excavations at Neshet Ramla were supported by Neshet Israel Cement Enterprises Ltd.

## References

- Akazawa T, Ohnuma K (1988) Reexamination of the lithic artifacts from Layer B (Square 8–19) of the Amud Cave, Israel. *Paléorient* 14:137–144. <https://doi.org/10.3406/paleo.1988.4463>
- Barkai R, Gopher A (2009) Changing the face of the earth: human behavior at Sede Ilan, an extensive Lower–Middle Paleolithic quarry Site in Israel. In: Adams B, Blades BS (eds) *Lithic materials and Palaeolithic societies*. Wiley-Blackwell, Oxford, pp 174–185. <https://doi.org/10.1002/9781444311976.ch12>
- Barkai R, Gopher A, LaPorta PC (2006) Middle Pleistocene landscape of extraction: quarry and workshop complexes in northern Israel. In: Goren-Inbar N, Sharon G (eds) *Axe age Acheulian tool-making from quarry to discard*. Equinox, London, pp 7–44
- Bar-Yosef O (1998) The chronology of the Middle Paleolithic of the Levant. In: Akazawa T, Aoki K, Bar-Yosef O (eds) *Neanderthals and modern humans in western Asia*. Plenum, New York, pp 39–56
- Bar-Yosef O (2000) The Middle and early Upper Paleolithic in Southwest Asia and neighboring regions. In: Bar-Yosef O, Pilbeam D (eds) *The geography of Neanderthals and modern humans in Europe and the Greater Mediterranean*. Harvard University, Cambridge, MA, pp 107–156
- Bar-Yosef O, Meignen L (2007) Kebara Cave, Mt. Carmel, Israel: The Middle and Upper Palaeolithic archaeology, part 1.: peabody museum of archaeology and ethnology. Harvard University, Cambridge, MA
- Boëda E, Noël-Soriano S, Griggo C (2001) Différents modes d'occupation du site d'Umm el Tlel au cours du Paléolithique moyen (El Kowm, Syrie centrale). *Paléorient* 27(2):13–28
- Boëda E, Bonilauri S, Connan J, Jarvie D, Mercier N, Tobey M, Valladas H, Sakhel H (2008a) New evidence for significant use of bitumen in Middle Palaeolithic technical systems at Umm el Tlel (Syria) around 70,000 BP. *Paléorient* 34(2):67–83
- Boëda E, Bonilauri S, Connan J, Jarvie D, Mercier N, Tobey M, Valladas H, Sakhel H, Muhesen S (2008b) Middle Palaeolithic bitumen use at Umm el Tlel around 70 000 BP. *Antiquity* 82:853–861. <https://doi.org/10.1017/S0003598X00097623>
- Bourguignon L (1992) Analyse du processus opératoire des coups de tranchet latéraux dans l'industrie moustérienne de l'abri du Musée (Les Eyzies-de-Tayac, Dordogne). *Paléo* 4:69–89
- Cornford JM (1986) Specialized resharpening techniques and evidence of handedness. In: Callow P, Cornford JM (eds) *La Cotte de St. Brelade 1961–1978: excavations by CBM McBurney*. GEOBooks, Norwich, pp 337–351
- Crew HL (1976) The Mousterian Site of Rosh Ein Mor. In: Marks AE (ed) *Prehistory and palaeoenvironments in the Central Negev, Israel. Vol 1: The Avdat/Aqev Area, Part*. SMU Press, Dallas, pp 75–112
- Davis SJM, Rabinovich R, Goren-Inbar N (1988) Quaternary extinctions and population increase in western Asia: the animal remains from Biq'at Quneitra. *Paléorient* 14(1):95–105
- Delagnes A (1992) Éclats à troncature inverse et enlèvements postérieurs : réflexions nouvelles autour d'un vieux débat. *Bull Soc Préhist Franç* 89:274–277. <https://doi.org/10.3406/bspf.1992.9533>
- Douze K (2014) A new chrono-cultural marker for the early Middle Stone Age in Ethiopia: The tranchet blow process on convergent tools from Gademotta and Kulkuletti sites. *Quat Int* 343: Changing environments and movements through transitions: Paleoanthropological and prehistorical research in Ethiopia a tribute to Prof. Mohammed Umer: 40–52
- Douze K, Delagnes A (2016) The pattern of emergence of a Middle Stone Age tradition at Gademotta and Kulkuletti (Ethiopia) through convergent tool and point technologies. *J Hum Evol* 91:93–121
- Efimienko PP (1958) Kostienki I. *Akademia Nauka, Leningrad*
- Ekshtain R, Barzilai O, Inbar M, Milevski I, Ullman M (2012) Givat Rabi East, a new Middle Paleolithic knapping site in the Lower Galilee (Israel). *Paléorient* 37(2):107–122
- Escutenaire C (1997) Les “couteaux de Kostienki” dans les collections du Paléolithique ancien de Belgique. *Notae Praehistoricae* 17:21–24
- Fleisch H (1970) Les habitats du paléolithique moyen à Naamé (Liban). *Bull Musée Beyrouth* 23:25–93
- Friesem DE, Zaidner Y, Shahaack-Gross R (2014) Formation processes and combustion features at the lower layers of the Middle Palaeolithic open-air site of Neshet Ramla, Israel. *Quat Int* 331: Opportunities, problems and future directions in the study of open-air Middle Paleolithic sites: 128–138
- Frumkin A, Gvirtzman H (2006) Cross-formational rising groundwater at an artesian karstic basin: the Ayalon Saline Anomaly, Israel. *J Hydrol* 318:216–333
- Frumkin A, Langford B, Marder O, Ullman M (2015) Paleolithic caves and hillslope processes in south-western Samaria, Israel: environmental and archaeological implications. *Quat Int* 398:246–258. doi: [10.1016/j.quaint.2015.05.064](https://doi.org/10.1016/j.quaint.2015.05.064)
- Garrod DAE, Bate DMA (1937) *The stone age of Mount Carmel. Vol. I. Excavations at the Wadi Mughara*. Clarendon Press, Oxford
- Gilead I (1980) A Middle Palaeolithic open-air site near Tell Far'ah, Western Negev: preliminary report. *Isr Explor J* 30:52–62
- Gilead I (1995) Problems and prospects in the study of Levallois technology in the Levant: the case of Fara II, Israel. In: Dibble HL, Bar-Yosef O (eds) *The definition and interpretation of Levallois technology*, Monographs in World Prehistory No.23. Prehistory Press, Ann Arbor, pp 79–92
- Gilead I, Grigson C (1984) Farah II: a Middle Paleolithic open-air site in the Northern Negev, Israel. *Proc Prehist Soc* 50:71–97
- Goder-Goldberger M, Cheng H, Edwards RL, Marder O, Peleg Y, Yeshurun R, Frumkin A (2012) Emanuel Cave: the site and its bearing on early Middle Paleolithic technological variability. *Paléorient* 38:203–225
- Gopher A, Barkai R (2011) Sitting on the tailing piles: creating extraction landscapes in Middle Pleistocene quarry complexes in the Levant. *World Archaeol* 43:211–229. <https://doi.org/10.1080/00438243.2011.579484>
- Goren-Inbar N (ed) (1990a) Quneitra: a Mousterian site on the Golan Heights, Qadem 31. Institute of Archaeology, Hebrew University, Jerusalem
- Goren-Inbar N (1990b) The lithic assemblages. In: Goren-Inbar N (ed) *Quneitra: a Mousterian site on the Golan Heights, Qadem 31*. Institute of Archaeology, Hebrew University, Jerusalem, pp 61–167
- Greenbaum N, Ekshtain R, Malinsky-Buller A, Porat N, Hovers E (2014) The stratigraphy and paleogeography of the Middle Paleolithic open-air site of 'Ein Qashish, Northern Israel. *Quat Int* 331: Opportunities, problems and future directions in the study of open-air Middle Paleolithic sites: 203–215

- Griggo C, Boëda E, Bonilaurie S, Al Sakhel H, Emery-Barbier A, Courty M-A (2011) A Mousterian dromedary hunting camp: Level VIIaO at Umm el Tlel (El Kowm, Central Syria). In: Bon F, Costamagno S, Valdeyron N (eds) Hunting camps in prehistory. Current archaeological approaches, Proceedings of the international symposium, May 13–15 2009, University Toulouse II – Le Mirail, P@lethnologie 3, Le Mirail, pp 103–129
- Groucutt HS, Scerri EML, Lewis L, Clark-Balzan L, Blinkhorn J, Jennings RP, Parton A, Petraglia MD (2015) Stone tool assemblages and models for the dispersal of *Homo sapiens* out of Africa. *Quat Int* 382:8–30
- Hauck TC (2010) The Mousterian sequence of Hummal (Syria). Ph.D thesis, University of Basel
- Hauck TC (2011) Mousterian technology and settlement dynamics in the site of Hummal (Syria). *J Hum Evol* 61:519–537
- Henry D (2003) Neanderthals in the Levant: behavioral organization and the beginnings of human modernity. Continuum Intl Pub Group, London
- Henry D (2012) The palimpsest problem, hearth pattern analysis, and Middle Paleolithic site structure. *Quat Int* 247.: The Neanderthal Home: spatial and social behaviours:246–266. <https://doi.org/10.1016/j.quaint.2010.10.013>
- Hover E (1990) The exploitation of raw material at the Mousterian site of Quneitra. In: Goren-Inbar N (ed) Quneitra: a Mousterian site on the Golan Heights, Qadem 31. Institute of Archaeology, Hebrew University, Jerusalem, pp 150–167
- Hovers E (1986) The application of geographical models in prehistoric research: a case study from Biq'atQuneitra. *J Isr Prehist Soc* 19:30–42
- Hovers E (2001) Territorial behavior in the Middle Palaeolithic of the Southern Levant. In: Conrad NJ (ed) Settlement dynamics of the Middle Palaeolithic and the Middle Stone Age. Kerns Verlag, Tubingen, pp 123–152
- Hovers E (2009) The lithic assemblages of Qafzeh Cave. Oxford University Press, Oxford
- Hovers E, Malinsky-Buller A, Ekshtain R, Oron M, Yeshurun R (2008) EinQashish-a new Middle Paleolithic open-air site in northern Israel. *J Isr Prehist Soc* 38:7–40
- Hovers E, Ekshtain R, Greenbaum N, Malinsky-Buller A, Nir N, Yeshurun R (2014) Islands in a stream? Reconstructing site formation processes in the late Middle Paleolithic site of 'EinQashish, northern Israel. *Quat Int* 331.: Opportunities, problems and future directions in the study of open-air Middle Paleolithic sites:216–233
- Jelinek A (1977) A preliminary study of flakes from the Tabun Cave, Mt. Carmel. In: Arensburg B, Bar-Yosef O (eds) Eretz-Israel 13. Israel Exploration Society, Jerusalem, pp 87–96
- Jelinek A (1982) The Middle Paleolithic in the Southern Levant, with comments on the appearance of modern *Homo sapiens*. In: Ronen A (ed) The transition from Lower to Middle Palaeolithic and the origin of modern man, BAR International Series 151. BAR, Oxford, pp 57–104
- Jöris O (2006) Bifacially backed knives (*Keilmesser*) in the Central European Middle Paleolithic. In: Goren-Inbar N, Sharon G (eds) Axe age: Acheulian toolmaking – from quarry to discard. Equinox Publishers, Oxford, pp 287–310
- Kalbe J, Sharon G, Porat N, Zhang C, Mischke S (2014) Geological setting and age of the Middle Paleolithic site of Nahal Mahanayem Outlet (Upper Jordan Valley, Israel). *Quat Int* 331: Opportunities, problems and future directions in the study of open-air Middle Paleolithic sites, pp 139–148. doi: <https://doi.org/10.1016/j.quaint.2013.05.052>
- Karkanas P, Bar-Yosef O, Goldberg P, Weiner S (2000) Diagenesis in prehistoric caves: the use of minerals that form in situ to assess the completeness of the archaeological Record. *J Archaeol Sci* 27:915–929
- Le Tensorer J-M (2004) Nouvelles fouilles à Hummal (El Kowm, Syrie centrale) premiers résultats (1997–2001), BAR International Serie 1263. Archeopress, Oxford, pp 223–240
- Leakey LSB (1931) The stone age cultures of Kenya Colony. The University Press, Cambridge
- Lindly J, Clark G (1987) A preliminary lithic analysis of the Mousterian site of 'Ain Difla (WHS 634) in the Wadi Ali, West-Central Jordan. *Proc Prehist Soc* 53:279–292
- Malinsky-Buller A, Ekshtain R, Hovers E (2014) Organization of lithic technology at 'Ein Qashish, a late Middle Paleolithic open-air site in Israel. *Quater Int* 331:234–247
- Marks AE (1976) Prehistory and palaeoenvironments in the central Negev, Israel, vol 1. SMU Press, Dallas
- Marks AE (1977) Prehistory and palaeoenvironments in the central Negev, Israel, vol 2. SMU Press, Dallas
- Meignen L (1995) Levallois lithic production systems in the Middle Paleolithic of the Near East: the case of the unidirectional method. In: Dibble HL, Bar-Yosef O (eds) The definition and interpretation of Levallois technology, Monographs in World Archaeology 23. Prehistory Press, Madison, pp 361–380
- Meignen L, Bar-Yosef O, Speth JD, Stiner MC (2006) Middle Paleolithic settlement patterns in the Levant. In: Hovers E, Kuhn SL (eds) Transitions before the transition: evolution and stability in the Middle Paleolithic and Middle Stone Age. Springer, New York, pp 149–169
- Mercier N, Valladas H (2003) Reassessment of TL age estimates of burnt flints from the Paleolithic site of Tabun Cave, Israel. *J Hum Evol* 45:401–409
- Mercier N, Valladas H, Bar-Yosef O, Vandermeersch B, Stringer C, Joron J-L (1993) Thermoluminescence date for the Mousterian Burial Site of Es-Skhul, Mt. Carmel. *J Archaeol Sci* 20:169–174
- Moncel MH, Chacón MG, Coudenneau A, Fernandes P (2009) Points and convergent tools in the European Early Middle Palaeolithic site of Payre (SE, France). *J Archaeol Sci* 36:1892–1909
- Munday FC (1977) Nahal Aqev (D35): a stratified, open-air Mousterian occupation in the Avdat/Aqev area. In: Marks AE (ed) Prehistory and Palaeoenvironments in the Central Negev, Israel, Vol.II: The Avdat/Aqev Area, part 2, and the HarHarif, 3. SMU Press, Dallas, pp 5–60
- Otte M (1980) Le couteau de Kostienki. *Helinium Wetteren* 20:54–58
- Pagli M (2013) Variabilité du Moustérien au Proche-Orient: approche géographique des dynamiques de changement en milieu méditerranéen et en milieu steppique. Ph.D thesis, University Paris X-Nanterre
- Petraglia MD, Haslam M, Fuller DQ, Boivin N, Clarkson C (2010) Out of Africa: new hypotheses and evidence for the dispersal of *Homo sapiens* along the Indian Ocean rim. *Ann Hum Biol* 37:288–311
- Prevost M, Zaidner Y (2016) The Nahr Ibrahim technique and side-scraper re-sharpening at the Unit III of the Middle Paleolithic open-air site of Neshet Ramla (Israel); what is the link? In Proceedings of the European Society for the study of human evolution. 6th Annual Meeting of the ESHE, Madrid, 14–18 September 2016, p 193
- Rabinovich R (1990) Taphonomic research of the faunal assemblages from the Quneitra site. In: Goren-Inbar N (ed) Quneitra: a Mousterian site on the Golan Heights, Qadem 31. Institute of Archaeology, Hebrew University, Jerusalem, pp 189–219
- Roebroeks W, Kolen J, Van Poecke M, Van Gijn A (1997) «Site J»: an early Weichselian (Middle Palaeolithic) flint scatter at Maastricht-Belvedere, The Netherlands. *Paléo* 9:143–172
- Ronen A (1974) Tirat-Carmel. A Mousterian open air site in Israel. Institute of Archeology, Tel-Aviv, p 8
- Schroeder HB (1969) The lithic industries from JerfAjla and their bearing on the problem of a Middle to Upper Paleolithic Transition. Ph.D. thesis, Columbia University

- Schroeder HB (2007) Truncated-faceted pieces from Jerf al-Ajla. Tools versus Cores. Alternative approaches to stone tool analysis. Cambridge Scholars Publishing 1, Cambridge
- Schwarcz HP, Rink WJ (1998) Progress in ESR and U-series chronology of the Levantine Paleolithic. In: Akazawa T, Aoki K, Bar-Yosef O (eds) Neandertals and modern humans in Western Asia. Plenum Press, New York, pp 57–67
- Schwarcz HP, Blackwell B, Goldberg P, Marks AE (1979) Uranium series dating of travertine from archaeological sites, Nahal Zin, Israel. *Nature* 277:558–560
- Schwarcz HP, Grun R, Vandermeersch B, Bar-Yosef O, Valladas H, Tchernov E (1988) ESR dates for the hominid burial site of Qafzeh in Israel. *J Hum Evol* 17:733–737
- Sharon G, Oron M (2014) The lithic tool arsenal of a Mousterian hunter. *Quat Int* 331 Opportunities, problems and future directions in the study of open-air Middle Paleolithic sites: 167–185
- Sharon G, Grosman L, Fluck H, Melamed Y, Rak Y, Rabinovich R (2010) The first two excavation seasons at NMO: a Mousterian site at the bank of the Jordan River. *Eurasian Prehistory* 7:135–157
- Sharon G, Zaidner Y, Hovers E (2014) Opportunities, problems and future directions in the study of open-air Middle Paleolithic sites. *Quatern Intl* 331: Opportunities, problems and future directions in the study of open-air Middle Paleolithic sites :1–5.
- Shea JJ (2003) The Middle Paleolithic of the east Mediterranean Levant. *J World Prehist* 17:313–394
- Solecki RL, Solecki R (1970) A new secondary flaking technique at the Nahr Ibrahim Cave site, Lebanon. *Bull Musée de Beyrouth* 23:137–142
- Speth JD (2004) Hunting pressure, subsistence intensification and demographic change in the Levantine Late Middle Palaeolithic. In: Goren-Inbar N, Speth JD (eds) Human palaeoecology in the Levantine Corridor. Oxbow Press, Oxford, pp 149–166
- Speth JD (2006) Housekeeping, Neandertal-style: hearth placement and midden formation in Kebara Cave (Israel). In: Hovers E, Kuhn SL (eds) Transitions before the transition: Evolution and stability in the Middle Paleolithic and Middle Stone Age. Springer, New York, pp171–188
- Speth JD, Clark J (2006) Hunting and overhunting in the Levantine Late Middle Palaeolithic. *Before Farming* 2006(3):1–42. <https://doi.org/10.3828/bfarm.2006.3.1>
- Stiner MC (2005) The Faunas of Hayonim Cave (Israel): A 200,000-year record of Paleolithic diet, demography and society. Peabody Museum of Archaeology and Ethnology, Cambridge
- Stringer CB, Grun R, Schwarcz HP, Goldberg P (1989) ESR dates for the hominid burial site of Es-Skhul in Israel. *Nature* 338:756–758
- Tsatskin A, Zaidner Y (2014) Geoarchaeological context of the later phases of Mousterian occupation (80–115 ka) at Neshar Ramla, Israel: Soil erosion, deposition and pedogenic processes. *Quat Intl* 331: Opportunities, problems and future directions in the study of open-air Middle Paleolithic sites, pp 103–114
- Turq A, Marcillaud J-G (1976) Les racloirs à amincissement de type“ Kostienki” de La Plane commune de Mazeyrolles (Dordogne). *Bull Soc Préhist Franç Comptes rendus des séances mensuelles* 73(3):75–79
- Valladas H, Reyss JL, Joron JL, Valladas G, Bar-Yosef O, Vandermeersch B (1988) Thermoluminescence dates for the Mousterian ‘Proto-Cro-Magnons’ from Qafzeh Cave (Israel). *Nature* 331:614–616
- Weinstein-Evron M, Zaidner Y (2017) The Acheulo-Yabrudian – Early Middle Paleolithic sequence of Misliya Cave, Mount Carmel, Israel. In: Hovers E, Marom A (eds) Human paleontology and prehistory: contributions in honor of Yoel Rak, Vertebrate Paleobiology and Paleoanthropology Series. Springer, New York, pp 187–202
- Weissbrod L, Zaidner Y (2014) Taphonomy and paleoecological implications of fossorial microvertebrates at the Middle Paleolithic open-air site of NesharRamla, Israel. *Quatern Intl* 331 opportunities, problems and future directions in the study of open-air Middle Paleolithic sites: 115–127
- Yeshurun R, Bar-Oz G, Weinstein-Evron M (2007) Modern hunting behavior in the early Middle Paleolithic: faunal remains from Misliya Cave, Mount Carmel, Israel. *J Hum Evol* 53:656–677
- Zaidner Y (2014) A new open-air Middle Paleolithic site at Neshar Ramla, Israel. *Stratum Plus* 2014(1):29–44
- Zaidner Y, Grosman L (2015) Middle Paleolithic sidescrapers were resharped or recycled? A view from Neshar Ramla, Israel. *Quat Intl* 361: the origins of recycling: a paleolithic Perspective:178–187. doi: <https://doi.org/10.1016/j.quaint.2014.11.037>
- Zaidner Y, Weinstein-evron M (2014) Making a point: the Early Middle Palaeolithic tool assemblage of Misliya Cave, Mount Carmel, Israel. *Before Farming* 2012(4):1–23. <https://doi.org/10.3828/bfarm.2012.4.1>
- Zaidner Y, Frumkin A, Porat N, Tsatskin A, Yeshurun R, Weissbrod L (2014) A series of Mousterian occupations in a new type of site: the NesharRamla karst depression, Israel. *J Hum Evol* 66:1–17
- Zaidner Y, Frumkin A, Friesem D, Tsatskin A, Shahack-Gross R (2016) Landscapes, depositional environments and human occupation at Middle Paleolithic open-air sites in the southern Levant, with new insights from Neshar Ramla, Israel. *Quat Sci Rev* 138:76–86
- Ziaei M, Schwarcz HP, Hall CM, Grun R (1990) Radiometric dating of the Musterian site at Quneitra. In: Goren-Inbar N (ed) Quneitra: a Mousterian Site on the Golan Heights, Qadem 31. Institute of Archaeology, Hebrew University, Jerusalem, pp 232–235