Chapter 1

FURTHER STUDIES OF ANCIENT BLACK GLASS: OBSIDIAN TRACING AND HYDRATION DATING TULARE LAKE WIDESTEM POINTS

Jerry N. Hopkins, Alan P. Garfinkel,
Alexander K. Rogers, Tim R. Carpenter and Craig E. Skinner

Abstract: *Widestem points are to some degree common at the Witt Site (Ca-Kin-32) locality of Tulare Lake. Within the Hopkins collection, there are 101 examples of widestem points that were complete enough to allow classification. These artifacts were manufactured from a variety of toolstone materials. Most of these points were fashioned from locally available chert (cryptocrystalline silicate = ccs) and other materials (fine grained volcanics = fgv) including basalt, fine grained igneous (aka rhyolite), quartz (crystal, milk white and rose) and quartzite (n = 65) along with (n = 36) specimens made of obsidian (obs).*

Virtually identical point forms to the Tulare Lake Widestems are recognized from Northern California and are identified at the Borax Lake Site (CA-LAK-36) and in the larger vicinity of the Clear Lake region. Those North Coast Range projectile point forms (known as Borax Lake Widestem Points) appear to overlap in age with both fluted points and crescents, but continue to be employed until a more recent era discontinuing at a time estimated to be 6,000 years cal b.p.

In the present study, we formally classify Tulare Lake Widestem Point forms from Tulare Lake found within the Witt locality and determine whether they are of comparable age to other early Holocene artifacts recovered from Borax Lake. The entire sample of formally classifiable Tulare Lake Widestem Points manufactured from obsidian was analyzed to both chemically characterize these artifacts as to provenience (geographic source) and to determine their obsidian hydration measurements.

Obsidian studies appear to date the Tulare Lake Widestem Points to an average age of 8,250 calibrated years before present. Applying a single standard deviation added to that mean or average provides a time range for the bulk of the Tulare Lake Widestem assemblage from ca. 7,500 to 9,000 years ago.

Source determinations for Tulare Lake Widestem show that imported obsidian was coming from Fish Springs, Coso, Annadel and Casa Diablo obsidian sources. Most of the obsidian Widestems at Tulare Lake came from the Casa Diablo suite of obsidian sources. This obsidian toolstone contributes a significant portion to the Widestem assemblage and testifies to long range movement and the value of the imported toolstone to the indigenous people who occupied Tulare Lake.

INTRODUCTION

Proveniences for Tulare Lake Widestem Points

Jerry Hopkins was the first to identify and describe the Tulare Lake Widestem Points, all of which were found in surficial contexts recovered mostly within boundaries of the Witt Site locality. These points have not previously been formally defined as a specific type of projectile point for the Tulare Lake region. Loci numbers (1 - 15) of the Witt locality were assigned by Hopkins to identify specific sub-locality collection zones where Paleoindian artifacts were found on Tulare Lake's fossil shorelines (Township 23 South, Range 20 East) at elevations between 190 and 195 feet amsl (above mean sea level), a contour interval that marks the level at which Lake Tulare stood during late Pleistocene/early Holocene times. These eroded shorelines were well below the 210 foot shoreline of more recent high-stands that placed these artifacts under water for several millennia.

Raw Material Selection

Most of the Tulare Lake Widestem Points were fashioned from local toolstone materials consisting of chert (ccs) and fine grained volcanic materials (fgv) available within the nearby Jacilitos Creek drainage (about 15 miles [24 km.] southwest of Coalinga [two days walking distance from Tulare Lake]. See Figure 1.1 for raw material selection. Also, obsidian (obs) toolstone material that originated from five different California volcanic glass source locations were imported and most likely traded into the Tulare Lake region and used for both projectile points and other tool forms. These volcanic glass sources will be the subject of some discussion later on in this report.

Two widestem points (DL2JH44 and DL2JH48) were initially misidentified as being made of obsidian. They were fashioned from grey or black glassy material which is similar in appearance to obsidian artifacts recovered from Tulare Lake as well as other California locations. They were ruled as *not obsidian* by Craig Skinner. Upon close examination, we later identified the points as being fashioned from fused shale originating from Monterey Formation shale deposited throughout the Pacific Rim during the Miocene.

There are at least three sources of fused shale in California. The primary sources are located in Grimes Canyon (Ventura County), a little south of Fillmore and Happy Camp Canyon (Santa Ynez Valley, Santa Barbara County). The Chumash exploited fused shale toolstone for weapons and tools for 8,000 years or more.

TULARE LAKE WIDESTEM POINT IMAGES

One hundred-one (101) Tulare Lake Widestem Points from the Jerry Hopkins Collection were sorted and photographed for this study (see Figures 1.2 – 1.11).

OBSIDIAN GLASSY ROCKS

Obsidian is a compact natural volcanic glass that occurs as crusts on lava flows or as the outer layer of swollen volcanic domes. It develops because of the rapid cooling of melts that are usually gas-rich. When its composition is silica-rich, obsidian belongs to the rhyolite family. There are also trachytic, andesitic and phonolitic obsidians. Once cooled, obsidian can be shattered like glass into sharp, conchoidal (curved) fractured fragments. It is typically jet black and sometimes colored by titanium oxide and other materials. Streaks and swirls of oxide can make broken surfaces look like color-flowed marbles, i.e., brown and black-streaked “mahogany” obsidian.

Obsidian, together with flint, was considered a much valued raw material for flaked stone tools because of its sharp-edged fracture and its great hardness (Mohs’ hardness 5-5 ½) (Schumann 1993:238). Because obsidian fractures with a beautifully curved glass-sharp edge, it can easily be fashioned to make tools and weapons such as knifes, blades and projectile points even better than flint. Consequently, it was much-admired among early cultures of Native Americans.

Because obsidian absorbs water once it is broken, ancient obsidians can be accurately dated by measuring their hydration rind thicknesses. Just how much water their surface layers have absorbed has allowed modern-day scientists to determine ages of specimens by using contemporary, source-specific, temperature-dependent obsidian hydration dating methods and equations.

Exotic Colored Obsidian

Obsidian is natural glass that was originally molten *magma* associated with a volcano. It is most often black in color, but may be about any color ranging from clear to opaque. Glass Buttes, Oregon has produced a variety of exotic gem-quality obsidian including mahogany, red, flame, midnight lace, jet black, pumpkin, brown, rainbow, gold sheen, silver sheen, green, lizard skin, snowflake and more (Bakken 1977).

So far with the exception of black, only mahogany brown or red obsidian "streaked" with different layers or colors has been found at Tulare Lake by Hopkins. However, Hopkins has seen several mahogany obsidian points in other collections from Tulare Lake. These colors generally result from tiny crystals or inclusions of hematite or limonite (iron oxide). Only one source for this type of colored obsidian toolstone material found at Tulare Lake has so far been identified. The material has been chemically characterized as originating from Buck Mountain in Modoc County. No doubt, our stone-age ancestors living in the Tulare Lake Region placed great value on colored obsidian since they imported this very special obsidian that originated from such great distances.

ANALYSIS OF TULARE LAKE WIDESTEM POINTS

X-Ray Fluorescence Analysis

With permission from Northwest Research Obsidian Studies Laboratory (personal communication with Craig Skinner 2008), TULARG borrowed a portion of his introduction to obsidian characterization studies as follows:

> Although a variety of physical, optical, petrographic and chemical attributes are used to characterize volcanic glass; certain trace element abundances have been demonstrated as the most useful to "fingerprint" obsidian sources and artifacts. The use of X-ray fluorescence analytical methods has shown the greatest overall success for raw material sourcing. X-ray fluorescence has ability to nondestructively and accurately measure trace element concentrations in obsidian and has been widely adopted for this purpose.

Figure 1.12 in this study provides a map of obsidian source locations in California and western Nevada that includes the sources we identified for the Tulare Lake Widestem assemblage (Tables 7 – 12 are located at the end of the manuscript). Table 7 identifies the specific source determinations and hydration measurements for the Tulare Lake Widestem obsidian artifact sample - Table 8 the distribution of artifacts by geochemical source along with estimates of straight-line and topographically sensitive walking distances from these sources to Tulare Lake - Table 9 source-specific hydration measurements - Table 10 attributes and metrical data for TLWS points - Table 11 attributes and metrical data for the OBS points and Table 12 lists miscellaneous artifacts for the Tulare Lake obsidian points.

Obsidian Hydration Analysis - Analytical Methods

Obsidian hydration measurements and hydration results were obtained through the services of the ArchaeoMetrics Obsidian Hydration Laboratory on Tulare Lake Widestem Points that were submitted for analysis. General procedures for determining metric rim (or rind) thicknesses for these specimens were followed. Initially, it was established that the best area in which to cut a portion of the obsidian specimens was determined. Two parallel cuts were made on the appropriate portion of the specimen using a lapidary saw mounted with two four-inch diameter diamond-impregnated .004-inch blades. The base or notches of projectile points were then cut. Weathered specimens were addressed in the same manner. On average, the majority of thin section cuts yielded samples averaging 0.35 millimeters in thickness. Samples were mounted with “Lakeside” thermoplastic cement onto sequentially numbered microscope slides. Generally, five specimens were mounted on each slide. The samples were then manually ground to reduce thickness, allowing specimens to be read under the microscope. First, slurry of water containing six-hundred silicon-abrasive grit was mixed on a glass plate. Grinding was accomplished in two steps. The initial grinding rendered the surface flat and removed the saw cut marks from one side of the specimen. The specimen was then flipped, remounted and the second side was ground to proper thickness for viewing under the microscope. Ultimate thicknesses of the specimens measured between 30-50 microns, depending on opacity or unique source-specific quantities such as hardness of obsidian vs. softer obsidians.

The prepared slides were then measured using a “Meiji” petrographic microscope fitted with a “Lasico” digital filar eyepiece. Once a defined hydration rim was observed on a color monitor screen, the hydration rim was centered in the middle of the monitor to reduce parallax and measured using a micrometer. Typically, ten measurements are taken from each specimen. However, due to imperfections in the stone, weathering or damage to the surface from the saw or grinding as few as three measurements were recorded. Surfaces exhibiting cortex were also recorded and identified as such. Hydration values were recorded to the 0.01um (nearest 1/10 [tenth] of a micron) and both the mean and standard deviation for each specimen were computed.

Archaeometrics (2009) submitted the following report regarding an analysis of obsidian Widestem specimens from Tulare Lake:

> In all, 48 obsidian Tulare Lake Widestem Points were submitted to ArchaeoMetrics Inc. for analysis. These artifacts exhibited signs of surface abrasion and moderate to severe weathering. In order to obtain the most accurate hydration rim readings, internal hydration rims were selected that were associated with areas that exhibited internal fractures and what is known as “step” fractures. Both the ventral and dorsal sides of each specimen were examined. Of the 48 artifacts, 42 were cut multiple times (re-cut) due to weathering. Four of the 48 artifacts had no visible hydration rim values (despite re-cuts),

12 artifacts had two rim values (hydration rim readings) and one artifact had three rim values. A total of 59 individual and distinct hydration rim values were obtained from the obsidian Tulare Lake Widestem assemblage.

ATLATL DART POINT IDENTIFICATION

Arrow and Dart Point Determinations

In David Thomas' key for the Great Basin, he indicated that a basal width of less than 10.0 mm was used for an arrow and if the projectile point exceeded a basal width of 10.0 mm it should be classified as a dart point. Thomas based his assessments working with a very large projectile point sample throughout the larger Great Basin. However, Robert Yohe's efforts (Yohe 1992; 1998) based on the more regionally restricted assessments resulted in a slightly different set of determinations for identifying and separating dart points from arrow points.

Yohe determined that arrow point basal width was about 15.0 mm. Measurements greater than this were assigned to the dart point category. Dart points varied from about 8.0 to 15.0 mm. The mean for the Tulare Lake Widestem Point assemblage in this study was 17.6 mm. Hence, according to both Yohe' and Thomas' assessments, the Tulare Lake Widestem Points are all dart points.

Dart point lengths overlapped with arrows; but arrows measured from 12 mm to 41 mm in length and darts were from 35 mm to 65 mm. During Van Buren's (1975:31) testing experiments, it was determined that a 6 to 7-foot long dart performed best and was the most consistent.

Hafting - Slot or Socket

The most commonly used method for hafting (cf. Van Buren 1974:19-20) was that which was accomplished by sawing or abrading a notch in the forward end of an arrow shaft. The notch usually varied from 1/8-inch to 3/16-inch in width and extended from 3/8-inch to 5/8-inch *in depth into the shaft (dart shafts were considerably wider than arrow shafts and they would therefore require a wider notch width to accommodate the wider dart point stem). The base or stem of an arrowhead or dart point was inserted in the slot and was then bound securely with rawhide, sinew or fiber cord.*

Some foreshafts were smaller than the main shaft and designed to fit into a recess in the forward end of the shaft. Most foreshafts, however were fitted over the end of the main shaft because lightweight sections of reed or cane could be slipped over the forward ends of shafts without appreciably affecting aerodynamics of the shaft. The stem of the projectile point was usually seated in the foreshaft against a natural joint and held in place by use of pitch, asphaltum or resin-glue combinations. The stem of the projectile point was seated, as in a socket, thus stayed with the foreshaft and the foreshaft usually remained with the game in which the projectile point was embedded. The main body of the shaft could easily be removed and reused or, if the game escaped, the loosely attached main shaft could fall free from the foreshaft, thereby making the main shaft reusable and the foreshaft disposable.

THE TULARE LAKE ATLATL DART POINT

The introduction of the atlatl and dart weapon-delivery system that provided greater propulsive force to the missile is poorly understood at Tulare Lake since it's not known when the spear-thrower was first introduced. However, we do suspect that spear throwing devices were present among New World Paleoindian hunters (Dixon 1999). The spear or dart thrower served as the principal hunting weapon in the Tulare lake-marsh country perhaps as early as 10,000 to 11,000 years ago (Hopkins 1993:49) and may well have endured into the historic period overlapping the bow and arrow beginning about A.D. 500 (1,500 B.P.) (cf. Wallace (1988:97).

The bow and arrow was a late development in the evolution of weapons and hunting equipment. It was introduced at different times in different places and it appears that the atlatl and dart in the Tulare Lake region, employing a Widestem type missile tip as well as other type projectile points, persisted for a substantial amount of time subsequent to its eventual replacement by the bow and arrow. Van Buren suggests that the throwing stick and dart did not replace the thrusting spear, but instead was employed together with it. Likewise, his suggestion applies to the atlatl and the bow and arrow as well. The first spears may have been a staff of considerable length with a sharpened or fire-hardened wooden tip later being replaced by chipped stone points. Such a weapon could be used to fend off attacking wild animals or to pierce the hide of large game that had become disabled or mired in swampy areas (Van Buren 1974:35).

During its initial occupation, the Tulare Lake Region, no doubt, consisted of lakeside hunting camps with lush hunting grounds close by. During early periods, the atlatl clearly served as the weapon system of choice. Some researchers estimate that atlatls register an impact over 150 times as intense as that of hand-thrown spears. A variety of forms of projectile points, i.e., robust Lake Mohave, Pinto, Elko and various other types of dart points collected from Tulare Lake shorelines were affixed to spears or dart-shafts that were thrown by the atlatl.

Most researchers agree that big game hunting demanded heavy-duty weaponry to bring down mega-fauna. But, as big-game hunting decreased probably resulting from overkill that may have contributed to the extinction of mega-fauna, the development of smaller more efficient projectiles that were more suitable for taking smaller prey animals likely became more important. It is postulated by the authors that the smaller variants of Western Fluted (aka Clovis-like) points found at Tulare Lake were tips for fore-shafted spears and possibly atlatl darts. Both spears and darts could be thrown on flat trajectories at close-range targets and likely would penetrate deep enough to embed the point and a portion of the shaft in the target.

One of the specimens in this sample (DRL1W6164) made of Coso obsidian was fluted on one face and exhibited *channel scratching,* suggesting that it is of ancient age. Early Widestem points with thick cross-sections (common on dart points) could have easily been further reduced in thickness and this reduction in point morphology might have improved accuracy considerably. As suspected, obsidian hydration rim measurement readings used in establishing the chronological placement of obsidian missile tips has postulating ages that place the Tulare Lake Widestem Point in the chronological range of the atlatl, many years prior to the introduction of the bow and arrow in the region.

X-RAY FLUORESENCE ANALYSIS

Attributes and Metric Data

In order to formally define the precise configuration and morphology of the Tulare Lake Widestems, we followed the standardized attribute measurements (see Table 10 and 11) often applied to California and Great Basin projectile points (after Thomas 1970, 1981; Justice 2002). These metrics were employed here to facilitate a comparison of the Tulare Lake Widestem assemblage with the Borax Lake specimens. Mean results for Tulare Lake Widestem Points were compared with Borax Lake Widestem Points following Justice 2002:421, Appendix: Projectile Point Measurements.

Key (attribute measurements in millimeters):

ML	Maximum Length	
MW	Maximum Width	
MT	Maximum Thickness	
NW	Neck Width	Measurement at the narrowest portion of the necks of notched points.
PSA	Proximal Shoulder Angle	Measurement on the side with the lowest angle and most notch closure (employing a polar-coordinate-grid) with zero placed to the left and readings taken moving to the right when reading notch angles).
DSA	Distal Shoulder Angle	Measurement on the side with the lowest angle and most notch closure (employing a polar coordinate-grid) with zero placed to the left and readings taken moving to the right when reading notch angles.
MWP	Maximum Width Position	Measurement from the basal edge to the position of maximum width that can fall anywhere from the base to the tip.
SHW	Shoulder Width	Measurement at the maximum width of the shoulder.
WG	Weight in Grams	

It should be pointed out that some difficulty was experienced in measuring PSA and DSA, resulting from section saw cuts removed from notch openings of several Tulare Lake specimens. Geographic sources and specific hydration measurements for the Tulare Lake Widestem Points are reported in (Table 9 and 12).

OBSIDIAN TRACING AND DATING TULARE LAKE WIDESTEM POINTS

Thirty (30) of the 48 Tulare Lake Widestem (TLWS) projectile points from Tulare Lake were amenable to hydration dating. This Sub-sample of the obsidian TLWS Points was chemically characterized to source. Four geographical-specific obsidian sources were identified in this subsample: Coso West Sugarloaf (WSL, n = 3), Casa Diablo Lookout Mountain (LM, n = 6), Casa Diablo Sawmill Ridge (SR, n = 16) and Fish Springs (FS, n = 5).

The analysis is based on obsidian hydration dating (OHD), using modern temperature-dependent diffusion theory (Rogers 2007) and flow-specific hydration rates (Rogers 2011, 2012). Site temperature parameters were computed from data from Hanford, California (Rogers 2012). The age calculation includes a correction for paleo climatic changes in the temperature regime (Rogers 2010).

Ages were computed for each obsidian specimen individually, using a computer code in MatLab 7.01. The hydration rims were corrected to an effective hydration temperature (EHT) of 20 degrees C; all artifacts were assumed to be surface collected, so no correction for burial depth was made. All age computations assume the hydration rim growth to be proportional to the square root of time, per classic diffusion theory. The ages are given in calibrated years before 2,000 (cyb2k), with probable error.

The analysis employs flow-specific hydration rates. The rate for Coso West Sugarloaf was previously available (Rogers 2011) and the rates for the other three sources were computed as described in Rogers 2012. The rate parameters used here are summarized in Table 1.

Table 1 – Hydration Rates in μ/1000 Years, at 20°C

Source	Subsource	Rate
Coso	West Sugarloaf	17.21
Casa Diablo	Lookout Mountain	12.37
Casa Diablo	Sawmill Ridge	12.05
Fish Springs	(none defined)	11.26

Temperature parameters for the site were derived from data for Hanford, California, station 51, number 034747, downloaded from the website of the Western Regional Climate Center. The data are for a 30-year period, 1981 – 2010. The resulting parameters are as shown in Table 2, with details in Rogers 2012.

Table 2 – Temperature Parameters for Tulare Lake, in °C

Parameter	Value
Average annual	17.00
Annual Variation	15.56
Mean diurnal variation	14.53
Effective Hydration Temperature	19.98

Prior to chronological analysis, the hydration rim data were analyzed for outliers and two data points were removed by Chauvenet's criterion. Two more were removed judgmentally, since they seem too small and may represent surfaces that were reworked. Table 3 presents the input data and Table 4 the resulting ages.

Table 3 – Input Data

Casa Diablo LM		Casa Diablo SR		Fish Springs		Coso WS	
Cat. No.	**Mean, µ**	**Cat. No.**	**Mean,µ**	**Cat. No.**	**Mean,µ**	**Cat. No.**	**Mean,µ**
DRL2JH5	10.45	DRL2JH4	10.05	DRL2JH2	9.59	DRL4JH22-1	11.89
DRL4JH20	10.63	DRL2JH7-1	7.92**	DRL2JH-1	9.68	DRL4JH22-2	12.63
DRL4JH21-1	9.52	DRL2JH-2	10.17	DRL2JH3-2	10.00	DRL3JH33	11.93
DRL4JH21-2	10.50	DRL2JH8-1	9.29	DRL4JH23	10.00	DRL1W6164	12.01
DRL3JH36	10.59	DRL2JH8-2	10.02	DRL3JH34-1	9.55		
DRL4JH38-1	12.44*	DRL2JH11	10.01	DRL3JH34-2	10.02		
DRL4JH38-2	14.04*	DRL4JH13	6.17*	DRL4JH37	9.59		
DRL3JH39-1	8.98	DRL4JH14-1	9.32				
DRL3JH39-2	9.54	DRL4JH14-2	9.99				
DRL3JH39-3	9.89	DRL4JH15	10.50				
		DRL4JH18	9.99				
		DRL4JH19	9.28				
		DRL4JH24-1	10.52				
		DRL4JH24-1	11.47				
		DRL2JH26-1	9.00				
		DRL2JH26-2	10.53				
		DRL2JH27	10.53				
		DRL2JH29	10.30				

	DRL4JH30 10.50		
	DRl4JH31 8.01**		
	DRL3JH35 9.95		

* Removed by Chauvenet's criterion
** Removed judgmentally
Note – hyphenated numbers indicate successive cuts on the same specimen

Table 4 – Ages for Obsidian TLWS Points from Tulare Lake

Cat. No.	Rim, μ	Source	Age, cyb2k	P.E, cyb2k
DRL2JH5	10.45	CDLM	8,626	2,195
DRL4JH20	10.63	CDLM	8,924	2,271
DRL4JH21	10.01	CDLM	7,873	1,417
DRL3JH36	10.59	CDLM	8,859	2,254
DRL3JH39	9.47	CDLM	6,989	1,028
DRL2JH4	10.05	CDLM	7,945	2,023
DRL2JH7	10.17	CDSR	8,380	1,508
DRL2JH8	9.66	CDSR	7,500	1,350
DRL2JH11	10.01	CDSR	8,100	2,062
DRL4JH14	9.66	CDSR	7,500	1,350
DRL4JH15	10.50	CDSR	8,939	2,275
DRL4JH18	9.99	CDSR	8,068	2,054
DRL4JH19	9.28	CDSR	6,886	1,754
DRL4JH24	11.00	CDSR	9,871	1,776
DRL2JH26	9.77	CDSR	7,681	1,383
DRL2JH27	10.53	CDSR	8,990	2,288
DRL2JH29	10.30	CDSR	8,602	2,189
DRL4JH30	10.50	CDSR	8,939	2,275
DRL3JH35	9.95	CDSR	7,995	2,035
DRL2JH2	9.59	FS	7,948	2,024
DRL2JH3	9.84	FS	8,396	1,511
DRL4JH23	10.00	FS	8,678	2,209
DRL3JH34	9.79	FS	8,305	1,495
DRL4JH37	9.59	FS	7,948	2,024
DRL4JH22	12.26	CWSL	8,543	1,534
DRL3JH33	11.93	CWSL	8,056	2,049
DRL1W6164	12.01	CWSL	8,172	2,078

Statistics on the ages are given below in Table 5. Note that the mean ages are indistinguishable statistically; this occurs because of the technique used in Rogers 2012 to compute hydration rates for Casa Diablo and Fish Springs, and may not represent archaeological reality.

Table 5 – TLWS Point Age Statistics, Tulare Lake

Source	Subsource	Mean Age, cyb2k	S.D. Age, cyb2k	CV	N
Coso	West Sugarloaf	8,253	203	0.02	3
Casa Diablo	Lookout Mtn.	8,203	681	0.08	6
Casa Diablo	Sawmill Ridge	8,265	769	0.09	13
Fish Springs	n/a	8,255	279	0.03	5
Aggregated Data		8,248	638	0.08	27

Five data points were excluded from the analysis of central tendency of age. These five points may, however, represent interesting archaeological phenomena, so their ages are reported in Table 6.

Table 6 – Tulare Lake Anomalous Data Points on TLWS Points

Cat. No.	Rim mean, μ	Source	Age, cyb2k	Age P.P., cyb2k
DRL4JH38-1	12.44	CDLM	12,762	3,245
DRL4JH38-2	14.04	CDLM	17,292	4,395
DRL2JH7-1	7.92	CDSR	3,249	831
DRL4JH13	6.17	CDSR	5,148	1,313
DRL4JH41	8.01	CDSR	5,251	1,339

Cat. No. DRL4JH38-1 and -2 represent a single specimen with two obsidian hydration cuts. Both yield dates that are too old to be archaeologically reasonable (12,762 ± 3245 ± 4,395 cyb2k). Either this specimen has unusually high water content or else, more likely, it was exposed to fire at some time in its use life.

Cat. No. DRL2JH7-1 represents one cut out of two on a single specimen. The other cut (-2) on this specimen yielded an age of 8,380 ± 1,508 cyb2k, which is reasonable; however, the -1 cut gives an age of only 3,249 ± 831 cyb2k, possible indicating a point which has been curated and then reworked sometime in the early Newberry Period (2,000 BC – AD 600).

As a final caveat on the entire analysis, the single independent data point is represented by the three Coso West Sugarloaf points. These suggest a central data point with an age of about 8,200 – 8,300 cal BP, or the Mid-Lake Mohave Period (7,000 to 11,000 years before present). Typically when one estimates the suite of readings, one includes a single standard deviation added to that mean or average. With the latter in mind, the bulk of the assemblage would appear to fall within time range from ca. 7,500 to 9,000 years ago (calibrated before present, see Table 5 above).

The ages computed for the other sources are not independent, because the rates for these sources were computed based on the CWSL rate by assuming that the projectile points were manufactured at approximately the same time, irrespective of obsidian source; that they experienced similar temperature histories; and that the growth of the hydration rim is proportional to the square-root of time. This methodology yields valid rates as long as the assumptions are valid, but not otherwise. Thus, the ages shown here must be regarded as tentative pending independent verification of the Casa Diablo and Fish Spring's obsidian hydration rates.

TULARE LAKE AND BORAX LAKE WIDESTEM POINT COMPARISONS

The Tulare Lake Widestem Dart Point is morphologically similar to the Borax Lake Widestem series, recognized at the Borax Lake Site and nearby vicinity of the Clear Lake region by Harrington (1948). Justice (2002:101-105) illustrated and described 14 specimens of Borax Lake Widestem Points; three were fashioned from ignimbrite/obsalt from Lake County, two of basalt from Plumas County, one of chert from Calaveras County, two of Franciscan chert from Lake County and six obsidian specimens from Lake and Sonoma Counties.

Justice (2002:101) points out, the use of the term *square stemmed* (for the Borax Lake Widestems) requires some qualification as this refers to projectile points with lateral margins exhibiting relatively straight edges with a straight to rounded base (Justice's Figure 13). Haft variation ranges from slightly contracting through parallel and slightly expanding. The haft element joins short, horizontal to downward projecting shoulders and a short triangular blade. Edge grinding of the haft element is common but not present on every specimen. Borax Lake Widestem technology is hypothesized to derive from the Great Basin Stemmed cluster, specifically the morphological changes that take place within the Silver Lake type (Justice 2002:108).

Both Tulare Lake and Borax Lake Widestem types appear to follow similar manufacturing strategies and many specimens from both locations show evidence of repeated resharpening. The Borax Lake Widestem type appears well represented at various localities in the North Coast Ranges from Clear Lake to sites in Del Norte, Mendocino and Humboldt counties (Justice 2002:110).

At Tulare Lake, although some isolates have been found nearby, the Widestem type point style occurs predominantly at the Witt Locality on the southwestern side of the lake. Source-specific hydration measurements, morphological attributes and metric data of the specimens were collected and reported in (Table 10). Measurements were taken and mean values are included in the tables for comparative purposes. We have included data for a small sample of Borax Lake Widestem Points for comparisons to Tulare Lake examples. Borax Lake data are from Justice (2002:423).

It is interesting to note, while morphology of the two types is quite similar to the projectile points from both geographic regions, there is substantial variation in the sizes of artifacts in each area. As a result of combining mean values for maximum length, width and thickness for the Borax Lake specimens, we find that the Borax Lake examples are about a third larger than the Tulare Lake Widestem Points. While basal widths for Borax Lake (19 mm) exceed the average of points from Tulare Lake (17.6 mm), both are within suggested atlatl dart criteria. Size variations of the Tulare Lake specimens may be attributed to extensive resharpening that may suggest atlatl weaponry was in use for a greater time span at Tulare Lake or the size of game within the Tulare Lake basin was considerably smaller than that of the Borax

Lake region. Projectile points were often broken during use and rejuvenated for re-use that may have altered profiles of certain specimens, accounting for some of the size differences.

SUMMARY AND CONCLUSIONS

Widestem points are frequently discovered at the Witt Locality on the prehistoric shorelines of Tulare Lake. There are 101 such artifacts in the Hopkins Collection. Most (n = 49) are not fashioned from volcanic glass. Those artifacts within this assemblage are overwhelmingly chert. A few (n = 2) are fine grained volcanic and fortunately a significant complement were obsidian (50).

The metrics for both the obsidian and the non-obsidian toolstone, Tulare Lake Widestems are rather consistent and demonstrate that this form was one widely employed and was somewhat of a template for the prehistoric Tulare Lake Natives. The Borax Lake Widestem Points although very similar in form to those discovered at Tulare Lake were slightly larger. The Tulare Lake Widestems were about a third shorter than those from Borax Lake and they were also slightly narrower on average. We do not believe this was a function of differences in toolstone use – one being dominated by obsidian and the other with a significant complement of chert. The Tulare Lake Natives may have reworked their points to a greater degree in general. Otherwise, both forms were similar in manufacture in the objective to produce a roughly square stemmed dart point.

Obsidian studies appear to peg the Tulare Lake Widestem points to an average age of 8,250 calibrated years before present, or dating to the time span when Western Stemmed Points were popular (Lake Mohave Period, 7,000 to 11,000 calibrated years before present). Applying a single standard deviation added to that mean or average provides a time range for the bulk of the Tulare Lake Widestem assemblage from ca. 7,500 to 9,000 years ago.

Source determinations for Tulare Lake Widestems show that imported obsidian was coming from Fish Springs, Coso, Annadel and Casa Diablo obsidian sources. Significantly most of the obsidian Widestems at Tulare Lake came from the Casa Diablo suite of obsidian sources. The obsidian toolstone was a significant portion of the Widestem assemblage and this testifies to long range movement of obsidian and the value of this imported toolstone to the indigenous people who occupied Tulare Lake from about 7,500 to 9,000 years ago.

ENDNOTES

1. Annadel Hydration Rate

We were unable to confidently develop a source-specific, temperature-dependent hydration rate and apply it to the Annadel obsidian Tulare Lake Widestem points. We reviewed the existing literature and given the small sample from Tulare Lake we did not feel we could validly calculate a hydration dating equation with specific applicability to the assemblage of Widestem dart points from Tulare Lake as their numbers were so few and the data so minimal.

2. A Possible Obsidian Cache from Dudley Ridge (Tulare Lake)

While this report does not directly pertain to Tulare Lake Widestem Points, the authors acknowledge that obsidian caches found in the region are rare and worthy of note and discussion.

What may have once been a obsidian storage or cache pit containing three hunks of unworked obsidian material was unearthed by local collectors on the highest elevation of Dudley Ridge on the south side of Tulare Lake (once Tachi Yokuts territory). This obsidian material was likely intended to be recovered later by its owner/s for use or trade. The largest specimen was an unreduced piece weighing 23 pounds (10,160 grams). The other two pieces, 14 ounces (397 grams) and 17 ounces (485 grams) are of more common sizes of obsidian that Native American Indians (master explorers) transported via established trade routes. Thick knapped blanks of material were often reduced in size at the source and other locations along trade routes for later refinement into finished tools or weapons. Such rough-shaping of raw material removed cortex and other less desirable material for knapping finished products. It also reduced weight of the load enabling transporters to carry more of the higher quality stone for sale or exchange over impressive distances.

In North America, raw obsidian is generally only found in localized areas of the West, where the process of plate tectonics have created geologic conditions favorable to volcanism and the formation of obsidian (Bakken 1977). These obsidian specimens found at Tulare Lake were sourced by Northwest Research Obsidian Studies Laboratory as having originated from three different trans-Sierran source locations (Mono Glass Mountain, Queen and Buck Mountain - Modoc County, near the California/Oregon border). To reduce the load, the largest and heaviest specimen may have been transported by foot travel to Tulare Lake in a burden basket or a sack secured to the carrier's body. Such baskets may have been devised by Native carriers as a pack that could be strapped on the shoulders or back to lighten the load. The route of this large hunk of obsidian may have followed a southerly direction through Owens Valley on the eastern side of the Sierras, then north following the Kern River drainage to Tulare Lake. Water once flowed regularly into Tulare Lake via Kern River about seven or eight miles-from where the bulk materials were discovered.

Hopkins discussed the obsidian specimens with Craig Skinner. His comments follow:

> It's hard to know what to think about these three specimens, especially that 23 pound chunk of obsidian from Glass Mountain. Of the three items, I'd give the Queen piece the best chance of being authentic; that's a source that's not well known to modern flintnappers and is one that produces obsidian occasionally found west of the Sierras in good archaeological contexts.
>
> The 23 pound piece seems to be the least likely to be prehistoric seeing as the source is easily accessible from the highway and I've never seen bulk obsidian from Glass Mountain show up at archaeological sites very far south of the Medicine Lake area. It's possible that it may have been brought in much later by automobile; however the finders, who Hopkins find credible, strongly claim they found it together with the other obsidian specimens.

Hopkins enlightens us by pointing out that automobile transport of heavy amounts of raw obsidian, like this specimen, could have occurred during historic times after the Mission Period ended, acknowledged during times when groups of Tache Yokuts Indians returned to their native homelands seeking their former way of life.
Eventually, Natives were removed from the region, influenced by pressure from an influx of trappers and farmers moving into the region. The Native Indians were forced to live on rancheros and reservations or adapt to lifestyles of the whites, working for them on cattle ranches or tending agricultural crops.

> It's hard to tell about the visually quite distinctive Buck Mountain sample; though every once in a while I run across it in what appears to be good archaeological context in southern California - although it's rare. Of all the northeastern California sources, it's the one that is consistently found the farthest from the source area.

Travel routes to Tulare Lake were also discussed with Dr. Gerrit Fenenga, who is well versed on California Indian trade routes and networks:

> Dr. Fenenga was of the opinion that a westerly route from the eastern side of the Sierras was highly unlikely given the rugged topography transporters would have had to deal with during travel. It would simply have been too demanding to carry the 23 pound specimen on foot. He agrees with us that our suggested route along the eastern side of the Sierras would have been more likely.

Hopkins reports that he is not aware of any other raw obsidian or preform caches discovered in the Tulare Lake region. However, finished and broken obsidian artifacts (projectile points, crescents and other tool forms) have been found at Tulare Lake by local collectors in considerable numbers. Several of these items, originating in California and the Great Basin, were chemically characterized to source and subjected to hydration analysis (cf Garfinkel, et al. 2008).

The archaeological record affirms that Tachi Yokuts Indian tribes generally had control over lands from south and west of Tulare Lake, north to the Diablo Range (east of the San Francisco bay area) and traveled numerous trade routes throughout the state gathering materials within their networks for barter or sale, both in route and at their final destinations.

Tachi trading customs and accounts were discussed by the late Frank Latta, a natural born ethnographer/self-taught archaeologist from Kern County and Kahn-te the oldest Tache chief he interviewed. This Tachi chief was in charge of early trading activities at "Udjiu" (better known as Poso Chane village), a trading center located near the confluence of Jacilitos, Las Gatos and Warthen Creeks east of Coalinga. Annual trade events were conducted at this village with coastal Indians that periodically brought seashells and shell beads (clam, *Olivella* and abalone (*Haliotis*), salt, salt grass and various seed foods). According to Kahn-te, coastal Indians came mostly for obsidian and soapstone beads in trade for their possessions (Latta 1977:728-9).

A fourth sample of obsidian was recently discovered and can now be included with the possible cache from Dudley Ridge. It was found by Hopkins in the same area as the original three samples discussed earlier. A fragment of material was removed from the sample and sent to Northwest Research Obsidian Studies Laboratory for XRF sourcing. Craig Skinner concluded:

> It originated from Glass Buttes (Glass Buttes, Variety 3) in Oregon. The sample I received was of transparent glass or a mottled mahogany. The initial piece contained a cortex of mahogany obsidian.

Given the large size of the original sample and the distance to the source, Skinner was very suspicious that it was a historical introduction and not a prehistoric one. The Oregon source area is very well known and accounts for a disproportionately large number of anomalous obsidian samples in the western U.S.

> *With respect to discoveries of Yokuts artifacts, clearly manufactured during historical periods and found mixed with prehistoric artifacts in the same areas in the Tulare Lake region supports the author's suspicions that raw material and finished artifacts may have been brought in during historic periods, i.e., see A Yokuts Indian Digging Stick from the "Stick in the Mud Site," Chapter 3 of this volume.*

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