World Archaeology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rwar20

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Available online: 14 Jul 2011

To cite this article: Avi Gopher & Ran Barkai (2011): Sitting on the tailing piles: creating extraction landscapes in Middle Pleistocene quarry complexes in the Levant, World Archaeology, 43:2, 211-229
To link to this article: http://dx.doi.org/10.1080/00438243.2011.579484

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Sitting on the tailing piles: creating extraction landscapes in Middle Pleistocene quarry complexes in the Levant

Avi Gopher and Ran Barkai

Abstract

Discoveries in Israel during the last two decades indicate flint quarrying from primary geological sources as early as the Middle Pleistocene. One of the most characteristic expressions of this old extraction activity is ubiquitous stone tailing piles created during quarrying consisting of extracted rock waste. Workshop flint-knapping products are found within and on top of these piles.

This paper discusses the creation of these piles in relation to the organization of quarrying and relevant human behavior at extraction sites. In the same context we speculate on the significance of these fascinating landscapes of extraction and the decision to work stone on top of the tailing piles.

Keywords

Flint extraction; tailing piles; Middle Pleistocene; Lower–Middle Paleolithic; Israel.

Introduction

Flint quarrying was quite an unstudied topic in the southern Levant until the 1990s. A series of discoveries of Paleolithic and Neolithic quarrying sites was made in the 1990s (Barkai and Gopher 2001, 2009, in press; Barkai et al. 2002, 2006; Gopher and Barkai 2006). One of the major finds was the discovery of a series of large-scale industrial complexes of the Middle Pleistocene in northern Israel. These complexes clearly indicate major quarrying activities in the later parts of the Lower Paleolithic Acheulian and in the Middle Paleolithic Mousterian (Barkai and Gopher 2001, 2009, in press; Barkai et al. 2002, 2006; Gopher and Barkai 2006). Moreover, quarrying flint from primary (including
deep, sub-surface) geological sources in the southern Levant during the Middle Pleistocene is also indicated by direct analysis of archaeological flint items from Tabun and Qesem caves by way of analyzing the content of the cosmogenic isotope $^{10}$Be (Boaretto et al. 2009; Verri et al. 2004, 2005).

A characteristic expression of this quarrying activity in the above-mentioned early extraction complexes is stone tailing piles consisting of rock waste and knapped flint items. We argue that these piles were purposely created during the process of on-going long-term raw material extraction and flint reduction practiced at these industrial areas. In a few complexes, the presence of dozens, hundreds and sometimes over a thousand such tailing piles was recorded in what could only be described as immense industrial areas on any scale one chooses to look at (Barkai and Gopher 2009; Barkai et al. 2002, 2006). These piles vary in size including small piles (1–2m in diameter) and up to a meter of elevation as well as piles with a diameter of tens of meters rising to an elevation of 3–5m. The piles are concentrated within a relatively restricted area and thus create an extraction landscape which is highly visible in the wider geographical landscape and appears as an artificial scar in the pristine natural environment. However, the landscape of extraction itself, within the quarrying complexes, is far from being homogeneous since large, high and impressive piles appear together with much smaller piles creating a diverse cultural landscape. In this paper we present a first attempt to tackle intriguing questions regarding the formation of such landscapes of extraction and present an interpretation of human behavior at the quarry complexes that led to the creation of these Paleolithic industrial areas.

One of the most common features of these tailing piles is that flint knapping has taken place on the piles throughout their formation process as evident by the presence of flint-knapping waste and flint-shaped tools within and on them. Noteworthy is the fact that quarrying tools too appear within and on these tailing piles, sometimes in quite considerable numbers (e.g. at Sede Ilan: Barkai et al. 2006). One may suggest, however, that flint knapping took place elsewhere and the undesired flint items were discarded on the pile of quarrying debris. Preliminary surveys between the piles and in their close vicinity did not provide evidence for intense knapping activity. We argue, however, that the composition of the lithic assemblages retrieved from excavating three such piles in two different quarrying complexes suggests otherwise. In our perspective, the presence of the complete chaîne opératoire of flint working on and within the piles, including raw material blocks, cores, core trimming elements, blanks (flakes and blades, including small flakes), knapping debris (chips and chunks) and shaped items (both roughouts of bifacial tools and shaped flake tools) point in favor of in situ knapping activities on top of the piles. The fact that desirable lithic products were transported from the quarry site and the very large-scale samples in each pile hampered our efforts to conduct refitting studies and reconstruct the reduction sequence in full. These limitations notwithstanding, our suggestion regarding working the flint on top of the piles accords well with other patterns of human activity at these quarrying complexes and the deliberate construction of these extraction landscapes.

We worked for quite a while, and still work, in both quarry complexes described below and have answered a few of the questions relevant to quarry organization and products (Barkai and Gopher 2001; Barkai et al. 2002, 2006; Gopher and Barkai 2006). We also
touched upon aspects of their location and impact on the landscape (Barkai and Gopher 2009) and about caching behavior as revealed at Mt. Pua (Barkai and Gopher in press). However, these large-scale complexes seem to have been major loci of Lower and Middle Paleolithic activities and many open questions remain to be discussed. We wish to tackle one of these here – namely the question of why the knapping of flint took place on the tailing piles throughout their formation processes and how this would relate to the quarrying in functional and social terms.

In this paper we will concentrate on two Lower–Middle Paleolithic quarry complexes – Mt. Pua and Sede Ilan. After briefly presenting the two sites we focus on the formation process of stone (tailing) piles and its relation to the organization of quarrying and on the question of why people decided to knap the extracted flint nodules on top of these piles and continued doing so all through the long-term use of these extensive complexes.

**Lower–Middle Paleolithic quarry and workshop complexes in Galilee**

The two quarry sites described below are large-scale complexes and show highly designed procedures of quarrying and a planned and structured sequence of flint extraction and reduction. These quarry landscapes of the Lower and Middle Paleolithic reflect the large-scale works and decision making as well as the spirit of these old Paleolithic communities – their culture, society and world-views.

**Mt. Pua**

The Mt. Pua flint quarries are located in the central Dishon Valley, Upper Galilee, Northern Israel (Fig. 1). The quarry complex lies on the flat narrow summit of Mt. Pua, and is developed in thinly bedded, flint-bearing Eocene limestones that are gently inclined to the north. The summit is surrounded by steep valley walls that are accentuated by a master joint system rendering the landscape roughly rectilinear in outline. Flint is present in a limited number of horizons, and access to the flint is partially determined by the presence of near-vertical joint intersections. The flint occurs as flattened oblate spheres that display concentric layering and are clay-rich along their outer layers. Extraction zones are best developed along the summit of the mountain where incipient karstification (i.e. dissolution of the limestone bedrock) has further accentuated intersecting joint planes, permitting easier access to the flint-bearing horizons. The gentle dip of the underlying limestone beds permitted the development of a stable platform below the quarry face, where levers and wedges could readily be used to pry loose the flint-bearing limestone blocks. Hammer-stones were then used to crush and break limestone blocks along the bedding and joint planes in order to free the flint nodules. These hammer-stones were fashioned from dense limestone blocks (Fig. 2), not basalt, even though basalt sources are found in close proximity to the site. Preliminary mapping revealed c. 1500 tailing piles (Plate 1) spread over an area of approximately 800 x 150m. The tailing piles are of four geometric types: large linear constructions, large circular mounds, small elongated shaped piles and small circular piles. The piles vary in size from less than 1m to over 30m in diameter (or length), and from some 30cm up to over 3m in elevation. One large linear
Figure 1 Location map of the quarry and workshop complexes presented in the text. 1: Mt. Pua; 2: Sasa; 3: Sede Ilan; 4: site 164 (Carmel Mt.).
Stone pile was partially excavated (Pua Workshop pile no. 3, PW3, Plate 2) and one small circular stone pile was totally excavated (Pua Workshop pile no. 100, PW100, Plate 3). These initial excavations were intended to elucidate the formation and content of these waste piles, and to compare and contrast the characteristics of large and small tailing piles.

In a large linear tailing pile, PW3, 30m long and 12m wide, a square of 2 x 2m was chosen at random and excavated to bedrock. The excavation through the pile included controlled removal of broken limestone blocks, and the systematic collection of all flint items from the limestone quarry debris, down to a depth of 90cm, at which point an exhausted flint extraction surface was reached. Two flint caches were discovered at a depth of c. 90cm below the surface level, under a limestone block and on top of the exhausted extraction surface, each including thirteen large flint artifacts stacked one on top of the other (for details, see Barkai and Gopher in press). The archeological context of the two lithic concentrations permits interpretation of them as caches, purposefully placed on top of the exhausted quarry surface and this of course has far-reaching significance in understanding and elaborating on these quarry sites.

A small circular pile, PW100, located some 40m south west of PW3 was selected for excavation at random from among the many small tailing piles at Mt. Pua. It was 5.3m
long and 4.2m wide at the central axis and it was excavated in four separate excavation units following the length and width intersecting axes. Work at PW100 focused on controlled removal of broken limestone blocks and a systematic collection of all lithics. The thickness of the quarry debris at PW100 was approximately 100cm from the

Plate 1 Air photo of the extraction landscape at Mt. Pua in 1969 (white spots are tailing piles).

Plate 2 A large tailing pile (PW3) at Mt. Pua (note for scale a person and trees).
uppermost surface of the pile down to bedrock. The quarry debris consisted of a mixture of broken limestone blocks, flint nodules and knapped flint artifacts. As bedrock was reached, it became clear that PW100 was placed on top of an exhausted flint extraction surface similar to PW3, but not on the same flint horizon. Just above the abandoned extraction surface, at the bottom of the waste pile, many flaked flint artifacts were present, suggesting that flint knapping took place on top of the used extraction surface from the very beginning, before the waste pile was created at the same spot and throughout its build up.

The lithic assemblages excavated in these two piles have been described in detail in the past (Barkai et al. 2006). Generally speaking, blank production was more intensive at the large tailing pile PW3 than in PW100 and this is indicated by the higher number of cores in PW3. The large number of chunks in PW100 suggests a focus on raw material testing and the initial stages of raw material manipulation. This inference is supported by the large number of tested nodules and the small number of core trimming elements at PW100. Moreover, the considerably higher number of tested nodules at PW100 might be indicative of different production cycles, again with initial flaking being performed at PW100 and more advanced flaking taking place at PW3.

The small number of core trimming elements in both piles indicates that there was little core preparation before blank detachment (most probably related to the trajectory of simple flake production and not to the Levallois trajectory, although our preliminary study of cores from Mt. Pua indicated that Levallois cores at the site were not necessarily always prepared according to the volumetric concept (e.g. Boëda 1994) and that ‘short cuts’ have been taken in order to produce Levallois blanks with as little effort as possible. It should be borne in mind, however, that some or many of the well-prepared Levallois cores might have been taken away from the quarry complex. Flint nodules that required very little preparation for blank reduction were thus selected as
cores. As a result, very little core preparation and maintenance was needed before, during and after blank reduction. Cores that reached their maintenance stage were discarded and replaced by fresh ones. The excavation of PW100 uncovered a large number of flint raw material items that exhibited no evidence of knapping. About one third of the items are unused large flint blocks, the abundance of which may indicate the flint-rich environment of the Mt. Pua complex.

Primary cortical blanks removed during primary stages of flaking were preferred for flint tool shaping at both the large and small piles while non-cortical flakes, removed during advanced flaking stages, were most probably transported from Mt. Pua. Levallois blanks appear in both piles in small numbers only, suggesting that many desired Levallois blanks were transported away from the site.

Shaped items are more common at PW3 than at PW100, indicating differences in knapping intensity between the two piles. Altogether, very few ‘curated’ items were found, the majority being ‘expedient’ items or artifacts rejected during the production process. Roughouts represent early stages of handaxe production, and it is possible that successful biface roughouts were transported from the site to be finished and used elsewhere. The only advanced shaped handaxe at PW3 was found in one of the caches on top of the exhausted extraction surface. Seven to ten per cent of the shaped items were made on Levallois products. The frequencies of shaped items made on Levallois blanks and the frequencies of Levallois cores are similar in both assemblages (see Barkai et al. 2006 for details). This observation, in conjunction with the observation that Levallois cores typically produced more than one item, implies that most Levallois products produced on site were not used as blanks, but were transported from Mt. Pua. It should be kept in mind, however, that prepared cores might have also been taken from the workshop to be reduced elsewhere.

The analysis of the two flint assemblages discussed above indicates two patterns of lithic reduction, with a focus on raw material testing and primary reduction at the small tailings pile (PW100) and more advanced reduction stages at the large pile (PW3). The transportation of flint artifacts from the quarry site, especially large flakes and bifaces, is feasible given the presence of late Acheulian sites near Mt. Pua (Ohel 1986; 1990).

*Sede Ilan*

The Sede Ilan Paleolithic extraction and reduction complex is located in Lower Galilee, Israel, some 10km west of the Sea of Galilee (Fig. 1). The complex is comprised of hundreds of tailing piles and is similar in scale and density to the Mt. Pua complex described above. An air photograph taken before modern construction reveals the huge extent of the Sede Ilan complex (Plate 4). Although partly damaged in the mid-twentieth century, this expansive Paleolithic industrial complex still has major parts available for archaeological and geological investigations. Noteworthy is the close proximity of the prominent topographic feature, Mt. Tabor (Plate 5).

The Sede Ilan quarry complex lies on the slopes of two plunging folds, and the quarry activity is focused on one Eocene flint-bearing horizon. Owing to the geological structure
Plate 4 Air photo of the extraction landscape at Sede Ilan (white spots are tailing piles).

Plate 5 One of the tailing piles at Sede Ilan with Mt. Tabor in the background.
and stratigraphic relationships in the area, prehistoric quarry activities are tightly focused along the limbs and hinges of these two folds. The flint-bearing horizon has been mined to the limits of Paleolithic technology, particularly where closely spaced joints have been accentuated by karstic activity.

Where quarrying is developed along the limbs and hinges of the two folds, the style of quarrying varies depending upon elevation and bedrock structure. Quarrying activity focused along the hinge of the fold may be oriented towards gathering flint between joint surfaces where karstic activity has loosened them from the bedrock matrix. However, flint occurring along the limbs of the folds is mined through the purposeful development of highly organized quarrying. The zones of extraction appear to have been maintained, with mine tailings intentionally backfilled towards the opposing edges of each quarry face in order to stabilize the back walls of the remaining declivity.

Complementing this sophisticated quarry development is a chain of operation (chaîne opératoire) suite of quarrying tools designed, manufactured and implemented from basalt and limestone, and attesting to the ingenuity of Lower–Middle Paleolithic quarrying endeavors. Specifically, basalt was obtained from the high plateau above the site and brought into the quarries where at least five diagnostic tool types were manufactured. These tool types include cylindrical wedges, anvil stones, pounding instruments, wedges resulting from the breakage of pounding instruments and a class of purposefully designed flakes. Moreover, the basalt quarrying tool kit is complemented by an assemblage of curated wedges fashioned from siliceous limestone (some of which were recovered from open joints).

Field work at Sede Ilan included geological mapping and a test excavation at one of the large tailing piles at the eastern edge of the complex (Plate 6). The excavation was carried
out in an elongated pile (SE3) some 1.3m high at its center consisting of broken limestone blocks mixed with lithic artifacts and raw material blocks, as well as a prominent component of basalt items. SE3 is 15m long and 8.6m wide at its center. The test excavation was located at the southern edge of this pile, at a place where the deposits are relatively thin. The excavated material, which is 50cm thick, rested on accentuated and levered limestone blocks. Flaked lithic artifacts are abundant throughout the depth of excavated smashed limestone blocks. It appears that the waste material was piled on top of an exhausted extraction surface. The pile is clearly aligned with other similar piles, located along a selected flint horizon at the eastern edge of the Sede Ilan complex (Plate 6). The waste piles along this line are similar in scale and are placed 20–30 meters from each other. Several extraction localities were placed along this line and the waste material from the extraction was piled, most probably in order to concentrate the waste and clear potential areas for future extraction (note similar waste piles at Mt. Pua and site 164 (Barkai et al. 2002, 2006)).

The excavated flint industry from SE3 (Barkai and Gopher 2009; Barkai et al. 2006) is rich in cores and shaped items and includes Levallois cores. We suggest this area was used for advanced stages of blank reduction and tool shaping. Shaped items include ad hoc tools, with no early-stage bifaces, handaxes or other shaped items apart from retouched blanks. Few tested nodules were found at Sede Ilan, in contrast to the high frequency of Levallois cores, reinforcing the impression that advanced flaking was the focus at SE3. The assemblage composition is not markedly different from the excavated assemblage of PW3 at the Mt. Pua, although shaped items and cores, especially Levallois cores, are more common at Sede Ilan. The general character of the large tailing piles at Mt. Pua and Sede Ilan is similar, suggesting that they reflect continuous flint reduction processes, including advanced flaking stages.

In addition to the flaked flint assemblage, flint blocks with no evidence of flaking were also recovered from the Sede Ilan excavation. Flint nodules still embedded within the limestone karrens were found as well. A rich basalt assemblage was also recovered, including long and narrow items, large and round basalt cobbles, flat, tapering rectangular wedge-like items, some with thinned edges and basalt fragments. Limestone flaked artifacts were also recovered, including thin and small limestone flakes, thick and large limestone flakes and limestone cores. We suggest that the limestone flakes were hammered into tightly sealed joints, thereby permitting diurnal temperature changes and seasonal weather patterns to further accentuate the joint surfaces. The limestone cores index the end of a production trajectory focused towards the protracted exploitation of the land through the use of a plug-and-feather method.

In summary, the Sede Ilan Lower–Middle Paleolithic quarrying and workshop complex is interpreted as being both expansive and sophisticated. Hominin utilization of these specific Eocene flint outcrops was recurrent and a quarry toolkit of local basalt and limestone was employed. Quarry debris was piled in waste piles, and flint reduction, focusing on the Levallois technique, took place on top of these tailing piles.

No post-Middle Paleolithic artifacts were found on the tailing piles and quarrying localities. The rocky landscape in the undamaged areas seems to have remained very much unchanged since the Middle Pleistocene apart from some possible karstic activity.
A summary of the lithic finds at Mt. Pua and Sede Ilan

The two complexes share similar technological and typological lithic characteristics and show clear evidence for very large-scale flint production. Tested nodules and large numbers of cores are found in each of the complexes. Levallois cores are found and the Levallois reduction strategy is the most characteristic lithic marker of the two industrial areas. However, simple flake production is the most common reduction strategy practiced and we suggest that large flake production was the major primary goal of the flint knappers at the sites. Evidence for core preparation and maintenance is scarce and it is inferred that a very straightforward knapping approach prevailed in both complexes with a clear selection of the raw material nodules according to their suitability for the planned reduction. Blanks and shaped items were found, but many other blanks and shaped items (and perhaps prepared cores as well) were most probably transported from these workshops. Handaxes, rejects and early-stage bifaces appear in small numbers at both complexes.

Measurable variability within the assemblages is visible at both sites, although the visibility of the Levallois-related products and debitage is the salient feature. Large flake production represents a predominant trajectory at Mt. Pua. The Levallois technique is conspicuous in Sede Ilan and Mt. Pua. It is of note that the Levallois production end products were taken away from the workshop site while easily recognizable Levallois cores were left on-site. With respect to handaxes, the end products were transported away from the quarry workshops and the manufacturing debitage of the preliminary stages of producing bifacial preforms is immiscible with the debitage resulting from the production of other objects (e.g. Newcomer 1971). This present immiscibility may result in the apparent paucity of handaxes in direct contrast to the pronounced evidence for the use of the Levallois technique.

Dating the Paleolithic flint quarries

A central issue in the study of the above-mentioned Paleolithic quarry complexes is that we have no direct, absolute dating. We thus base the dating of these sites on the archeological finds. The presence of handaxes and early-stage roughouts of handaxes suggests that the quarrying activity is related to the Acheulian complex of the Lower Paleolithic period (e.g. Goren 1979; Goren-Inbar 1985). Large flake production is a well-known Acheulian cultural marker (e.g. Madsen and Goren-Inbar 2004; Sharon 2007, 2009, 2010) well represented in both Mt. Pua and Sede Ilan and it is thus clear that the use of these quarry complexes began during Lower Paleolithic times. The use of the Levallois technique in the Levant began during the Lower Paleolithic period (e.g. Goren-Inbar 1985; Goren-Inbar and Saragusti 1996, Goren-Inbar et al. 2000) and a possible connection between handaxe reduction and the Levallois technology was suggested (DeBono and Goren-Inbar 2001). Thus, the co-occurrence of handaxes and Levallois technology may be attributed to the late Lower Paleolithic period. Alternatively, we may simply view the fact that handaxes are not found in Middle Paleolithic Mousterian assemblages in the Levant and the fact that the Levallois technique is usually not found in many Lower Paleolithic
Acheulian assemblages in the Levant, and say that the conspicuous presence of Levallois cores and products in these two complexes indicates the continued use of these flint sources during the Middle Paleolithic Mousterian. Thus the presence of either of these two elements or both is chronologically suggestive though not at a very high resolution. We assume that the Acheulian component in the Mt. Pua and Sede Ilan quarry sites should be considered late Acheulian while we cannot say much on the Middle Paleolithic Mousterian. The chronology of the above-described quarry sites must thus remain general and, considering the presence of both handaxes and Levallois cores and products, it would be late Acheulian and Mousterian. Based on the large accumulation of archaeological data from the Levant it could be suggested that these quarry complexes were in use during Lower Paleolithic times, as early as 500kyr and even earlier, and quarrying continued during Middle Paleolithic times between 200 and 50kyr (see summaries of Paleolithic chronology in Gopher et al. (2010) and Bar-Yosef (1998)). The late LP Acheulo-Yabrudian cultural complex (400–200kyr; Gopher et al. 2010) shows no use of the Levallois technique and may thus have used such quarry complexes for large flake and handaxe production. In any case, the use of these flint sources was extremely long and continued for an estimated period of some half a million years.

It should be borne in mind, however, that post-Mousterian activity is not indicated at either quarry complex.

Discussion and summary

The two quarry complexes (and other such complexes too; see Barkai et al. (2006)) share similar characteristics, such as the long-term use of specific flint outcrops; recurrent, large-scale use of designated industrial areas and an alteration of the pristine landscape; sophisticated, well-planned quarrying procedure and a careful arrangement of the industrial landscape; and an extremely rich lithic industry distinguished by large flake production, bifacial tool shaping and the use of the Levallois technique. This permits the formulation of a general model for Middle Pleistocene flint extraction strategies on which we shall not enlarge here (but see Barkai et al. 2006).

It seems quite clear that Lower and Middle Paleolithic hominins in the area needed homogeneous undamaged raw material and preferred flint from primary geological contexts for tool production. High-quality homogeneous flint that can be found only within primary geological sources would have been needed for the production of large quantities of handaxes during the Acheulian and to account for the conspicuous presence of the Levallois technique in the Mousterian. One may guess they used other available, surface raw materials too but the scale of these quarry complexes indicates a clear tendency towards quarried flint. In light of the scale one must also assume long-term recurrent use of specific flint outcrops in Middle Pleistocene Paleolithic Levantine landscapes. This in turn would mean that the pristine environment was shaped and significantly altered by the flint quarrying and quarry landscape maintenance. The location of the quarry complexes also indicates that traditional ecological knowledge, land-use legacies and resource management were possibly at work here (for detailed discussion on these aspects as seen at Sede Ilan, see Barkai and Gopher (2009 and references therein)).
The location of the quarry sites described above, as well as that of others, shows that the view from the quarries is open to central landscape markers such as prominent mountains or large valleys, and/or that quarry complexes are visible from a distance. Since tailing piles, especially the larger ones, let alone concentrations of many such piles, as well as scars in the landscape resulting from quarrying, are visible from large distances, they most probably became landscape markers. Mt. Pua is located on a highly visible summit, although the nature of the Middle Pleistocene landscape at the Dishon valley still awaits a detailed reconstruction (Barkai and Gopher 2001; Barkai et al. 2002; Gopher and Barkai 2006; Ohel, 1986; Ronen et al., 1974; Yair 1962). Sede Ilan is located in the shadows of the topographically prominent Mt. Tabor and is visible from a distance.

One very striking aspect of these quarry complexes, and a point in favor of their major ‘presence’ in Paleolithic landscapes is that the original quarrying landscapes, even if as old as Lower Paleolithic, are preserved and survive to this very day.

The creation of the tailing piles is related to the organization of quarrying. Piles are thus the result of organized quarrying. They follow a ‘backfilling’ logic of exhausted extraction quarries. The result is a variety of tailing pile forms and sizes – round or linear, large and massive or small.

Following the data we collected in both these sites and in other sites as well (Barkai et al. 2006) and using the unique finding of two flint caches at the base of the excavated tailing pile PW3 at Mt. Pua (Barkai and Gopher in press), we may summarize the process of tailing piles formation as follows:

- An extraction area for flint quarrying was established at a specific location – whether at one point or a few points along the line of available raw material. Flint nodules were extracted from this quarry and taken for reduction in a near-by exhausted area that was to be used as a refuse area for the waste from the active quarry. In the case of Mt. Pua PW3, a selected group of flint items was brought to the exhausted quarry and deposited/cached there on bedrock. We cannot say whether these items were produced from nodules extracted from this specific quarry or originated elsewhere. The caches were covered by a large limestone block (see Barkai and Gopher in press for details).
- Extraction limestone debris from flint quarrying was piled on top of the caching locality.
- Knapping on the pile continued throughout its formation process and flint items as well as tested flint nodules accumulated with the limestone waste from quarrying. At the end of this process of unknown duration, the quarry was abandoned.

This general reconstruction stands for other cases too where caches were not found. While it is speculative to argue that piles (and associated quarries?) might have been assigned to a person/family or larger social unit, it would not be an overstatement to argue that features such as quarries and tailing piles are of social significance. We cannot say whether these complexes related to group territories or to long-term traditional use of specific localities by specific group members (e.g. as suggested for Mousterian Levantine cave sites by Hovers (2001)) or whether these complexes were frequented by members of...
different groups, at different occasions or together. The variety of possibilities is wide and we cannot answer these questions that may bear on sharing or ‘owning’ flint resources in these complexes both at the small-scale community level and at the larger-scale social levels. The possible use of the quarry or specific parts of it as a ‘field-school’ teaching ground for young apprentices, both for quarrying and for flint knapping, should be borne in mind too, especially concerning the social aspects that may have accompanied this.

The fact that large numbers of stone waste piles (backfill piles), aligned between exhausted extraction quarries, are rich in lithic (flint) workshop assemblages – actually indicating flint workshops on the tailing piles – raises the natural question why knapping took place on the waste tailing piles of the quarry. While understanding that the logic of back piling quarried material and creating tailing piles lies in the field of quarrying strategies/tactics and basically relates to the functional aspect, a repeatedly occurring question that may have no such answer is: why was the knapping practiced on the piles throughout their formation process, or, in other words, why sitting on the piles?

We may, again, assign this fact to some kind of a quarrying logic. It may in some ways be more comfortable than any other arrangement; it may be more efficient being close to the quarrying itself; or it may be related to the need to keep the actual quarrying area clean of flint debris which is not relevant and restrict waste to areas already mined. However, none of these explanations seems sufficient. In our perspective these piles, especially the large ones, are an uncomfortable working landscape. Moreover, there is plenty of space available between the tailing piles and we assume that better choices for knapping locations could be made apart from sitting on the pile itself.

Yet another way of looking at this question is to view the quarrying events (as long as they may have lasted) as social arenas in which one of the central materials that people needed for their survival and well-being is acquired from the landscape and shaped – turned into a cultural being. Within these circumstances, social considerations may lead the decision of where to knap. Naturally one may want, or would by tradition be obliged, to be close to the quarrying activity and to be part of the climax of the event – to be where the most visible result of quarrying is most apparent. However, many ‘small’ aspects of the practicalities of the quarrying and knapping elude us and remain open: what was the quarrying delegation like? How many people did it include per event? Were they all working in one quarry area or were they spread out? How many people did the actual quarrying work? Were all of them engaged or just a few? Did different people quarry and knap? Were these parallel activities? We may not be able to answer all these questions, but, using the ethnographic record as a general background for understanding human behavior at extraction sites, we may suggest that stone quarrying is highly significant, socially structured and a symbolically loaded practice in hunter-gatherer groups throughout the world (e.g. Binford and O’Connell 1984; Burton 1984; Jones 1984; Jones and White 1988; Pêtrequin and Pêtrequin 1993; Stout 2002, 2005). This generalization may be sufficient for us to assume or suggest a similar scenario in the Paleolithic even though the sites concerned are quite remote and rooted in deep Paleolithic times. In this respect one may note that we freely allow ourselves an unexplained use of ethnographic analogies from recent hunter-gatherers.
This is the freedom one allows oneself when admitting to speculation. However, using the recently published statements by Gamble et al. (2010) concerning the social brain hypothesis may provide a setting for our claims. Since we know little about the hominins of the region between c. 0.5 and 0.1 Ma (but see Hershkovitz et al. 2011), it would be premature to enlarge on this.

Another line of thinking, in the direction of a more symbolic explanation of such behavior at these quarry complexes, might be related to a possible perception of the flint nodule as naturally embedded within the limestone karrens. To maintain as long as possible the original connection between the two substances, limestone and flint, it may have been imperative to reduce the flint nodules and perform the knapping on top of the waste material that came from the extraction of these nodules. At the end of the working session, only the selected products were taken from the extraction locality while most of the flint was left together with the smashed parent rock on the pile for years to come (for a similar line of reasoning suggested for a Neolithic quarry, see Cooney (1998)). For some reason, these Middle Pleistocene industrial areas were not exploited during later periods, although ancient people continued to use flint on a large scale in the Levant during the later Paleolithic and Neolithic periods. These immense Lower Paleolithic/Middle Paleolithic complexes seem to have been untouched although plenty of flint was and still is available there. Perhaps the symbolic meaning of such extraordinary places was more lucid to prehistoric people than it is to us and the tradition was deeply rooted into the social memory of these and later prehistoric groups.

One interesting piece of information that may be relevant to the above discussion relates to a totally different socio-economic context, hundreds of thousands years apart, in the urban Early Bronze Age of northern Israel, at Har Haruvim (fifth millennium BP calibrated), where one finds a similar logic and organization of flint-quarrying operations. The tailing pile here is quite similar to the ones we have shown above (Shimelmitz et al. 2000) except that the industry is oriented towards the production of Canaanean blades and includes the impressive debitage and cores of this very specific industry.

Thus the pattern of activities at Paleolithic quarry complexes might be relevant for extracting and working flint in much later periods and might appear as a more general pattern of human behavior at quarry sites in the Levant and beyond. We hope that future field work will contribute new insights on this interesting issue.

Conclusion

In this paper we have presented thoughts regarding the organization of activities at two Middle Pleistocene flint extraction complexes from the Levant focusing on the most prominent feature in these Paleolithic industrial areas – the tailing piles.

The scale and time range (hundreds of thousands of years) of human activity at these extraction complexes, as reconstructed above, is, given the extent of the evidence uncovered, unique and difficult to comprehend. However, we cannot determine in a precise way the actual duration of extraction episodes at these flint sources. It is also difficult to estimate the scale of the group or groups that worked at these complexes – was it one group visiting the quarry area annually for a limited duration of time, working in a
specific locality each year, thus creating this landscape of extraction during a prolonged period of time, or did several different groups meet at these flint sources for a specific occasion and work simultaneously at different extraction quarries, creating the landscape of extraction more rapidly? An additional question that needs to be answered is whether the differences between the piles stand for different groups, different individuals within a group, different degrees of know-how (experienced versus apprentice) or different working phases (extraction, nodule reduction, advanced flaking and so on).

We argue that the large number of tailing piles might be an outcome of functional aspects that have to do with the organization of extraction activities and long-term planning of work or a spatial functional division of working phases (extraction, early stage and late stage reduction, etc.). On the other hand, the number of piles might reflect a social organization dictated by ownership, group identity or sense of belonging. Moreover, a more symbolic explanation might suggest that the group or groups working at the quarry never returned to a previously exploited extraction area even if it was still not exhausted and, for reasons beyond our understanding, started anew at each visit. A combination of several of these factors might be relevant to the creation of these extraction landscapes.

The logic of creating tailing piles may be a pattern inherent in either the quarrying of flint itself or human behavior within flint quarries, or both. There is much sense in organizing the piles as they did, and there is sense in the need of miners to work as a group and stay/be in the very center of the activity of quarrying. However, for ‘sitting on the piles’, i.e. knapping on the piles, we have rejected the straightforward functional argument of ‘the most parsimonious thing to do’ and suggested a more social or symbolic reasoning. This may, if we speculate yet again, relate to a separation (in visibility) between working groups or to the connection (direct visibility) between a person and the extraction area. On a deeper level, it may also be a way to keep the physical connection between the desired flint and the limestone from which it was extracted.

Flint quarrying is an important part of the economy and thus an important social event and process as well. It takes place in visible and well-known landmarks and it leaves significant markers in the landscape. Sitting on the tailing piles was at the heart of how people participated in quarrying.

References


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