

AN INVESTIGATION
INTO EARLY DESERT
PASTORALISM

EXCAVATIONS AT THE
CAMEL SITE, NEGEV

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THE CAMEL SITE OBSIDIAN ANALYSES, SYNTHESIS, AND IMPLICATIONS

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MICHAEL GOTTESMAN

The use of obsidian as a raw material for chipped stone tools in the Near East has been known since the earliest analyses of Neolithic stone tool assemblages in the region (e.g., Braidwood 1948:120). The special properties of the material—ease of knapping, especial sharpness of edges, and its point source origins—were implicitly recognized very early in the history of work in the region. In the Near East, the analytic potentials of the material were pioneered in the 1960s with the development of methods for compositional characterization and hydration dating. Chemical characterization of obsidian provided precise definition of origins and allowed models of distribution and exchange to be developed (e.g., Renfrew et al. 1966). Hydration analysis, less utilized in the Near East, allowed for independent dating of artifacts (Ambrose 1976).

The recovery of three small obsidian artifacts (Figure 9.1) from the Camel Site constitutes the first discovery of obsidian in Early Bronze Age contexts in the deserts of the Negev and Sinai. However, in light of the well-established presence of obsidian in the Negev during the Pre-Pottery Neolithic B (PPNB) (e.g., Cauvin 1991, 1994; Perlman and Yellin 1980), especially from the site of Nahal Lavan 109 (Burian and Friedman 1988; Burian et al. 1976), the issue of the specific origins

of the three pieces needed to be addressed before conclusions concerning the significance of the discovery could be drawn. Hydration analysis of the artifacts supports an Early Bronze Age attribution. Only after establishing the Early Bronze Age affinities of the artifacts could the significance of the elemental analysis indicating a source in eastern Anatolia, in significant contrast to the exclusively central Anatolian source of Negev PPNB obsidian, be interpreted.

BASIC DESCRIPTION OF THE OBSIDIAN ARTIFACTS

Three small obsidian artifacts were recovered from the Camel Site. The obsidian itself is black with some gray banding. All three were recovered in the southeastern quadrant of the site—in fact, outside the actual architectural remains (Figure 9.2). Interestingly, several unusual small flakes of black flint were also discovered in this area. Dimensions, provenience, and technical type are summarized in Table 9.1. Each piece shows a well-defined bulb of percussion and a narrow striking platform. None show characteristics associated with the more standardized knapping technologies of the third and fourth millennia B.C.E., for example, the bladelet technologies of the

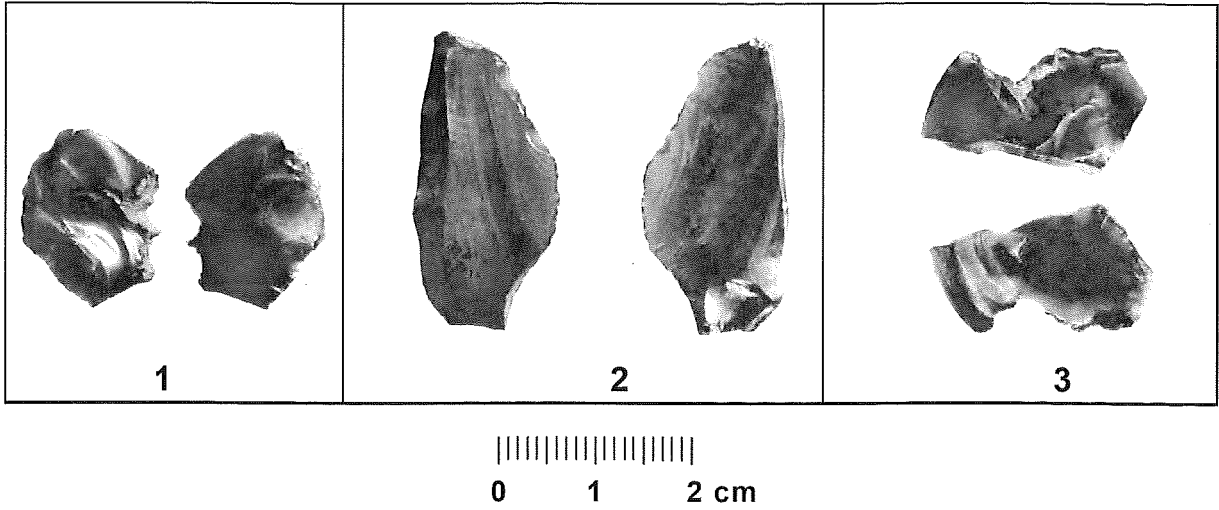


Figure 9.1. Obsidian artifacts.

Figure 9.2. Plan of the Camel Site showing location of obsidian finds, indicated by O symbols.

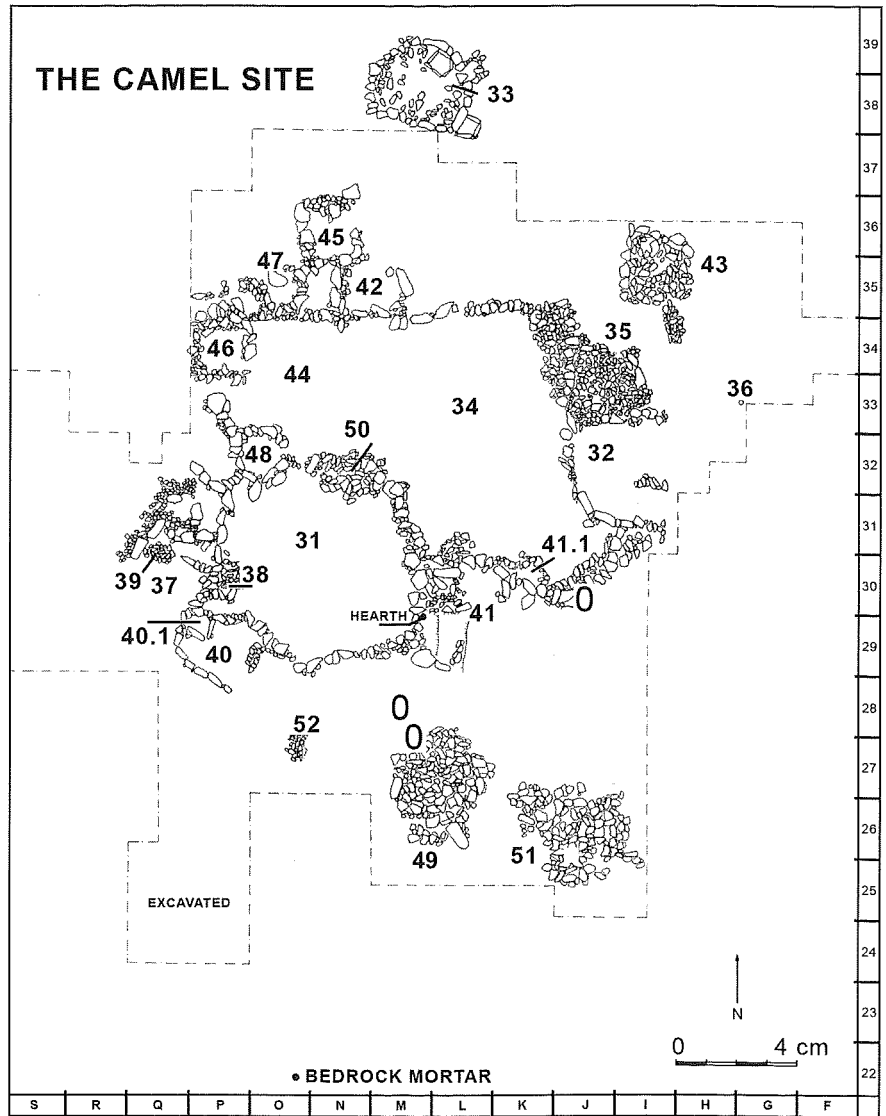


Table 9.1. Summary of Basic Features of Obsidian Artifacts

Provenience Description	Length (mm)	Width (mm)	Thickness (mm)	Mass (g)
M27d upper layer, small blade (USF sample 499)	34	17	4.8	2.34
M28c upper layer, small broken flake (USF sample 500)	25	14	2.5	0.80
J30c surface layer, small broken flake (USF sample 501)	17	19	4.0	0.65

southern Levantine deserts (e.g., Gilead, 1984; Rosen 1997b:65–67). Although one piece (M27d) is technically a blade, it is clear that it is technologically an elongated flake. All three pieces show edge damage caused by trampling and sandblasting, and none show convincing evidence for intentional retouch. Two (M28c, J30c) show broken edges. Dorsal scarring, reflecting previous flake removals, is present on only one piece (M27d). One flake (m28c) has a hinge fracture.

Beyond the specifics of the description of the artifacts, the presence of only three obsidian artifacts on the site and the total excavation of the site with 100 percent dry-sieving through 2–3 mm mesh indicate that the flakes were imported as flakes and not knapped on-site. That is, the absence of obsidian cores and other waste demonstrates that reduction took place elsewhere and that artifacts were imported onto the site as small flakes. A similar case can be made for the few pieces of black flint, also without evidence for on-site production.

COMPOSITIONAL ANALYSIS (R. H. TYKOT)

The three pieces of obsidian from the Camel Site were analyzed as University of Southern Florida samples 499 to 501. Obsidian from geological sources in Turkey is well known at Mesolithic and Neolithic sites in southern Anatolia and the Levant (Cann and Renfrew 1964; Cauvin 1991; Cauvin et al. 1986; Gratuze et al. 1993; Perlman and Yellin 1980; Renfrew et al. 1966, 1968; Wright 1969) and has even been identified as far west as Sitagroi in northeastern Greece (Aspinall et al.

1972). At the same time, obsidian from sources in eastern Turkey and Armenia was distributed to Mesopotamia and also the Levant (Blackman 1984; Gratuze et al. 1993). While the central and eastern Anatolian sources were considered the most likely sources for the Camel Site samples, Aegean, Caucasian, and Red Sea sources were not excluded as possibilities (Williams-Thorpe 1995; Zarins 1990).

Chemical Analysis

Neutron activation analysis has been the most widely used method for the characterization of archaeological materials, but it does not provide bulk compositional data, it is not inexpensive, and commonly it is destructive to artifacts. Furthermore, it has been demonstrated that nearly all the Mediterranean, European, and Near Eastern obsidian sources may be distinguished based on their major element chemistry (Francaviglia 1984; Keller and Seifried 1990; Tykot 1997, 2002). X-ray analysis using the electron microprobe is an optimal analytical technique for obsidian sourcing, as only a tiny 1 mm sample is required for quantitative analysis and the instrumental cost is very low on a per-sample basis. A batch of 18 samples can be prepared and analyzed in several hours. This technique has been used for obsidian sourcing in Europe (Bíró et al. 1986), the Mediterranean (Tykot 1996, 2002), Anatolia (Keller and Seifried 1990), and East Africa (Merrick and Brown 1984a, 1984b).

Samples 1 mm in size were removed from the Camel Site artifacts, mounted in an epoxy disk 1 inch in diameter, and polished flat using

successively finer grinding compounds. Nine elements were then quantitatively determined using an electron microprobe equipped with wavelength dispersive spectrometers. Standard mineral and rock reference materials were analyzed to ensure the accuracy of the analyses and their comparability with other laboratories and other techniques; as few as 100 ppm of some elements are detected, and precision is better than ± 5 percent for most elements—almost always better than the range in variation within a single obsidian source. Two spots 40 microns in diameter were analyzed on each sample to ensure against heterogeneity; the beam was positioned with an optical microscope to avoid analyzing microlite

inclusions. The resulting data were then normalized to 99 percent to eliminate the effects of variable water content and to enable comparison with existing obsidian source databases produced using similar techniques (e.g., Bíró et al. 1986; Francaviglia 1984, 1990a, 1990b; Keller and Seifried 1990; Tykot 1996).

Results

All three Camel Site obsidian artifacts are peralkaline (high alkalis and iron and low aluminum concentrations) (Table 9.2), immediately eliminating most of the Mediterranean and Near Eastern sources. For the remaining peralkaline

Table 9.2. Electron Microprobe Analyses of Obsidian Artifacts from the Camel Site

USF	SiO ₂	Al ₂ O ₃	TiO ₂	Fe ₂ O ₃	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	MnO	BaO	Total
499a	74.40	11.09	0.10	2.85	0.00	0.08	5.64	4.14	0.01	0.04	0.00	98.35
	74.89	11.16	0.10	2.87	0.00	0.08	5.68	4.17	0.01	0.04	0.00	99.00
499b	74.61	11.08	0.10	2.82	0.00	0.09	5.74	4.07	0.00	0.03	0.05	98.60
	74.92	11.12	0.10	2.83	0.00	0.09	5.76	4.09	0.00	0.03	0.05	99.00
Mean	74.90	11.14	0.10	2.85	0.00	0.08	5.72	4.13	0.01	0.04	0.02	99.00
Std	0.02	0.03	0.00	0.02	0.00	0.00	0.06	0.06	0.01	0.00	0.04	0.00
500a	74.88	10.61	0.13	3.36	0.00	0.13	5.56	4.45	0.00	0.04	0.00	99.16
	74.76	10.60	0.13	3.36	0.00	0.13	5.55	4.44	0.00	0.04	0.00	99.00
500b	74.45	10.57	0.12	3.34	0.00	0.14	5.42	4.49	0.02	0.04	0.00	98.59
	74.77	10.61	0.12	3.35	0.00	0.14	5.45	4.51	0.02	0.04	0.00	99.00
Mean	74.76	10.60	0.12	3.35	0.00	0.14	5.50	4.48	0.01	0.04	0.00	99.00
Std	0.01	0.01	0.01	0.00	0.00	0.00	0.07	0.05	0.01	0.00	0.00	0.00
501a	73.89	10.58	0.12	3.26	0.00	0.16	5.50	4.33	0.01	0.05	0.01	97.91
	74.71	10.70	0.12	3.29	0.00	0.16	5.56	4.38	0.01	0.05	0.01	99.00
501b	73.94	10.42	0.13	3.25	0.00	0.14	5.58	4.38	0.01	0.05	0.00	97.90
	74.77	10.54	0.13	3.29	0.00	0.14	5.64	4.43	0.01	0.05	0.00	99.00
Mean	74.74	10.62	0.12	3.29	0.00	0.15	5.60	4.40	0.01	0.05	0.00	99.00
Std	0.04	0.11	0.00	0.00	0.00	0.02	0.06	0.03	0.00	0.00	0.00	0.00

sources (Pantelleria, Bingöl, Nemrut Dag, and the Red Sea region), analytical data have been published by Gratuze (1998, 1999), Poidevan (1998), and Francaviglia (1990a). Although there are some differences in absolute concentrations of silicon and aluminum between the Camel Site artifacts, attributable to systematic differences in analytical methods, the Bingöl A source (including Cavuslar and Orta Duz) in the Lake Van region of eastern Anatolia is the best match.

HYDRATION ANALYSIS (M. GOTTESMAN)

Obsidian hydration dating converts a hydration layer to an absolute date utilizing an established rate for the inward diffusion of molecular water using the equation $x = kt^{.5}$, where x is the hydration rind width in microns (μ), k is the hydration rate at a specific temperature/relative humidity, and t is time in thousands of years. Since 1960, obsidian hydration dating (OHD) has seen a number of developments that have increased our understanding of the hydration process (e.g., Friedman and Long 1976). These studies, mostly laboratory based, have addressed the two primary sets of hydration forces: compositional dependence (Friedman and Long 1976; Stevenson and McCurry 1990) and environmental factors (Mazer et al. 1994).

The major tasks in OHD are to determine the rim width and the hydration rate for the specific artifact. The rinds are presently measured by optical microscopy on thin sections. Other methods, including acousto-optical and secondary ion mass spectrometry (SIMS) (e.g., Stevenson et al. 2001) are being developed, and the measurement process is also being constantly improved with computer-assisted imaging. In practice, the accurate determination of the rind width is the greatest variable in OHD due primarily to variable weathering processes.

Hydration Methodology

The determination of hydration rates was based on high-temperature (160 °C) laboratory procedures and then calibrated to ambient site conditions using the Arrhenius equation (Friedman and

Long 1976; Laidler 1984; Lee 1969; Mazer et al. 1992; Stevenson and McCurry 1990): $k = A (RH)^{\exp E/RT}$, where k is the archaeological hydration rate, A is the exponent at 160 °C, RH is the relative humidity, E is the activation energy, R is the universal gas constant, and T is temperature. New obsidian glass flakes were subjected to various temperatures and reaction media over various time depths, and the hydration rate constants (A , E) were calculated (Ambrose 1976; Mazer et al. 1992; Stevenson and McCurry 1990).

Rind width measurement is as follows. A thin section slide is prepared for each sample. The rind thickness was measured by taking five independent measurements under a Jenaval model polarizing light microscope with a Leitz filar micrometer attachment at 625 \times power. The rind or depth of water diffusion is visible because the rind of obsidian with added external water ions refracts light at a different angle than the internal parent material. The diffused water lowers the density and changes the speed of light passing through the sample. The light wave is bent as it enters the glass and at exiting. This double refraction causes the phenomenon of birefringence. This might be caused by the straining of the glass that results from a slight expansion due to the entrance of molecular water, often referred to as strain birefringence (Ross and Smith 1955). All flake surfaces visible in cross section on the microscopic slide are carefully examined. Usually there are only two surfaces visible, such as the dorsal and ventral surfaces of a flake. In practice, however, more than two surfaces (reuse or retouch edge flake scars) are sometimes found. Only clearly visible intact hydration rinds with well-defined diffusion fronts are measured.

A measurement consists of the average of five measurements made at one point on the hydration rind. Measurements are made for each distinct hydrated surface for which a clear hydration rind is visible. The resulting measurements from various surfaces are themselves averaged if they are within 0.4 microns. If the variability is greater than 0.4 microns, they are reported separately (often diagnostic of reuse). Normally, a reported measurement is either a single or the average of two hydrated layers.

All reported measurements should be accurate to within ± 0.2 microns. Although this measurement error in theory could be used to calculate a confidence range for the date, other factors, such as environmental change over time, may cause variation in hydration rate and deviation between hydration years and calendar years.

Calculation of dates based on the piece-specific rate method uses only the smallest verified rind from each sample, based on the assumption that the smallest measurement is more likely to date the last knapping episode.

The effect of the chemical composition of obsidian on the hydration rate has been addressed theoretically (Ericson 1981) and by correlation of high-temperature hydration rates with glass chemical constituents (Friedman and Long 1976). Recent work by Mazer et al. (1992) and Stevenson et al. (1998) has shown dependence between connate water (OH⁻) of the specific obsidian sample and the rate. Additional work (Stevenson et al. 1993) done on the Coso volcanic field in California showed that the range of natural or connate water varied enough, even within a given volcanic flow, that each artifact needed to be measured. The process of determining the water content via infrared spectroscopy for each sample to be dated would have put a serious damper on the utilization of OHD.

Pioneering work by Ambrose (1979) and Stevenson et al. (1988, 1993, 1998, 2000) established relationships between the rate of hydration, the amount of intrinsic water (probably due to the depolymerizing effect of water ions on the silica matrix), and density. This work (especially Stevenson et al. 1993) also determined that the amount of water varies significantly from sample to sample in a single obsidian source, requiring artifact-specific measurements of this variable (density) for the purpose of rate estimation.

The amount of intrinsic water is the currently identified major internal chemistry factor, and there is a quantifiable proxy relationship between relative density and intrinsic water. The density measurement utilizes the weight in air versus the weight in liquid of each sample of obsidian, taking advantage of the Archimedean principle. This gravimetric method was utilized here. Weights were taken on a scale valid to four decimal places

(with a Mettler AG104 balance), using a heavy liquid to increase surface adhesion and reduce bubbles, thereby reducing errors.

The algorithms that determine how to go from density to water content to effect on hydration rate are available in software from Stevenson. These algorithms include correction factors for calculating density for the special liquid's temperature and for laboratory-to-laboratory calibration using a master quartz wedge.

The rate or speed of hydration (a higher rate means a younger date for a given rim thickness) is affected by the quantity of water ions available in the surrounding atmosphere, referred to as relative humidity (RH). Friedman et al. (1994) review the algorithm defining the relationship between relative humidity and hydration rate.

The other significant environmental factor affecting obsidian hydration is the rate of chemical reaction. This is defined by the Arrhenius equation (Laidler 1984), which requires measurements of the temperature at which the reaction is taking place. Because the temperature at any site changes constantly, a means that "averaged" the temperature, accounting for the greater effect of temperature rise versus temperature drop on the chemical reaction, was developed. This "average" is known as the effective hydration temperature (EHT). The superior method for measuring EHT and RH is via saturated salt cells buried for one year at various depths in a site. The weight change over a year is then used to calculate EHT and RH (e.g., Trembour et al. 1990).

Another method for estimating EHT is to use air temperature data from weather stations using Lee's equation (Lee 1969). However, air temperature is not equal to subsurface temperatures, and our experience indicates that air temperature data used in Lee's equation results in EHTs understated by several degrees. This can have a significant effect on the calculation of dates. Therefore, some reports use an EHT calculated via Lee's equation multiplied by a "correction" factor.

A different type of salt cell may be used to measure RH, another critical variable. Usually, EHT and RH cells are buried in pairs at various depths in a site to provide a profile of environmental variability with depth. In the absence of cell data, RH may be more easily estimated than

EHT, assuming that the RH approaches 95 to 99 percent in most sites below 20 cm. The accuracy of any study of age determination is highly dependent upon this data, which is greatly enhanced if it is from the use of site-specific cells.

The current thinking on obsidian hydration dating is best summarized by three major assumptions (Stevenson et al. 2000):

1. Obsidian sources will have a range of hydration rates that are a function of the variation in intrinsic water content;
2. There is no observable relationship between trace element concentrations and the intrinsic water content;
3. Ambient temperature and relative humidity conditions significantly influence the rate of obsidian hydration.

Thus a piece-specific hydration rate method, applied here, utilizes three analytical procedures:

1. Measurement of the hydration rind thickness;
2. Measurement or estimation of soil temperature and relative humidity;
3. Calculation of rate constants determined from glass composition (the Ambrose/Stevenson relative density/intrinsic water method).

The Samples from the Camel Site

This approach to the estimation of hydration rates differs from earlier methods that were largely or entirely empirical, wherein hydration rim depths were “matched” to associated non-obsidian dating information to create a source-specific hydration rate. This method results in a hydration rate for each artifact. Given the need to test the archaeological associations, hydration rates could not be “matched” to the actual Camel Site date, ca. 3000 B.C.E., for obvious reasons of logic. However, to better control the relative dating of the artifacts, samples were also run from the known-age site of Nahal Lavan 109, an early Pre-Pottery Neolithic B site dating to the first half of the ninth millennium B.C.E. (calibrated),

about whose associations there was no question (Burian and Friedman 1988; Burian et al. 1976).

For this analysis, two or three slides were made for each sample. This was done due to the difficulty in finding a reading from an accurate rind. The sample size is small, and there is obvious “sandblasting” damage to most of the surfaces. The water content was determined gravimetrically, as discussed above. For the environmental factors, RH was estimated to be 97 percent (from salt cell data as measured from similar sites in the California Great Basin). For EHT, the more sensitive and more important factor, weather station data from Mitzpe Ramon was used for the Camel Site, and data from Sderot was used for Nahal Lavan 109. This factor was also compared with similar data from the California Great Basin, Death Valley, and Mojave weather stations and with salt cell data from Inyo-182 (another site in the western Great Basin area).

The results of the obsidian hydration dating for these two sites are somewhat better than simple relative dating. As an absolute dating technique, however, these results are promising but suffer from two major problems, sample size and rind measurement.

For the Camel Site, only three artifacts were recovered and available for measurement. Data are summarized in Table 9.3. The water-content percentages were very consistent, and it is felt that the environmental factors are reasonable, although salt cell data would be preferable. The rind size, however, measures 6.1 microns on OHL 16200, and this is the “cleanest” reading. For 16198 the rind read 5.0 microns, and for 16199 the rind was 5.2 microns, but both are on pieces that showed sandblasting. There is no known method of determining how much of the outer edge has been worn away. We have arbitrarily added 10 percent to the rind readings of three samples (two from the Camel Site and one from Nahal Lavan 109) to provide a perspective on the possible variability in the dates. The resultant range of “roughly usable” dates is 1850 to 5200 B.C.E.

For Nahal Lavan 109, five debitage samples were utilized. Only OHL 16222 had both a rhyolitic-level water percentage (0.1279 percent by weight) and a readable rind of 10.5 microns (dating provided at 10.5 and at 11.6 microns, or plus

Table 9.3. Obsidian Hydration Data Summary

OHL	Grid	USF	Rind (microns)	Mass (g)	EHT	RH %	RH (by Weight)	Hydration Rate	Age BP	B.C.E.
Camel										
16198	M27d	499	5.0	2.34	22.37	0.97	0.1105	6.6	3801	1851
	Upper	499	5.5						4597	2647*
16199	M28c	500	5.2	0.80	22.37	0.97	0.0989	5.5	4943	2993
	Upper		5.7						5981	4031*
16200	J30c	501	6.1	0.65	22.37	0.97	0.0958	5.2	7128	5178
Nahal Lavan 109										
16222			10.5	1.41	26.40	0.97	0.1279	13.0	8536	6586
			11.6						10328	8378*
16223			3.2	2.89	26.40	26.4	-0.0036	13.0	Aberrant	
16224			No hydration value	1.89	26.40	0.97	0.2304	28.7	Aberrant	
16225			4.4	0.54	26.40	0.97	0.3881	52.9	Aberrant	
16226			11.4	2.39	26.40	0.97	6.7352	757.9	Aberrant	
			11.4	2.39	26.40	0.97	0.1279	13.0	9937	7987**

NOTE: EHT for the Camel Site is taken from Mitzpe Ramon. EHT for Nahal Lavan 109 is taken from Sderot. USF refers to the composition analysis by Tykot.

*Added 10% to rind to adjust for sandblasted surface.

**Water content estimated using sample 16222 measurement.

10 percent, to possibly account for weathering). Samples designated as OHL 16223, 16224, and 16225 had both very erratic water contents and no reasonably sized rinds. Sample OHL 16226 did exhibit a good readable rind at 11.4 microns, but the water content (at 4.5224 percent) is off scale. So to provide at least one other date, the relative density and thus water content of 16222 was used. The result suggests a rough range of 6600 to 8400 B.C.E.

between the Pre-Pottery Neolithic B materials and those deriving from the Early Bronze Age. In other words, the Camel Site obsidian reflects a contemporary connection with Anatolia and not the mere looting or collection of materials from early local sites. This distinction is also supported by the differing water contents of the artifacts, suggesting the likelihood of different sources. The chemical composition analyses conducted by Tykot are also in accord with these conclusions.

Hydration Analysis Summary

For our purposes, the key result of the hydration analysis is the clear distinction that can be drawn

DISCUSSION

The discovery and analysis of three obsidian artifacts from the Early Bronze Age Camel Site offer

several conclusions beyond the linkage with Anatolia (Figure 9.3). In particular, the results indicate that the basic structure of the Negev–Anatolia Early Bronze Age exchange link contrasted in all its particulars—source, route, and function—with that of the Pre-Pottery Neolithic period, the only other period for which obsidian has been recovered in the central Negev.

In terms of sources, Pre-Pottery Neolithic B obsidian from the central Negev, as defined by Nahal Lavan 109 (Perlman and Yellin 1980), derives exclusively from Cappadocia in central Anatolia. In general, southern Levantine Pre-Pottery Neolithic obsidian originates primarily from central Anatolia, although in later periods, the later Neolithic and the Chalcolithic, eastern Anatolian

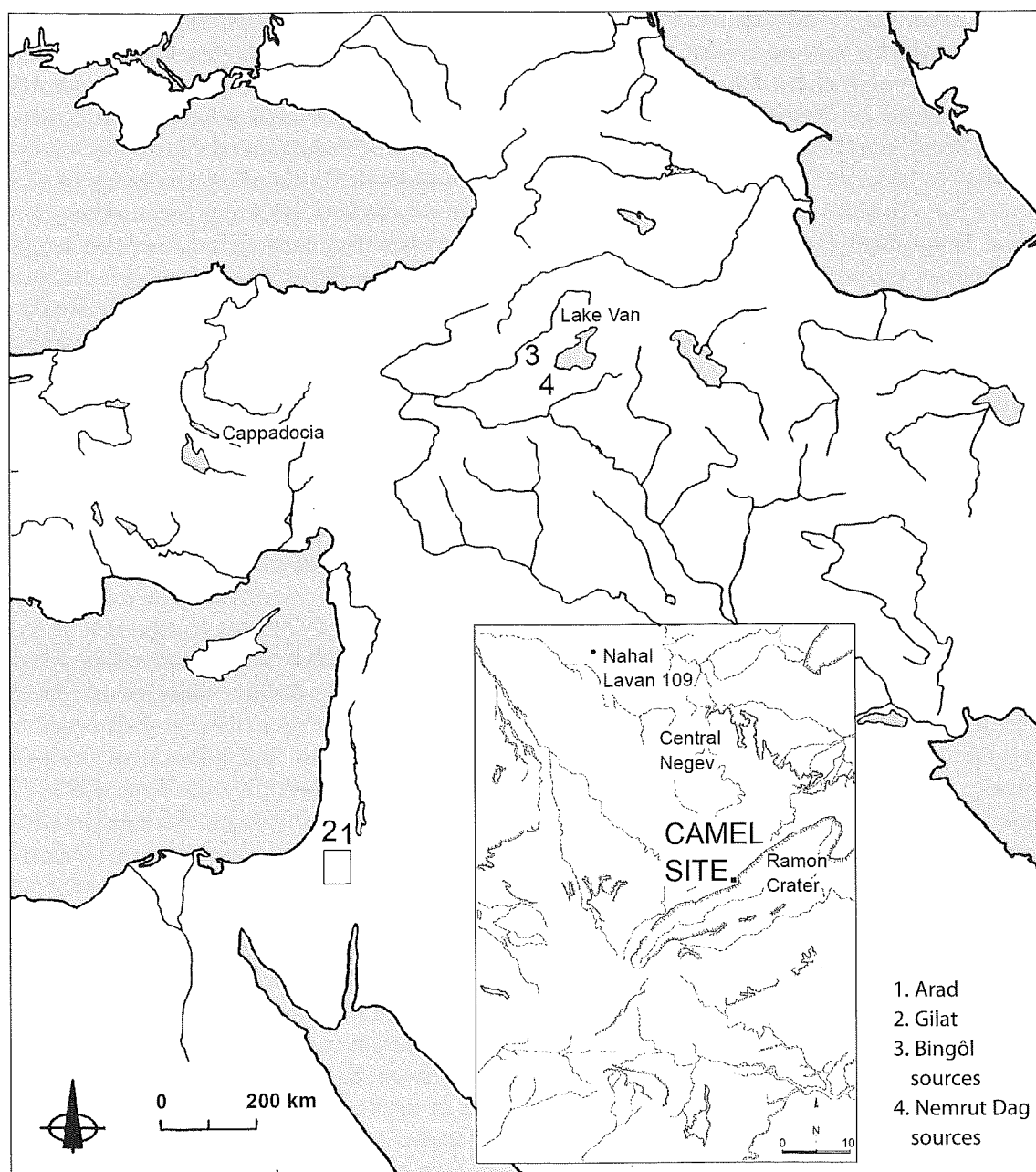


Figure 9.3. Sites and locations mentioned in text.

sources are also evident (e.g., Cauvin 1994: figure 4; Gopher et al. 1998). However, even when eastern Anatolian obsidian is present, as at Chalcolithic Gilat (Yellin et al. 1996), the central Anatolian sources dominate. The contrast with the Camel materials, deriving from the Lake Van area in eastern Anatolia, is obvious.

In terms of route, although the difference in sources between the periods suggests the possibility of different transport routes, the key issue is really that in the Pre-Pottery Neolithic B, one can trace a continuum of obsidian from central Anatolia through the western Levant and down to the deserts of the southern Levant in a fall-off curve interpreted by Renfrew (1975, 1977) as down-the-line trade. That is, there are numerous PPNB sites in Israel and Palestine with obsidian, and there is no major geographic gap in the distribution from north to south. Data from other periods remain too scanty for reasonable reconstruction. Garfinkle (1993) notes the general decline of the obsidian trade with the end of the Pre-Pottery Neolithic.

In significant contrast, Early Bronze Age sites in the southern Levant are lacking obsidian. Even given the very small number of artifacts recovered from the Camel Site, the absence of obsidian from geographically intervening sites, especially from the known desert gateway city at Arad (e.g., Amiran et al. 1997; Finkelstein 1995:67–86; Kempinski 1989), strongly suggests that there was no down-the-line obsidian exchange through the Mediterranean zone of the southern Levant. The only other alternative is a route through the Syrian and Jordanian deserts.

Finally, in terms of function, the differences between obsidian and flint in terms of raw material properties are reasonably straightforward. Obsidian is structurally amorphous. It is thus more easily knapped and capable of achieving a sharper edge than flint. It also tends to have a glossier and smoother surface than flint. Access to obsidian in the Near East is also more restricted than access to flint. On the other hand, flint is a stiffer, less brittle material and is somewhat harder. The larger number and range of flint sources result in greater heterogeneity and hence variability in its basic attributes. These differences are reflected in the archaeological record in what

appears to be a greater preference for obsidian in areas where it is readily available and an added value where it is present but scarce.

In the Neolithic Levant, both materials were exploited in the production of chipped stone tools, in spite of the scarcity of obsidian. Thus PPNB obsidian assemblages, especially as exemplified by the materials from Nahal Lavan 109 (Burian and Friedman 1988; Burian et al. 1976), include a large range of tool types, typologically identical to those made from flint, and the complement of debitage reflecting local production. Obsidian, while probably perceived as something special and perhaps more valuable than local flint, was nevertheless traded and treated as a raw material for the production of tools.

In post-Neolithic times, the range of uses of obsidian broadens, including jewelry, magic, medicine, vessel manufacture, mirrors, and sculpture (Coqueugniot 1998). The three pieces recovered from the Camel Site reflect a fundamentally different phenomenon from the Neolithic. They are not tools in a lithic technological sense; nor can they in any way be interpreted as raw material for tool manufacture. Furthermore, as indicated above, the absence of any production waste in a 100-percent-sieved site (2–3 mm mesh) indicates clearly that they were chipped elsewhere and imported to the site as small flakes. Thus their only value can lie in their trinket status as rare objects and cannot derive from any utilitarian function. In this they are akin to the other trinket-type artifacts recovered from the excavations, including pink quartz crystals, shells and shell beads from the Mediterranean and Red Seas, freshwater mother-of-pearl (Nilotic?), the several black flint flakes found near them, and perhaps small local fossils (Chapter 10). Notably, the Camel Site shows evidence for ostrich eggshell bead production (Rosen 1997a; Chapter 10).

These basic contrasts in the structure of the obsidian trade in turn suggest conclusions concerning both the nature of the obsidian exchange in the different periods and its role in the respective societies. Returning to the general characteristics of ancient Near Eastern obsidian exchange as down-the-line trade (Renfrew 1975, 1977), a key element in this trade is the mobility of the agents of exchange. Bar-Yosef and Belfer-Cohen

(1989) have suggested that hunting parties operated as prime agents in the movement of goods and the exchange of ideas in the Pre-Pottery Neolithic B—in fact, serving as the glue cementing the Levantine interaction sphere into an integrated unit. For our purposes here, the key point is that PPNB mobility—hunting—extended throughout the Levant, even in the Mediterranean farming zone, and it constituted a primary activity among large segments of the population. That is, the proportion of the population engaged in hunting must have been quite high, and thus the movement of goods such as obsidian was relatively straightforward.

In contrast to this system of relatively high-mobility hunting, albeit tethered to sedentary villages, Levantine Early Bronze Age society was primarily urban and sedentary, with an economy based on cereal agriculture, arboriculture, and domestic herd animals. Although one could attempt to make the case that the pastoral component of this society played a role similar to that of the hunters of the PPNB, the parallel is not justified, if for no other reason than the unlikelihood that more than a fraction of the urban Early Bronze Age population engaged in herdsman husbandry (see Khazanov 1984:22 for a definition of herdsman husbandry).

Thus the absence of obsidian in the Mediterranean zone is perhaps comprehensible, a function of increasing sedentism. This would also explain the decline in obsidian exchange in the later stages of the Neolithic and the Chalcolithic. On the other hand, the development of peripheral pastoral nomadic societies on the desert fringes—that is, the Camel Site, both in the east and the south (e.g. Betts 2001; Garrard et al. 1996; Rosen 2002a, 2002b)—provides a rationale for the alternative route suggested earlier and an agency of exchange for that route. As with the PPNB hunters, the high mobility of these early mobile pastoralists offers the means for the movement of obsidian from the Anatolian source area. Unfortunately, we are still lacking the intensive exploration of these regions necessary to confirm this hypothesis.

The significance of the trinket trade for Early Bronze Age desert nomads should not be underestimated. Wiessner (e.g., 1984) has noted the

role of reciprocal exchange among the Kalahari San, providing one of the basic glues of the social system. The scarcity of such artifacts as Anatolian obsidian may suggest that they were valuable. The presence of other beads and trinkets, deriving from a variety of sources, indicates the range and variety of trade connections. The combination of value and variation reflects the importance of the trinket trade to Early Bronze Age desert pastoral society (Chapters 10 and 13). The apparent structural transformation of the obsidian trade from its relatively utilitarian Neolithic antecedents to the Bronze Age trinket trade can be tied to the fundamental evolution of Near Eastern societies from Neolithic farmer-hunters to the complex and variegated societies of early historic times.

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