THE NAHAL GALIM/NAHAL ORNIT PREHISTORIC FLINT QUARRIES IN Mt. CARMEEL, ISRAEL

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Abstract

A preliminary survey on the slopes of Nahal Galim and its tributary, Nahal Ornit (Mt. Carmel, Israel), shows that local high-quality flint outcrops were intensively used for flint quarrying and tool production at least since the Middle Palaeolithic. The paper offers initial observations regarding the geology, geomorphology and archaeology of these locales, and presents first insights into the scale and methods of past quarrying activities.

Key words: Flint extraction, debris piles, raw materials, Palaeolithic.

INTRODUCTION

In a field survey on the slopes of the Nahal Galim / Nahal Ornit drainage system (Mt. Carmel, Israel) a high-density complex of large flint quarries was exposed (Rosenberg and Nadel, 2009: Fig. 1). The paper presents preliminary data regarding dozens of flint extraction and production loci in this drainage system, at the foot of the range near the outlet to the Mediterranean coastal plain. The study includes observations regarding extraction waste and knapped flint samples from the debris piles. These provide insights into the scale of local prehistoric quarrying activities.

In the Near East, Middle Palaeolithic flint quarries were found in the Upper Galilee, Israel (Barkai et al., 2002, 2006; Gopher and Barkai, 2001, 2006) and the Qena area, Egypt (Vermeersch, 2002). Another study claimed that flints found in an Acheulo-Yabrudian layer (E) at Tabun Cave in Mt. Carmel, were quarried from a place at least two meters deep while more-or-less contemporaneous flints from Qesem Cave were probably surface collected or obtained from shallow quarries (Verri et al., 2004). During the Upper Palaeolithic, deep vertical shafts were created in the Nile terrace, in order to extract desired flints (Vermeersch et al., 1990, 1995). Epipalaeolithic, and especially Neolithic flint sources and quarries have been documented in Israel and Jordan (Barkai and Gopher, 2001; Delage, 2007; Grosman and Gooren-Inbar, 2007; Quintero, 1996; Rosenberg et al., 2009; Taute, 1994).

Surveys of flint outcrops, combined with comparisons to raw materials found in relevant prehistoric sites were also conducted. Delage (see Delage, 2007 and references therein) has documented the sources of many flints used in Epipalaeolithic sites in Northern Israel. Druck (2004) has recently surveyed the western slopes of Mt. Carmel and correlated flint sources with knapped flints in Middle Palaeolithic–Epipalaeolithic layers in the Mt. Carmel caves. A comparative study has also correlated the sequence of Middle Palaeolithic–Natufian industries at Raqefet Cave to specific raw material sources in Mt. Carmel and the Menashe Hills (Lengyel, 2007; Nadel et al.,...
2008). Works like the latter demonstrate the potential of combining geological data, flint quarries characteristics, and studies of prehistoric exploitation and production technologies in the Mt. Carmel area – where a long sequence of prehistoric presence is documented (Bar-Yosef et al., 1992; Garrod and Bate, 1937; Jelinek, 1982; Olami, 1984; Shifroni and Ronen, 2000; Weinstein-Evron et al., 2007).

The Nahal Galim/Nahal Ornit quarrying complex is located in the immediate vicinity of several prehistoric sites such as the Epipalaeolithic through Chalcolithic sites of Ain Qedem (Olami, 1984: 52, 56–67; Rosenberg et al., 2011), Middle Palaeolithic/Neolithic site of Ornit Cave (Olami, 1965, 1984: 46, 49–50; Rosenberg and Nadel, 2011) and the Middle Palaeolithic site of Tirat Carmel (Ronen, 1974). The quarries are also
situated only a few kilometers from the Natufian/Neolithic site of Nahal Oren, the Geometric Kebaran site of Neve David, and the Nahal Me’arot caves of el-Wad, Jamal, Skhul and Tabun, representing a long Lower Palaeolithic – Neolithic sequence (Fig. 1).

For a detailed analysis of the study area and its geo-referencing, two complementary information sources were used. For visual referencing, a high-resolution orthophoto of the area was produced by a set of rectified images (Fig. 2a). Additionally, a detailed surface topography was produced from an airborne laser scanning survey (Fig. 2b) of the region. In order to achieve a high level of detail and accuracy in this complex topographic region and its vegetation cover, laser scanning driven analysis was preferred to terrain extraction via image stereoscopy. Point density of the ~1 point/m² provided a high resolution three dimensional description of the study area. The high-resolution laser scan captures not only the surface topography (see Abo-Akel et al., 2007) but also trees and stone debris piles.

GEOGRAPHICAL AND GEOLOGICAL SETTINGS

Mount Carmel extends over an area of ca. 230 km², with its highest summit reaching 546 meters a.s.l. The climate is typical Mediterranean with mean annual rainfall ranging from 500 to 750 mm. The Carmel Fault, a major branch of the Dead Sea Transform, offsets vertically the Upper Cretaceous sedimentary rocks by about 1000 m, while Tertiary structures offset them sinistrally by about 1500 m. Significant vertical and horizontal movements in the Quaternary are manifested by the steep slopes along the trace of the fault, the displaced alluvial fans and stream channels, and the formation of shutter ridges and morphological scarps along the fault trace (Heimann et al., 2007).

The Nahal Galim basin, as part of the western central and northern Carmel, is principally made up of the Main Chalk Complex of the Isfye and Khureibe/Arqan Formations (Picard and Kashai, 1958; Segev and Sass, 2006). Facies changes are common and relate to the proximity of the area to the platform edge during the Cenomanian and Turonian eras (Picard and Kashai, 1958; Ron et al., 1990). Thus, the local formation varies laterally from soft to hard chalk or limestone, and it contains abundant flint horizons, interbedded within the chalk layers. In some places, the flint nodules protrude and even become naturally detached from the rock, as the soft chalk or limestone around them have been eroded over time. The Main Chalk Complex is overlaid by a succession of reef-related limestone, dolomite and an intermediate marl unit, comprising also the Muhraqa Formation. Locally developed volcanic rock units, mostly pyroclastic, are common as lenticular intercalations in the chalk (Segev et al., 2002).

Under the present Mediterranean climate, the dolomite and limestone rocks are subjected to intense chemical dissolution processes, and exhibit typical morphologies of epikarst; but caves, cavities and speleothems are found as well. The rocks are covered by shallow soils of the terra rosa type, combining a fine-grained texture with a high content of stones, and rarely showing any profile development (Inbar et al., 1998). Vegetation on the terra rosa soils is characterized by the Quercus calliprinos – Pistacia palaestina maquis association (Pollak, 1984; Zohary, 1962). Trees hardly grow on the quarrying debris stone piles, though low vegetation may obliterate their contours (a situation also noticed at other quarries and production sites in Northern Israel – see Rosenberg et al., 2008).

Quarrying landscape at Nahal Galim/Nahal Ornit

Dozens of extraction locales and their associated piles (e.g., Barkai et al., 2006: 40) were identified within the surveyed area (ca. 0.5 km², Figs 2–4). Each pile is several meters long and sometimes the piles merge into one another. There are larger piles, one of which is the focus of this study.

Natural flint exposures appear on vertical rock surfaces, with the largest located in Nahal Ornit on the northern slope (Fig. 5). Flint bearing exposures, however, are commonly flat or step-like. In these, the flints are visible as nodules in various dimensions and shapes (Figs 6–8). In the step-like cases, the vertical exposures are usually 50–100 cm high, and henceforth termed extraction surfaces/extraction fronts. Flint is also present as horizontal layers, 5–10 cm thick and with
Fig. 2. (a) Orthophoto of the study area, with Locus 1 marked in a black square; (b) a laser scan image of the same area
Fig. 3. (a) Photo of a sector of the northern bank of Nahal Ornit, showing various flint quarries, with fan-shaped stone piles below, marked by arrows (width of photo *ca.* 60 m). (b) Photo of Locus 1 looking south-west; note that no trees or bushes grow on the stone pile. Arrows mark location of two transects (length of pile is *ca.* 40 m)
Fig. 4.  A fan-shaped pile of debris on the slope of Nahal Ornit

Fig. 5.  A vertical exposure of flint nodules embedded in soft chalk (width of photo ca. 4 m)
The Nahal Galim/Nahal Ornit prehistoric flint quarries

Fig. 6. Flint nodules protruding from hard limestone

Fig. 7. Flint nodules and flint layers exposed in a step-like quarrying front
Fig. 8. Loose flat flint nodules exposed between layers of hard limestone

Fig. 9. A tested flint nodule and a core between limestone blocks, within a debris pile below a quarrying front (scale bar 20 cm)
cortex on both sides. In the latter case, the flint is not homogenous, and cracks and fractures are common.

Large piles of limestone debris are found solely below the extraction surfaces (Figs 3, 4). They are assumed to be quarrying by-products (debris piles), and tested/knapped flint artifacts are common within these piles (Figs 9–11). The piles are mostly fan-shaped, with their top narrow and their bottom (down-slope) wider (Figs 2–4). They are not restricted to small gullies, and it appears that their location is solely correlated with flint outcrops. Importantly, their location is not slope-dependant, as they are present at all heights and locations, from the almost-flat top of the hills down to the wadi floor, regardless of elevation or inclination. The major component of these debris piles are angular limestone blocks and fragments in a variety of shapes and dimensions (see below).

In most locations, flint nodules are protruding from the rock surface (Figs 5–8). This phenomenon is caused by hardness differences between the softer limestone/chalk and the harder flint. In the studied rock formation, the flint nodules are usually homogeneous (and not cracked or fragmented). Thus, in locations where there are many scars of missing flint nodules, as well as many nodules that are broken or tested along the plain of the rock surface, natural processes cannot account for the observed phenomena. These concentrations are defined as flint extraction locales, especially when additional evidence for human activities (flint knapping) is abundantly found in the associated stone piles.

Extraction seems to have been executed in two main ways. One was to directly remove isolated flint nodules. The other was to break large limestone blocks off the natural wall surface, and then extract from them the desired nodules by additional crude breakage.

In some cracked limestone layers, loose flat flint nodules can practically be pulled out by hand, with no need for any tools (Fig. 8). Others could be removed with the aid of simple extracting implements like elongated wedges or ‘chisels’ (Fig. 12), heavy sticks, horns, etc. Both vertical

Fig. 10. A limestone block with an embedded flint nodule, within a debris pile below a quarrying front (scale bar 20 cm)
and horizontal extraction surfaces are common all over the surveyed area. Many are several meters long, though they sometimes merge into one another and comprise continuous occurrences reaching dozens of meters in length.

The debris piles are very common on the southern slopes of Nahal Galim (not on the northern slopes where there are almost no natural outcrops of flint nodules within the bedrock). They are also common on both the southern and northern slopes of Nahal Ornit (a short tributary that runs into Nahal Galim, where most of the current observations were made, see Fig. 1).

**Locus 1**

The largest stone pile recorded so far (Locus 1) is located on the southern bank of Nahal Ornit, where the slope is very gentle (Figs 2, 3b). It is ca. 40 m long (along the down-slope axis) and ranges in width between 5 and 10 m. The thickness (height) of the pile ranges from about 10–20 cm at the margins to at least 50 cm in the center, where the density of stones is very high (Fig. 13). Locus 1 is located diagonally below a shallow gully running down the steep slope, several meters away from its course.

In order to provide preliminary details of the quarry debris pile, two transverse sections were set on the surface of Locus 1 (Figs 3b, 13). These were located across the pile near its upper-southern (10.5 m long) and lower-northern (6 m long) ends. All surface limestone and flint specimens located within each transect were included in the two studied samples (ca. 230 objects). Additional flint items were collected from the surface of the pile in order to enlarge the studied assemblage (Figs 14, 15).

Four cores were found in the studied transects, and additional cores, including a few Levallois cores, were found on the pile’s surface or between the debris (Fig. 14: 8). Flakes and retouched flakes are present while blades are rare. Three limestone pieces with small flint nodules still embedded in them were also recorded. Some
Fig. 12. A heavy-duty chisel-like (splitter?) quarrying tool made of limestone

Fig. 13. Limestone pieces and fragments along the Locus 1 transect
Fig. 14. Elongated worked flint nodules (‘fingers’) (1–4), and flint cores (5–10)
of the most common flint items in this debris pile are elongated (thick or thin) nodules / ‘fingers’. Formal cores (Fig. 14: 6–10), tools anddebitage are less frequent although they are found on the pile surface (Fig. 15).

The worked flints are sharp and there are no apparent breaks; their cortex bears no damage caused by rolling or horizontal movements between the stones of the pile. The flint nodules are completely covered by cortex, usually several mm thick. Nodules are usually 10–20 cm long, though there are smaller and larger specimens. Similar nodules of high quality flints are visible along the slopes and in the bedrock, frequently characterized by brown or black colors and sometimes bearing apparent ‘test scars’ (Figs 9, 11).

Worked flint nodules found in Locus 1 and at various other loci in the area, include natural elon-
gated ‘fingers’ of flint, commonly found in the limestone (Fig. 14: 1–5). These have cortex, which covers most of the specimen, except for one end that usually bears a series of homogeneous flake scars around the perimeter of the piece. The ‘fingers’ appear in the debris piles in various dimensions; the smallest are just several cm long, while the larger objects are 10–15 cm long and more than 5 cm across. Similar items were reported from the Geometric Kebaran site of Neve David (3.5 km to the north), where they include a uniquely incised object, a laterally retouched object, a bladelet core and unmodified specimens (Kaufman, 1999: figs 1, 2).

In addition, somewhat thicker nodules were found in the Natufian layer at el-Wad (ca. 10 km to the south), where their shapes and flaking scars led researchers to identify within them male and female figurines, phallic objects and a zoomorphic representation (Weinstein-Evron, 1998: figs 57–60; Weinstein-Evron and Belfer-Cohen, 1993).

The limestone specimens are mostly angular, with hardly any round or semi-round specimens. Several objects appear to bear knapping signs, with flake scars and even negatives of the bulb of percussion. Elongated blocks and fragments 10–20 cm long are common, some with one sharp edge (resembling crude heavy chisels or splitters, Fig. 12).

We measured the maximum length of all the stones in the two transects (Fig. 16). While most limestone pieces are less than 20 cm long (ca. 98% in each strip); within the 3–20 cm range, the distributions in the two strips vary. In strip 1 (topographically lower), 89% of the stones are 3–11 cm long, while in strip 2 they form 59%. In strip 2, 38% are between 12–20 cm and only 9% in strip 1. Thus, the topographic higher strip has relatively larger stones within this length range.

The ratio of worked flints (tools and cores) to limestone specimens is 0.043 for strip 1 (n = 94 items) and 0.064 for strip 2 (n = 133 items). As noted earlier, flint items comprise a small fraction of the pile, and their size range is within the most common size of the limestone pieces.

**SUMMARY AND CONCLUSIONS**

Preliminary survey and investigations at the Nahal Galim / Nahal Ornit drainage system, suggest that a complex of extensive flint quarries and production workshops was operating on the lower western slopes of Mt. Carmel during prehistoric periods. Our initial work has shown that several quarrying and extraction strategies were employed, of which two are clearly identified so far. The first is the extraction of relatively loose nodules from cracked layers. The second is the quarrying of large limestone blocks, and then splitting them in order to extract inner flint nodules. Both created large fan-shaped debris piles below the flint exposures (Fig. 4). The second approach also created step-like quarrying surfaces along the relevant bedrock layers (Fig. 7).

While the dates and duration of local flint extraction and tool manufacture are yet to be studied, the presence of Levallois cores suggests that the quarries operated at least since the Middle Palaeolithic. In addition, the elongated ‘fingers’ strongly suggest the use of the quarries during the Geometric Kebaran and Natufian periods. The proximity of the quarries to the nearby Ornit Cave and to other Middle Palaeolithic and later prehistoric sites in Mt. Carmel, could imply that the Nahal Galim/Nahal Ornit complex was a main source of raw material for these sites. Furthermore, it is plausible that prehistoric inhabitants of Mt. Carmel and the Coastal Plain were occasionally performing part of the knapping activities at the quarries, as could be attested from the presence of flint cores and tools intermixed with the limestone components of the debris piles.

The intensity of quarrying and production activities at the Nahal Galim/Nahal Ornit complex
suggests the site was a center for flint extraction during a long period. Future studies will focus on topics such as the distribution patterns of the quarries and production loci in Nahal Galim and Nahal Ornit drainage system, the organization and technology of flint quarrying and knapping, the chronology of the site and its relation to prehistoric sites in the area.

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