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Obsidian in Transition: the Technological Reorganization of the Obsidian Industry from Petras Kephala (Siteia) between Final Neolithic IV and Early Minoan I

Cesare D'Annibale

Introduction

In the Aegean and Mediterranean in general, obsidian is often an integral component of Neolithic culture. In Crete, obsidian is present from the earliest Initial Neolithic levels at Knossos and continues to occur in varying proportions throughout the Neolithic and into the Late Bronze Age (Evans 1964: 231, 233; Carter 2004a; Conolly this volume). During this long period of usage, significant changes in production and consumption can be detected (*e.g.*, Carter 2003; 2004a), among the most significant of which is the appearance of a pressure flaked blade industry at some point during the FN–EM I period. Prior to FN, pressure-flaked blades are as good as absent from Cretan obsidian assemblages, principally the IN–LN assemblage from Knossos (Conolly this volume) and by EM II morphologically similar prismatic blades are a feature of most sites around the island. The precise nature and timing of this change have long been unclear. The recent excavation of an uninterrupted FN IV–EM I stratified sequence at the site of Petras Kephala in east Crete (Papadatos this volume; Tomkins this volume: table 3.1) has thus presented a rare opportunity to isolate and study this revolutionary change in obsidian industry in greater detail. Although Petras Kephala is unlikely to have been the ultimate place of origin of this change, it provides substantial evidence for observing processes of innovation and change in procurement, technology, production and consumption in a single location.

Provenance

The main sources of obsidian exploited throughout the Neolithic and Bronze Age in the Aegean are located on the island of Melos, at the sites of *Dhemenegaki* and *Sta Nychia*. The distinctive varieties encountered at these two sites usually allow macroscopic identification through use of variables such as colour, banding and translucency. Both varieties exhibit comparable quality and flaking properties, but different chronologies of exploitation, with the Dhemenegaki source being more popular during the Neolithic (Carter 2003: 78; Pappalardo *et al.* 2003). Although few analytical results have been published to date, all analysed samples from FN Phaistos proved to be Dhemenegaki obsidian, while the majority of EM I and all EM II samples from Phaistos and Ayia Triada were from Sta Nychia (Pappalardo *et al.* 2003). In general, a preference for Sta Nychia obsidian is a Bronze Age phenomenon on Crete (Carter 2003).

Preliminary macroscopic study of the FN IV–EM I obsidian assemblage from Petras Kephala indicates that Sta Nychia obsidian was the preferred variety during both the FN IV and EM I phases of occupation. The Dhemenegaki source plays a secondary role accounting for roughly 15% of the assemblage. Four groups of non-Melian obsidian were also identified in FN and EM I contexts, each comprising only a few pieces. Amongst these were a few possible pieces of Yali obsidian. While the well-known speckled obsidian from Yali lacks the flaking properties that might render it workable to the same degree as Melian obsidian, a new Yali source of markedly better quality has recently been identified in association with a FN site (Bassiakos *et al.* 2005: 18). For a definitive picture of which obsidian sources were used, we must await the results of further analytical work. On present evidence, however, east Aegean (Yali) and Anatolian obsidian sources are less common in east Crete than geographical proximity might had led one to expect.

Technology, Production and Consumption

The Petras Kephala obsidian assemblage consists of 1376 pieces, of which 1235 may be assigned to deposits laid down during FN IV and EM I. Although the EM I assemblage is larger, the relative proportions of the various artefact types remain constant between the two periods. Blades and flakes respectively constitute 30% and 8% of the FN IV assemblage and 29% and 9% of the EM I assemblage and splintered fragments are equally represented at 62% in both periods. The recovery of flakes from the initial shaping of cores is a clear indication that much of the obsidian was arriving in the form of raw nodules and not in prepared cores from some other processing or distribution sites. Flakes from initial blade core preparation are typically the rarest form of debitage produced. Included amongst the splintered fragments in the FN IV assemblage are 34 fragments of exhausted cores. The actual number of cores is likely to be smaller, as many of these fragments could derive from the same original core. Twice as many core fragments were recovered from EM I contexts.

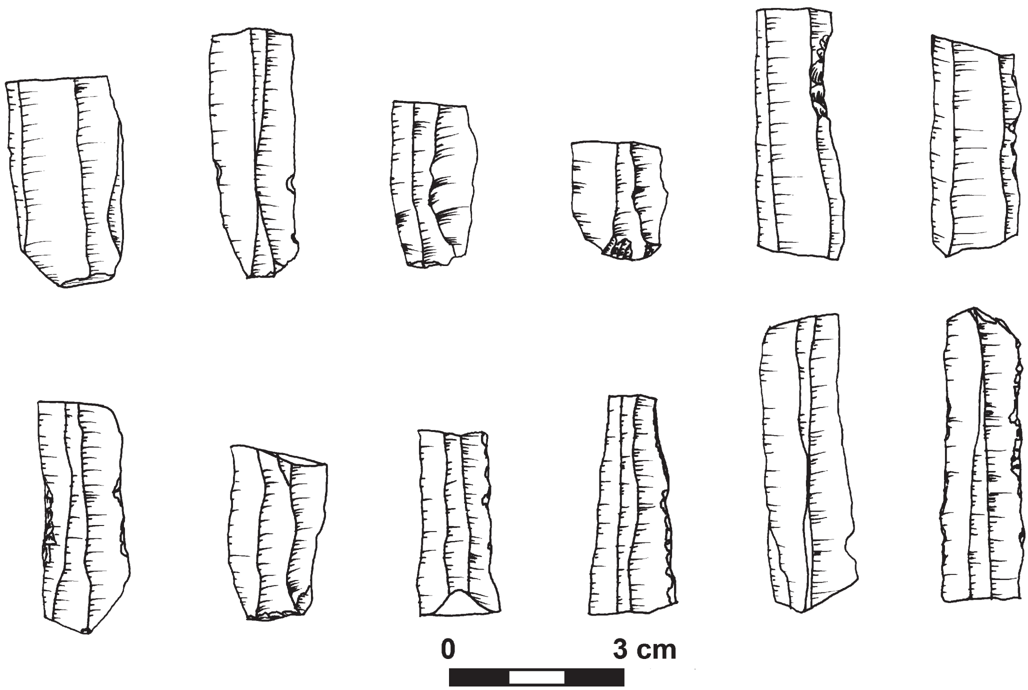
Although obsidian is frequently present in Neolithic and Early Bronze Age lithic assemblages, it is important to try to quantify the volume of obsidian in circulation during any given period, before making statements about high or low frequencies. Replication experiments have shown that a single core weighing 500 g can produce over 300 pieces of debitage (D'Annibale and Long 2003). Since the FN IV–EM I obsidian assemblage from Petras Kephala can be traced back to a very low number of cores, the entire assemblage could be accounted for by a series of interspersed and sporadic arrival episodes over the course of the life of the settlement. This would suggest relatively limited access to the source of the raw material, something also indicated by the use of a particular technique, known as the bipolar or anvil technique. This technique maximizes the amount of usable material by reducing the remnants of exhausted cores and is thus regarded as secondary and sequential to that of the blade industry. Bipolar technology is common throughout the Neolithic and the Bronze Age. At Petras Kephala it is represented by an impressive 795 splintered pieces from the total of 926 pieces of waste from the FN IV and EM I assemblages and is commonly used to reduce blades and blade segments. The above evidence implies an exceedingly high level of 'obsidian stress' at the site and the most economic explanation for this is limited access to the raw material. Although the obsidian industry was geared towards blade production, some flakes were used as expedient tools. Flake utilization is primarily a Neolithic tradition at Petras Kephala. The FN IV component comprised 40 flakes, of which 30 had been utilized. This aspect of the industry, whereby use was made of waste products from the shaping of blade cores, is virtually absent (n=1) from the EM I obsidian assemblage. What makes this all the more notable is the extensive recycling of obsidian blades and core fragments during EM I. Despite the need to maximize the amount of obsidian available, perhaps to overcome the lack of incoming supply, the inhabitants chose not to utilize flakes. This radical neglect of a potential source of tool blanks must be related to a focus on selected activities necessitating the use of standardized blades.

Blade production at Petras Kephala is evenly represented in both FN IV and EM I assemblages. There are major differences, however, in blade morphology between the two periods. Neolithic blades (Figure 12.1) are typically large and many can be classified as flake/blades (here the term 'blade' is used rather loosely). Although they roughly correspond to classic forms, such as trapezoidal, triangular and multifaceted types, most exhibit individual attribute variables. Typical attributes include ragged or irregular incurving or outcurving lateral edges, inconsistent dorsal ridge spacing from previous blade removals and inconsistent length, width and thickness. Overall, very few blades are mirror images of each other, although limited quantities of carefully executed blades do exist (Figure 12.2 top row).

A novel aspect of the FN IV Petras Kephala blade industry is the presence of blades and bladelets that conform to a stricter sense of proportion (Figure 12.3 top row). Bladelets are also present alongside blades in the FN IV obsidian assemblage from Nerokourou in west Crete (Christopoulou 1989; Tomkins 2007:

Figure 12.1. (right) Final Neolithic blades from Petras Kephala.

Figure 12.2. (below) Large blades from Petras Kephala: Final Neolithic IV (top row) and Early Minoan I (bottom row).



44). The attributes of these classic pressure-flaked prismatic bladelets conform to characteristics also observable on later Minoan blade forms produced on small tabular cores. These are rarely more than 5–6 cm in length and consistently less than 1.5 cm in width with the median clustering just under 1 cm and with lateral edges that exhibit a consistent width from just below the platform to just above the distal end. Differences in morphology are insufficient to allow typological distinction between FN IV and EM I examples at Petras Kephala (Figure 12.3 bottom row). These bladelets foreshadow a blade form that was to become the hallmark of later Minoan blade assemblages (D'Annibale in press b).

During EM I, the increased standardization of the blade industry is well

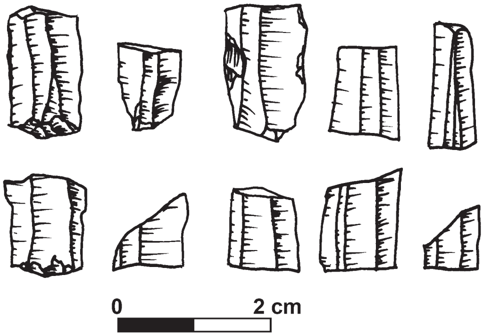


Figure 12.3. Bladelets from Petras Kephala: Final Neolithic IV (top row) and Early Minoan I (bottom row).

Figure 12.4. Microlith from bladelet from Petras Kephala.

illustrated by the fact that all tool types were now formed using blade blanks. Blades were retouched in order to create scraping edges, notches, and borer ends. Aside from their obvious use in a complete state, blades were also intentionally snapped to create segments or subjected to burin blows to create beaks or graving points to be used in composite tools. The most refined formal tools to be produced in this way are geometric microliths. Medial fragments of blades were segmented to sections less than 1 cm in size and then retouched to create working edges. Microlithic tools are exquisitely made and specifically intended for detailed work, possibly as drill bits, in association with other lapidary industries. A single example of such a tool, a trapeze, was recovered from a mixed FN/EM I context at Petras Kephala (Figure 12.4). Although no examples of this particular tool type have been reported from contemporary sites, 30 examples of microliths, dating from the EM II to LM periods, are known from the nearby settlements of Petras and Ayia Photia (D'Annibale in press a). These items appear to have a wide distribution in Crete, with examples known from EM sites such as Myrtos, Archanes, Platanos and Mochlos (Jarman 1972; Carter 2004b).

Although comparison with other FN–EB I obsidian assemblages around the Aegean is still in process, some general comments can be made. Blade production, subsequent burin technology and utilization of flakes are the main elements linking the Petras Kephala obsidian industry with that of the broader Aegean. Perhaps the closest parallels for the FN IV assemblage are to be found at FN IV Nerokourou, which presents almost identical blade forms and consumption patterns (Christopoulou 1989). A small number of blades and flakes are also present in FN III and FN IV contexts from Trench FF at Knossos (Evans 1971: pl. V; Tomkins 2007: 38, 41–42), although their technology of production remains to be clarified.

Some of the EM I blades from Petras Kephala (Figure 12.2 bottom row) bear a close resemblance to those from the EM I cemetery at Ayia Photia (Davaras 1971). Large prismatic blades, such as these, are characteristically long and wide and are produced using a macro-blade core. Thereafter, EM I macro-blade cores are restricted to mortuary contexts on Crete. They are generally regarded as a Cycladic element in the EM I assemblage from Ayia Photia, where they occur alongside other Cycladic or Cycladicising material culture of Kampos Group type (Day *et al.* 1998). Their presence at Petras Kephala, whose EM I assemblage lacks material of Kampos Group type and may thus partly or wholly pre-date Ayia Photia (Papadatos this volume), suggests access to a similar production technology and raises the possibility that Cycladic influence in the Siteia Bay area began at slightly earlier in EM I (pre-Kampos Group) than is currently envisaged. So far, however, none of the other studies of material from the site have produced corroborative evidence of Cycladic links. An alternative interpretation, based on the longer history of obsidian production now available from Petras Kephala, is that these large prismatic blades developed out of what is essentially a FN tradition of blade production. Large EM I blades from Petras Kephala are generally distinguishable from their FN IV counterparts by their more consistent dorsal scar spacing. As with some of the small bladelets, however, some EM I and FN IV large blades are typologically so close as to render them indistinguishable were it not for the independent dating evidence available. Such similarities suggest an industry in transition.

Obsidian Distribution Within the Site

At Petras Kephala the FN IV rectilinear structure and its associated extramural areas display the greatest concentration of obsidian with frequencies far in excess of those observed in rooms of the EM I complex (Papadatos this volume, fig. 15.3). There is also good evidence for blade production and consumption within the same space during FN and it would also appear that there was as much utilization of obsidian in adjoining *open* areas as there was in intramural contexts. Blade concentrations are, however, highest within the FN IV *structure* (n=80). On the other hand, the evidence from the EM I complex of rooms suggests a more restricted use of obsidian. Although obsidian was recovered from every room, only four of the rooms produced more than 50 pieces each and only one room produced more than 10 blades (n=14). These contrasts in distribution between FN IV and EM I may indicate changes in the use of space, with perhaps greater functional specialization emerging in EM I. The confinement of obsidian consumption to certain rooms in the EM I complex and the limited quantity of obsidian from outdoor areas may be indicative of restrictions in production and/or consumption to which obsidian was becoming subject. Although there is little indication of specialized activity within the EM rooms, the internalization of obsidian production and consumption is a noteworthy forerunner to what was to be the norm in the later Bronze Age.

Technological Developments

The reorientation of the obsidian industry in Crete has been attributed to the transition from the use of a conical core in the Neolithic to a tabular core in the Bronze Age, a change that is generally evident in the rest of the Aegean as well (Van Horn 1980). The adoption of tabular cores may have gone a long way towards formalizing blade production. However, a mere change in shape alone would not result in such marked blade standardization and other factors must have been in play. Evidence from Petras Kephala suggests that changes in the technique of obsidian tool manufacture may be directly linked to the introduction of metal tools.

The likely practice of metallurgy at FN IV Petras Kephala (Papadatos 2007; this volume) and the scarcity or absence of direct evidence elsewhere in Crete at this time imply some sort of restricted, specialized production of metal objects and tools. In obsidian production, the replacement of a billet made of stone, wood, bone or antler by a copper equivalent is a natural one and privileged access to such copper billets may have facilitated certain technical developments in the FN IV obsidian industry at Petras Kephala. Although no such tool has been recovered, copper punches have been associated with the obsidian industry in later Minoan contexts, including MM II Petras (Evely 1993: 86–96; D'Annibale in press c). Moreover, microscopic examination of a number of core fragments, primary flakes and blades in the FN IV obsidian assemblage from Petras Kephala has revealed impact marks that are characteristic of a metal punch. These appear in the form of tiny circular impact marks or Hertzian cracks on the platform of blades and flakes. Such marks are typically produced by the application of force by a sharp indenter. Of more interest is a number of flakes and blades that exhibit trails consisting of semicircular or partial Hertzian cracks (Figure 12.5). The trails are evidence for a pointed tool slipping along the surface with pressure being exerted at a consistent level, but without enough force to produce a successful detachment (Lawn and Marshall 1979: 70–72). A degree of caution should be maintained here as the difference between experimentation and accident can be somewhat ambiguous. Experimental percussion on obsidian with a metal punch leaves single impact marks that may not be readily differentiated from trampling impact marks caused by stone grains and gravels. However, the trail of partial Hertzian cracks, such as that reproduced by Lawn and Marshall, is much harder to produce accidentally because concentrated and consistent pressure is needed.

For the most part the obsidian specimens that display these marks derive from FN IV contexts. Another interesting aspect is the near exclusive use of Dhemenegaki obsidian for this experimentation. These impact marks are perhaps an indication of initial experimentation with metal punches during FN IV. It is important to note that the use of a metal punch on its own does not eliminate variation introduced by the vagaries of the individual knapper. The application

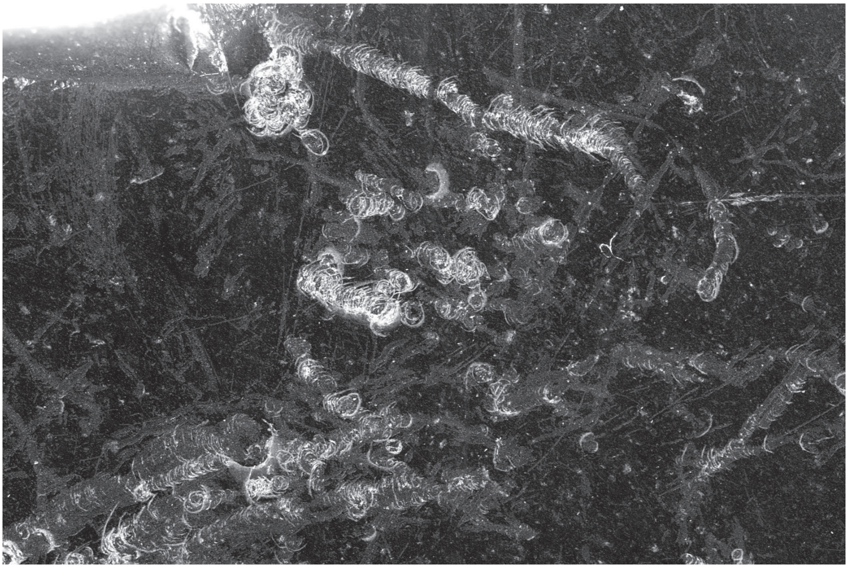


Figure 12.5. Partial Hertzian cracks on a Neolithic blade from Petras Kephala.

of consistent force is not guaranteed with each strike and knapping with a metal punch is still prone to slippage and mis-hits that may disrupt a successful blade detachment. Rather, blade technology could not become fully standardized until some sort of core holding device was employed in conjunction with a simple lever mechanism to apply consistent pressure. As such, classic parallel-sided prismatic blades struck from a small tabular core do not become the norm until after the EM I period.

Conclusion

Precisely when a local obsidian pressure-flaked blade industry first manifests itself on Crete remains unclear. What is clearer, thanks to the evidence from Petras Kephala, is that the technology and production of obsidian goes through a period of transition between FN IV and EM I. What distinguishes the obsidian assemblage from Petras Kephala is the co-existence of blade types produced by different mechanisms in both FN IV and EM I contexts.

By EM I blade production becomes standardized to such a degree that blades are near mirror images of each other. The switch to a standardized blade manufacturing process seems to be aided by the use of metal flaking tools, the earliest evidence for which occurs in the FN IV obsidian assemblage. It is suggested here that a key enabling factor in the development of greater standardization is the introduction of metallurgy, specifically, privileged access to metal tools. That said, however, the hand-held pressure method, even assisted by metal tools, cannot on its own entirely eliminate individual variation and replicate proportions on a consistent basis. This can be overcome with a core holding device that incorporates a metal punch or pressure-flaking lever device. In this way, the reduction of obsidian inevitably becomes restricted to those with access to such specialised tools, thus removing access to obsidian technology and tools from general distribution among the community. This process of exclusion by technology seems to begin in FN IV with the arrival of metallurgy.

The restriction of obsidian consumption to specialized and formal tasks is likely to derive from socio-economic factors. In the later Bronze Age, obsidian becomes not only restricted to major sites, but also directly tied to specific authorities within these sites and its role in the realm of socio-political ideology is demonstrated through a conspicuous association with ritual and power (*e.g.*, Carter 2004a). It seems that the beginnings of this trend away from the fulfilment of household tasks can be detected during the crucial transition between FN IV and EM I at Petras Kephala.

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