CONTRIBUTIONS TO
TULARE LAKE ARCHAEOLOGY IV

ICE-AGE STONE TOOLS FROM THE SAN JOAQUIN VALLEY

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(TULARG) members (left to right) Jerry Hopkins, Don McGeein, William Wallace, Edith Wallace, and Fritz Riddell conducting inspections of archaeological sites at Tulare Lake. Photograph by Jim West.

Preface

This is the fourth publication in the series resulting from the Tulare Lake Archaeological Research Group (TULARG). This series of monographs were originally the brainchild of William Wallace and Francis (Fritz) Riddell and began in earnest in late 1988. Dr. Wallace proposed that, "Quite likely, Tulare Lake saw human usage and habitation throughout the entire span of California's prehistory," a suggestion that excited and drew the attention of many California archaeologists. The initial intention of the founders was to gather, examine, and report archaeological information about the region's ecologically rich past.

The present publication consists of four manuscripts (included as chapters one through four). Initially, six chapters were planned but two authors could not meet the time constraints. Hopefully, they will be included in a subsequent TULARG publication.

Briefly, Chapter 1 surveys and identifies a flaked stone assemblage of time-diagnostic artifacts from Tulare Lake. This is the first published attempt to categorize and describe Tulare Lake's Paleoindian tool kit. Chapter 2 presents the initial attempts at obsidian tracing and hydration dating of Tulare Lake's ancient artifacts as well as providing a small sample from China Lake in eastern California. Chapter 3 critically reevaluates the number of reported Clovis-like projectile point discoveries from Tulare Lake and finally, Chapter 4 describes a unique ground stone "butterfly" crescent from the study area and discusses its possible meaning, function, and significance.

Tulare Lake, located in California's southern San Joaquin Valley midway between the San Francisco Bay and the Los Angeles Basin, was formed sometime during the later part of the Pleistocene epoch and, over millennia, expanded to cover about 760 square miles before it was drained and reclaimed for agricultural crops. Artifacts collected from early shorelines suggest the lake supported Paleoindian people for a considerable amount of time before the earliest Yokuts occupation.

While a respectable amount of information was gathered and made available about the region's archaeological past, the founders' research aims were left far from complete. Their dedication to the project has encouraged others to continue their efforts. Consequently, Bill and Fritz's research project will carry on. This publication, dedicated to both these pioneers in the study of California prehistory, is a step in that direction.

Jerry N. Hopkins and Alan P. Garfinkel

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Acknowledgements

This publication is dedicated in memory of Francis Allen (Fritz) Riddell (1921 – 2002, age 81) and to William James Wallace (1915 – 2005, age 90).

Fritz was the very first prehistorian in California to work as a full-time state archaeologist. Before his passing in Sacramento, Fritz battled cancer for more than 20 years, never once giving up. During this time, he continued to work diligently and is credited with changing California archaeology for the better. He received his Masters degree from University of California at Berkeley and worked on projects throughout California. Upon retirement, Fritz led an annual field expedition to Peru, working closely with Peruvian archaeologists and later was awarded an honorary doctorate by the Catholic University of Santa Maria, Arequipa, Peru.

Bill Wallace died September 25, 2005 in Southern California. He attended University of California at Berkeley, receiving his BA in 1937 and Ph.D. in 1946. His beginning interest was in history, but courses with Alfred Kroeber and Robert Lowie led him to change his major to anthropology. Bill held many assignments throughout his career, teaching and conducting research through his associations at Indiana University, University of Arkansas, University of California at Berkeley, University of Southern California, University of Hawaii, and at the University of California at Long Beach where he concluded his tenure, retired, and became Professor Emeritus. Bill has published numerous scientific papers and monographs on various archaeological projects throughout the state and is widely recognized for his innovative and groundbreaking studies.

In the final volume of the *TULARG Report* newsletter, Bill strongly urged members to maintain their interest in the Tulare Lake region's early human past and encouraged them to continue doing fieldwork, cataloging, photographing their collections, and carefully describing their findings in written reports.

The remaining donations from TULARG's publication fund were passed on by George Chritzman (past Treasurer) and helped underwrite this publication. This volume could not have been published without a number of donations, which helped defray administrative costs. Finally, a special debt of gratitude is owed to Gary Breschini and Coyote Press for publishing this volume. The editors express their appreciation to those who contributed.

Jerry N. Hopkins and Alan P. Garfinkel

Chapter 1

A Reconstruction Attempt of Tulare Lake's Paleoindian Tool Kit

Jerry N. Hopkins

Abstract: *Tulare Lake, located in the Southern San Joaquin Valley of California, has been recognized as an important region for Paleoindian occupation. Temporally diagnostic Concave Base projectile points made in the Clovis tradition, other Concave Base points which may be contemporaneous with Clovis, chipped-stone crescents, Great Basin Stemmed points including the Lake Mohave type, and a variety of cutting and scraping tools have been found by collectors and professional researchers. Since the basic tool kit of Paleoindians (11,550 to 8,550 cal BP) is reported by archaeologists as being similar throughout North America, an attempt was made to suggest what specific weapons and implements collected from ancient Tulare Lake shorelines belong in the tool kit. Besides a list of* **"probable"** *and* **"possible"** *elements of the tool kit, the reader is left with a descriptive guide to artifacts recovered from the region.*

INTRODUCTION

The oldest generally accepted evidence of human presence in America consists of Concave-Base, lanceolate projectile points distinguished by a longitudinal groove or channel ("flute") extending upward from the base on one or both sides. Missile tips of this sort were named "Clovis," after the New Mexico town near where they first were found in 1932. Prehistoric hunters produced these weapons and distributed them over much of North America. Although their main prey was mammoth, Clovis peoples also hunted other extinct animals such as Pleistocene horses, bison, camels, and possibly musk oxen (Frison and Bradley 1999).

Tulare Lake is by no means the only locality in California that has produced Clovis or Clovis-like points. The first evidence of fluted projectile points in California was encountered by the Campbells at Lake Mohave (Barbieri 1937: 104; Campbell et al. 1937).

Borax Lake, on the eastern edge of Clear Lake in the Coastal Range of north-central California, yielded 20 or more (initially classified as "Folsom") complete and fragmentary examples (Harrington 1948: 63-68; Meighan and Haynes 1968; 1970). Chipped stone blades, various kinds of scrapers, gravers, flake knives, and "turtle backs" were also recovered from the archaeological deposit.

Multiple specimens of this type point have also been reported found in the China Lake area of east-central California (Davis 1975) and isolated fluted points have been found over the length and breadth of California (Dillon 2002).

Until recently, a date of about 11,500 to 11,000 BP [^{14}C] was assumed for the Clovis migrations into North America. Recent archaeological data, however, indicates that radiocarbon dates for the terminal Pleistocene are about 2,000 years too young. Consequently, dates of ca. 12,500 to 10,000 BP [^{14}C] must be critically reevaluated (Fiedel 1999). Calibrated radiocarbon dates indicate that the first successful Clovis entry into the Americas more likely occurred about 13,500 years ago.

A more-recent reevaluation of the Clovis date record revises the Clovis time range to 11,050 to 10,800 ^{14}C yr BP. In as few as 200 calendar years, Clovis technology appears to have originated and spread throughout North America (Waters and Stafford 2007). With new archaeological data surfacing, more and more archaeologists have abandoned the Clovis first model, supporting a pre-Clovis colonization of the Americas.

No one knows for certain when humans first came to California's southern San Joaquin Valley or from where they came. Ancient lake-marsh shorelines of now-dry Tulare Lake have yielded a surprising number (more than 500) of Concave Base forms, often compared with Clovis points from the Southwest or other contemporary populations. I refer to these examples as Concave Base points in this monograph and until their morphological and technological attribute variability is more-completely studied or the sites where the points were found are dated. They are very similar to the Tonopah and Monitor Valley variants found in the Big Smoky Valley of west central Nevada. Numerous other time-sensitive artifacts (crescents and Great Basin Stemmed Series points) also appear in collections from Tulare Lake.

Younger Paleoindian groups that followed Clovis occupation in the Far West may have favored a more generalized foraging economy, opportunistically hunting smaller grazing animals such as bison, antelope, elk, and deer. Bits and pieces of mineralized bones of such animals and diagnostic projectile points were collected on eroded beach line surfaces of Tulare Lake. I suspect that these locations were animal kill sites and the bone fragments may represent remains of Paleo hunters' prey.

When hunters first arrived in the region, probably in pursuit of the large-bodied animals there, they brought the expertise to construct and employ specialized tools. Paleo peoples were skilled artisans in stone, bone, wood, and antler. A variety of such stone and bone tools collected from the shorelines, represented in the sample discussed here, are comparable to specimens in other collections from the same shorelines. Presumably, nothing more perishable has survived the natural elements of the region.

Since hunting requires some form of wooden or bone weaponry components, we can assume that inhabitants made much use of wood, bone, and hide as suggested by the abundance of crude stone tools recovered. However, because the diagnostic projectile points were exclusively surface finds recovered from exposures that have not been dated and the locality from where they came experienced occupation during more that one period, it is uncertain what other type artifacts accompanied them. Bone points and foreshafts reported from other early sites in North America have not been found or identified at Tulare Lake. Albeit, the author recovered two bone tools (presumably awls or flaking tools) and an antler tine with a suspension hole drilled through its proximal end (probably a handle for a hafted knife blade). A bone handle and an awl were also reported in two other collections from the area.

Of course, projectile points represent only part of the Paleo hunters' equipment. Knives for skinning and cutting up slain animals, scrapers for processing their hides, tools used for weaponry manufacture, and a variety of other implements clearly formed part of their tool kit. Such forms, which may not be contemporaneous with a single cultural assemblage, occur in abundance on the ancient shorelines.

Besides the artifacts in this sample, others probably exist in collections unseen by the author and more remain buried eluding both professional explorers and casual collectors. Bands of hunters that once roamed and lived about the shores of a veritable inland sea, now completely vanished, left these artifacts behind. When Tulare Lake was occupied by Paleoindians, it was about half its maximum size reported during historic periods, at times exceeding 600 square miles. Unlike many Paleoindian artifact discoveries elsewhere, few were isolates. Most of the weapons and tools were found concentrated along a half by five-mile stretch of ancient shorelines on the southern end of the lake.

The suggested thinning and up-curving of lacustrine deposits on the west side of the lake basin (interpreted from early lake soil borings) may have resulted from tectonic movement along Dudley Ridge near where the Witt Site is situated. It is possible such activity lifted late Pleistocene age deposits exposing soil to erosion. Fluctuating Holocene lake levels, wave action, and wind deflation subsequently may have eroded uplifted alluvium removing younger deposits and exposing older ones (West 1989). What is now the surface may represent living or hunting levels in layers once higher up in beach line sediments causing an admixture of different-age artifacts—sediments now entirely eroded and dispersed by recent agricultural modification. This hypothesis may explain why Paleoindian artifacts, usually found in lower buried levels, occur on shoreline surfaces. Paleoindian artifacts have not been reported elsewhere on the lake's vast shorelines that have fallen to agricultural modification, which would have exposed similar artifacts, supporting the argument that Paleoindians only frequented areas on the lake's southern end.

An attempt is made here to reconstruct the tool kit of Paleoindian hunters that once roamed the ancient shores of Tulare Lake by comparing reports of analogous forms reported from similar sites elsewhere.

TULARE LAKE IN THE TERMINAL PLEISTOCENE/EARLY HOLOCENE

Tulare Lake must have offered a less stressful environment to large terrestrial grazers during periods of drought than other lakes experiencing desiccation elsewhere in California and the Great Basin. The region, well supplied by high-relief watersheds primarily from the Sierra Nevada Mountains and a dry climate was favorable for animal and human adaptation, providing abundant vegetation and year-round aquatic resources—in short, everything mammals needed for survival. Indeed, nature needed little nudging in the region as grassland communities flourished in the basin (Preston 1981) attracting a variety of game. Paleo environmental data for the lake-marsh environment suggests a diverse economy prevailed with rich subsistence resources including fish, turtles, mussels, waterfowl, vegetation, and both large and small animals.

Faunal evidence from several collection locations suggests humans frequented the lake's shorelines in pursuit of herd animal species such as horses and other territorial animals that likely stayed in one area year-round. Paleoindians indeed were there exploiting a broad-based economy and, likely, diversified their meat diet from the largest animals with abundant, more accessible lacustrine resources of a variety of extant species including elk, deer, rabbits, gophers, beavers, and coyotes along with fish, mussels, fowl, turtles, and a variety of amphibians. Camps and hunting sites were positioned close to game takes and watering places, and lithic sources in the nearby mountains supplied raw materials for weapons and tools. A high quality chert quarry-workshop is within two days walking distance of the Witt locality (Wilke 1991). This source, located in the Jacalitos Creek drainage near Coalinga, is the suggested origin for various chert materials used by Paleo hunters for projectile points and other implements recovered from Tulare Lake.

Paleo hunters repeatedly occupied Dudley Ridge, a southeasterly trending peninsular-like feature on the southwestern end of the lake bordering several loci of the Witt Site, discussed here. The ridge of sand spits rises 25 to 30 feet above surrounding terrain and gradually descends into the lake basin. Large terrestrial species favored the shorelines adjacent to Dudley Ridge and specialized human hunters, exercising a measure of control over their domain, became expert in killing them. Perhaps marshes adjacent to the shorelines or the lake itself were used as traps for prey. Large, heavy animals may have been driven into the traps where they became mired in mud and slaughtered or drowned in the lake.

Evidence of extinct fauna, once indigenous to the entire lake region, has not been reported elsewhere from areas surrounding Tulare Lake. Perhaps they were drawn to the Dudley Ridge locality because it allowed a swamp-free access to drinking water from the higher ground of the ridge. The shallow lake with its gently sloping shorelines must have offered a highly productive habitat with near-shore animal contact zones bordered by dense marshes and grassland. Human hunters could have readily exploited resources in this locality.

LATE PLEISTOCENE FAUNAS OF TULARE LAKE

In addition to weapons and tools, the locality has produced mineralized bones of extinct species including mammoth (*Mammuth columbi*), bison (*Bison antiques antiques*), both large and small horses (*Equus occidentalis* and *E. Conversidens*), giant ground sloth (*Glossotherium harlani*), Pleistocene lion (*Felis atrox*), dire wolf (*Canis dirus*), shrub ox (*Euceratherium collinum*), and camel (*Camelops hesternus*) (Fenenga 1991). These ice age mammals disappeared from North America about 11,000 years ago, at the culmination of the Wisconsin glacial.

A bison atlas (first cervical vertebra) was recovered from Locus 2 (Figure 1). Many unidentified animal bones collected in close proximity to projectile points and stone tools recovered are severely fragmented and show evidence of crushing possibly resulting from marrow extraction by humans. Yet, indisputable stratigraphic association between the projectile points and extinct Pleistocene fauna has not been discovered or reported. Tulare Lake animal taxa are well represented both at Rancho La Brea "tar pits" in southern California and at the nearby McKittrick tar seeps (Stock 1938).

SURFACE COLLECTION AREAS

Artifacts were collected at several eroded site environs, loci 1 through 9 (Table 3). Consequently, since individual boundaries of the various loci have not been clearly defined, all the collection areas were grouped under "Witt Archaeological Locality."

The recorded location of the Witt Site (CA-KIN-32), identified here as Locus 1, was named after the late Donald Witt, the first person to discover Clovis or Clovis-like points in the region (Witt 1967). William Olsen's site survey record map placed the site's location about a half-mile to far north. It is argued that the site is actually about a half-mile south of its reported location aligned with several other Paleoindian occupied zones. The recorded location is well inside the lake's early shorelines and would have been two to five feet under water during the time other sectors yielding similar artifacts were occupied. It should be noted that due to the extreme flatness of regional terrain a rise of a few feet in water level could well cause a difference in shoreline location measurable in hundreds of feet (Riddell and Olsen 1969). All of the collection areas, with exception of a few nearby higher areas where isolated finds occurred, are located on the lowest strand lines of the lake at an elevation of 190-195 feet (amsl) of the lake basin, a contour thought to represent several old shorelines occupied by humans during the Pleistocene/Holocene transition.

Most of the ancient artifacts recovered from the area were associated with distinct low lake stands minimizing the possibility of site contamination by later visitors. Nonetheless, some contamination did occur (particularly south of the earliest remnant shorelines). Presumably, these early shorelines were under water most of the time following the transition, averting mixing of artifacts produced by many generations that followed in the region. The shorelines, now disturbed by agricultural plowing, still hold valuable archaeological data but seem to lack datable stratigraphic contexts.

Locus 1, 190 feet (amsl), is blanketed with heavy clay soil (thick mud or mire during wet sea-

Figure 1: Bison atlas.

sons). An early slough-line or channel has been visually identified from changes in soil color and a scant presence of plant life. This may once have been a hunting bog. Several of the oldest artifacts were found on the banks of this ghost channel.

Locus 2, 193 feet (amsl), is about a half-mile south of the 190 foot shorelines and a half-mile north of Dudley Ridge's summit, 200 feet (amsl). Sandy alluvium soil deposits at the center of the site merge into thick clay soil that is extremely muddy when wet. This, likely, was once marshland. The clay soil grades into thick sand at Dudley Ridge's crest. Many stone tool forms including *limaces* were recovered from this area along with later-age artifacts (ground stone milling equipment, charmstones, widestem and Pinto points) suggesting that, over time, several groups occupied the area. The heaviest chert chipping scatters occur at Locus 2, suggesting it may have been a common base camp.

Locus 3 is situated on a sandy beach terrace at 190–193 feet (amsl). Locus 4, 193 feet (amsl), is a featureless expanse of shallow sandy soil. Many crescents were found by the author and local collectors on the margins of sandy spots on the area's southern end. These sandy spots may once have been shallow ponds where waterfowl was hunted.

Locus 5 and 6, which border one another, have yielded most of the oldest artifacts and mineralized animal bones (64% of the Concave Base points, 52% of the Lake Mohave points, and 70% of the winged and lunate crescents in this sample). The oldest artifacts were found along the northernmost shorelines at the lake's southern end and the youngest (Tulare Lake Widestem and Pinto points, stone atlatl spurs, and a variety of scrapers) on the southern end of Locus 5.

Not much has been recovered from Locus 7. The shorelines are covered with deep sand probably burying artifacts. Locus 8 and 9 may have been a hunting camp. Here, again, the area is covered with deep sand making it difficult to survey. Two heavy-duty scraper planes were found at Locus 9 and light chert lithic scatters of younger artifacts occur. I suspect that many artifacts remain buried under these sand deposits.

While isolated early artifacts were found on the earliest shorelines, only a few light density sites produced a majority of the early forms. The concave base forms, many with snapped bases (56%), are usually found with broken animal bones suggesting these areas were animal kill sites or butchering locations.

From the mass of artifacts collected, it is evident that hunting groups occupied the region for a respectable period before moving on or positioned themselves at this sector for long periods in a semi-permanent or continuous way. It is also possible that small nomadic bands of hunters living close-by repeatedly returned to the same hunting sites. If this is the case, residential bases or campsites remain elusive and undiscovered; for, the lake's southern shorelines and surrounding areas have been subjected to intense exploration by the author and others for a number of years.

AGES OF THE ASSEMBLAGE FROM THE WITT LOCALITY

To my knowledge, radiometric datable contexts containing Paleoindian artifacts have not been discovered at Dudley Ridge. However, uranium-series [^{230}Th] dates of 11,380 and 15,800 years BP were obtained on human bone (Taylor et al. 1985: 314). Ages of diagnostic artifacts in the guide that follows are from sites elsewhere and should not be arbitrarily assigned to Tulare Lake artifacts. So far, only typological cross dating of time-sensitive artifacts has shed any light on the ages of the assemblage.

Cryptocrystalline silicate materials (chert and jasper) were the prevalent toolstone materials used for Paleoindian hunting implements at Tulare Lake. Consequently, very little obsidian toolstone was employed. Obsidian debitage is conspicuously absent from all loci. With exception of current obsidian studies discussed in this publication (Garfinkel et al., this volume), obsidian hydration dating has not been attempted on the early obsidian artifacts.

TYPOLOGICAL SUMMARY

The assemblage from the Witt locality, discussed here, consists of projectile points, a few bone artifacts, and several hundred flaked-stone tools. Many artifacts were semi-fashioned or broken making them problematic and difficult to categorize. Some of the broken tools may have split resulting from weathering. Besides causing patinas or weathering rinds, common on chert artifacts from the region, weathering processes can also fracture chert (Luedtke 1992: 110). The major form of mechanical damage is "frost fracture," which can occur when temperatures drop below freezing. This may explain the presence of numerous broken items in the sample or stone tools simply may have broken because of use, wear, or during manufacture or repair.

It seems certain that occupants of the region engaged in producing simple, serviceable tools made from a variety of materials. They fashioned implements quickly and efficiently to meet subsistence and survival demands rather than producing only elegant implements. Undoubtedly, due to mishaps during shaping processes, not all implements ended up looking exactly like what their producers originally had in mind. Many probably became discarded rejects and were picked by later occupants, reworked, and used as expedient tools. This may explain the varied assortment of tools found in the collection areas.

Projectile points and tool forms that tend to cluster for sure identification were sorted as a basis for classification. Artifact descriptions and occurrences from Richard M. Gramly's *Guide to the Paleo-Indian Artifacts of North America* (1992), with permission from the author, are restated or paraphrased in the Tulare Lake Guide that follows. Descriptive terminology for implements here is essentially after Gramly except where local variations occur. However, one is cautioned that certain scrapers may be combination implements belonging in more than one category. My comments on Tulare Lake artifacts are italicized.

Figures 2 - 62 are components of the sample displaying variations of the assemblage. Two other early projectile point types (Tulare Lake Widestem and Pinto, Table 2), thought to be younger and not belonging in the Paleoindian tool kit, also occur and are included in the guide. Items from the sample that may belong in the Tulare Lake Paleoindian tool kit are categorized as "*probable*" or "*possible*" elements (Table 1) and are discussed in the descriptive guide herein.

TULARE LAKE EARLY ARTIFACT GUIDE

ABRADER (probable)
(abrading stone, dressing stone, grooved stone, shaft smoother)

Abraders are slabs or cobbles that have been made smooth and regular by grinding. Most abraders are made of siltstone and sandstone. It is felt that abraders were used to dull the edges of striking platforms to enhance the effectiveness of a flintknapper's hammer blows. Another use may have been to grind bone, antler, and ivory artifacts. Prolonged usage may have created shallow grooves across the faces and edges of abraders.

Several rounded sandstone abraders and rectangular abrading stones were recovered from the collection areas (Figure 2).

Abraders are likely present in all Paleoindian phases.

ATLATL ENGAGEMENT SPUR (possible)
(snake head, acorn, spur, hook)

The detached atlatl spur is a ground stone, bone, or antler hook fixed to the end of a spear thrower shaped to engage a nock or conical depression in the proximal end of a dart shaft.

Several stone spurs (Figure 3) were found within boundaries of Witt Site loci; however, they are presumed younger than Clovis. None-the-less, considerable antiquity has been suggested for atlatls in the region, resulting from a stone spur recovery from a Buena Vista Lake site (south of Tulare Lake) dated at 7,600-8,200 BP (Frederickson and Grossman 1977). The same type spur is shown in Figure 3-2nd in the fourth row. Some researchers suspect atlatls were used later in the region to hurl darts tipped with stone points and "butterfly-shape" Crescents (Hopkins 1991).

A mineralized bone spur, Type 1A Unkeeled (Hopkins 1993: 52 Fig. 2), was recovered by the author from Locus 5 (Figure 4-middle) and another was found at Locus 9 (bottom). Another mineralized bone specimen was found on nearby Dudley Ridge (personal communication Fenenga 1993).

The degree of mineralization approximates that of extinct mammal bones from the shorelines. The spur shown in (Figure 4-top) was found four miles south of Dudley Ridge. The mineralized bone spurs evoke questions about the atlatl's initial entry into the region. Did Clovis hunters use the spear thrower? Undoubtedly, the small, delicate Concave Base points would have penetrated thick hides of large animals more effectively with aid of the spear thrower. Spurs, likely, were held in place by pitch, asphaltum, or resin-gluten combinations and cross-bound with animal sinew.

AWL – mineralized bone (probable)
(perforator)

Awls are bluntly pointed (once sharp?) bone rods of moderate length. Heavily worn awls have been reported from the Lindenmeier Folsom site. Bone awls may also have been used for flaking tools.

Three bone awls or possible flaking tools (Figure 5) were recovered by the author from Locus 6 and another was reportedly found in the same locality by another collector.

Currently known from the Folsom phase in the American West.

AWL – stone (possible)
(beaked scrapers)

The awl is a unifacial tool with a prominent projection.

Several stone awls were recovered from early shorelines of the lake (Figure 6).

Awls are a rare form on sites of all phases of the Paleoindian era.

BIFACE (possible component)

Bifaces are flaked stone artifacts that exhibit removals upon both faces, excluding projectile

Figure 2: Abraders.

Figure 3: Atlatl engagement spurs (stone).

Figure 4: Atlatl engagement spurs (mineralized bone).

Figure 5: Awls (mineralized bone).

Figure 6: Awls (stone).

Figure 7: Bifaces.

points and projectile point preforms, including knives, hand axes, uncompleted implements, and fragments in a catch-all category.

Many large bifaces have been collected from Locus 2 (Figure 7). From personal observation of the artifacts, bifaces may have served as knives or were transformed into projectile points.

BIFACIAL CORE (probable)

Bifacial cores are a biface, usually large, that are a source of flakes for tool use.

Bifacial cores are rare at Tulare Lake (Figure 8).

They are present at fluted point (Clovis) sites in the West (e.g., Anzick, Montana; Simon, Idaho) and at various sites in the East (e.g., Potts, New York).

BLANK (possible)

Large flakes fresh from the quarry are often termed "blanks," it being thought that they were preforms for scrapers. The word "blank" has also been applied to crude bifaces that were reduced to easily transportable forms at quarry-workshops.

These may be scraper preforms (Figure 9).

BURIN (probable)
(burin spall artifact)

A flaked stone implement with a narrow, chisel-like working edge that is formed by striking off blocky, quadrilateral or triangular flakes.

In the Old World, there are many varieties of burins; but in the New World Paleoindian era, the range appears to have been limited. The fracture planes of broken projectile points were sometimes used as striking platforms for removing burin spalls (cf. burins on fluted points from the Nobles Pond site, northeastern Ohio; Gramly and Summers 1986); more often, however, burins were based on truncated or snapped blades and flakes.

This assemblage has not been sufficiently examined for evidence of burin technology; nevertheless, Gerrit Fenenga and I have observed several examples of burin facets in other collections from the Witt locality.

They are present in Clovis and Folsom phases as well as various fluted point industries east of the Mississippi River; also reported from late Palaeo-Indian contexts, e.g., the Cummins site, western Ontario (Julig 1988). Burins occur at pre-Clovis sites of Beringia (Morlan 1987).

The data suggest that the burin technique may have been widespread throughout North America during early fluted-point times (Epstein 1963). Burins occurred on several types of Paleoindian points including Clovis, Cumberland, Folsom, Plainview, Meserve, Angostura, a number of variant forms, and unifacial tool forms. (Tuohy 1969) reported on 147 projectile points from three sites in Nevada described as Lake Mohave, Silver Lake and long-stemmed forms, and variants known elsewhere in the Desert West. Nearly one-half of these points exhibit burin facets, mostly on point tips.

CELT (possible)

Celts are axes without a perforation or groove for hafting. They are mounted at a right angle to the axis of a handle.

These specimens (Figure 10) may be hand axes or knives and not celts.

A study of flaked tools recovered from the East Wenatchee Clovis site in Washington reveals the celt's presence (Gramly 1993: 7, 19, 46, 47).

CHOPPER (probable)
(cleaver, *hachoir*)

Choppers are a hand-held unifacial or bifacially flaked stone tool used for heavy-labor such as felling trees or dismembering carcasses. They are manufactured by the removal of flakes in such a manner as to create a cutting edge.

Choppers from Tulare Lake were fashioned from cobbles or stone blocks and may have been used to crush animal bones (Figure 11).

Figure 8: Bifacial cores.

Figure 9: Blanks.

Figure 10: Celts.

Figure 11: Choppers.

They have been recovered from most fluted point Paleoindian sites with large assemblages.

CLOVIS and **CONCAVE BASE POINT** (probable)

The Clovis weapon or knife tip may have a characteristic pattern of finishing that entails basal fluting. During fluting, long relatively narrow flakes are removed parallel to the principal axis of a point. The purpose of fluting is undoubtedly an attempt to improve hafting and perhaps to adjust the center of the point's mass. In addition, fluting minimizes the butting impedance of the shaft and binding.

Finished fluted points usually exhibit ground margins within the basal concavity and along their sides as far as the ends of the channel flakes. Grinding or dulling of the edges protects the binding of a hafted point and gives a more stable haft. Where fluted points are made of glassy raw materials, such as obsidian or quartz crystal, it is not uncommon to observe abraded flutes, a technique called "channel scratching." The slick surfaces of broad flake scars were roughened, likely as an aid to hafting.

Concave Base points from Tulare Lake are a small to medium size fluted and unfluted, auriculate point with a concave-base. Some bases are thinned on one or both sides and some are not thinned at all. The basal area is usually over half the length of the point and edges are usually ground.

Several earlier reports were written describing Clovis points recovered from the region (Hopkins 1991, 1993; Riddell and Olsen 1969; Wallace and Riddell 1988; Wilke 1991).

Concave Base points from Tulare Lake (Figures 12-13) vary in size from tiny to large but are predominantly small in comparison to classic Clovis points. They display a wide range of fluting—single and multiple, unifacial and bifacial, as well as simple basal thinning. Fluting by means of percussion was seldom employed. Pressure thinning of bases was a very late stage in the manufacture of Tulare Lake points, as indicated by the fact that thinning-flake scars are not invaded by margin-trimming flakes (Wilke 1991). Many specimens show evidence of resharpening, repair, or restoration.

A sample of 103 specimens from Tulare Lake was measured (Rondeau 2005: 37-39, Table 2). Mean metric data is as follows: length = 41.26 mm, (N = 45); width = 19.71 mm, (N = 64); thickness = 5.70 mm, (N = 93); weight = 4.9 gr, (N = 43).

The lustrous nature of the finished points suggests annealing or thermal alteration of raw material (chert) to enhance flaking properties (Wilke 1991). The second point, bottom row, left to right, (Figure 12) was fashioned from silicified wood.

Fluted points are found across North America except regions where the Wisconsin ice-mass persisted. The Clovis variety is the most widely distributed of all fluted points (Sellards 1952: 41-42). Great Basin Concave Base points occur in the Great Basin and the Far West.

CORE (possible)
(bifacial core, bipolar core, blade core, core-biface, discoidal core, polyhedral core)

Cores are a source of flakes or prismatic blades. Cores are classified according to the shape of the removals that are struck from them and by the number and positions of striking platforms. Studies to date suggest blade cores and prismatic blades occur more often in Clovis assemblages than afterwards.

Primary cores (Figure 14) are conspicuously scarce at the Witt locality suggesting that little preliminary material breakage was done on the immediate shorelines. Nonetheless, large reduction flakes of chert materials used for Clovis-like points can be found in collections of debitage collected from the shorelines.

Figure 12: Clovis and Concave Base Points.

Figure 13: Clovis and Concave Base Points.

CRESCENT – lunate (probable)

The Crescent is a small biface of crescentic shape with edges often exhibiting grinding at their mid-points.

Lunate Crescents (Figure 15), also known as "Great Basin Transverse" (Clewlow 1968), occur on and near the ancient shorelines. They are also widespread over an extensive range south of the Witt loci near more-recent shorelines, in areas where only a few isolated concave base and Lake Mohave discoveries were reported. Crescents are most often found on surfaces of plowed fields (playas) where no accurate provenience can be ascribed. Crescents are thought to be at least early Holocene in age, but may be older.

Mark Basgall, in discussing diagnostic artifacts of the north-central Desert, about chipped stone crescentics, reports:

> Apparently wholly absent in assemblages of the Pinto period, these artifacts can be considered reliable indicators of the Lake Mohave complex in the present region [Basgall 1993: 95].

They have been reported from surfical sites in California, Nevada, at the late Paleoindian Lind Coulee site in Washington, and elsewhere west of the Rockies. Rare discoveries of crescents, presumed to be Paleoindian in age, have been made in the East. A large crescent was identified in the Fenn Clovis cache from the Wyoming-Idaho border (Frison 1991).

Lunate crescents commonly occur at sites attributed to the Western Pluvial Lakes Tradition and are thought to date to that time period, ca 9,000 to 6,000-5,000 B.C., overlapping the Paleoindian and Early Archaic periods (Justice 2002).

CRESCENT – winged (probable)
(butterfly)

This crescent variant exhibits wings and might be described as a butterfly-shape variant of the lunate form.

Winged crescents (Figure 16) are thought by some archaeologists to have been hafted in a transverse fashion (Figure 17) and skipped across water with aid of the atlatl into flocks of waterfowl in a stunning attempt. Several specimens display flattened surfaces in the center of the artifact, which would have enhanced transverse hafting.

This artifact dates generally from ca. 9,000 to 5,000 B.C., overlapping the Paleoindian and Early Archaic periods and has a much more restrictive distribution than that described for Lunate Crescents. Almost all reported examples are from California (Justice 2002).

CRESCENT – eccentric (probable)

This artifact is a rare well-crafted biface, crescentic in outline with one or more pairs of bilateral notches. Some suggested uses are zoomorphic amulets or fetishes, animal figurines, hafted knives, transverse points, and notched spoke shave scrapers.

This crescent variant (Figure 18) occurs on and near Paleoindian frequented shorelines.

Their occurrence is essentially limited to California (Lake and Sonoma Counties to the north, San Diego County to the south, Tulare Lake in the central part of the state and coastal islands San Miguel, Santa Rosa and Santa Catalina). A specimen was found in southern Nevada and another in northern Baja California, Mexico.

Studies have shown these often date to the Early to Middle Holocene, appearing between 8,000 to 6,000 B.C. in the Early Archaic period and extending perhaps as late as 4,000 B.C. into the Middle Archaic period (Justice 2002).

In nearly all cases, the eccentric crescent is restricted in distribution to California.

CRESCENT SCRAPER (probable)

Most of the crecentiform implements (Figure 19) from Tulare Lake ancient shorelines do not display a fine degree of workmanship. Chrysophrase (a green apple chromium-colored variety of chalcedony) seems to be the favored ma-

Figure 14: Cores.

Figure 15: Lunate Crescents.

Figure 16: Winged Crescents.

Figure 17: Transverse hafting (replica).

Figure 18: Eccentric Crescents.

Figure 19: Crescent Scrapers.

terial. They are thin and hardly more than roughed out examples of lunate crescent forms. Chrysophrase has been mined at several localities east of Tulare Lake in Tulare County – one mile east of Lindsay; Venice Hill, near Visalia (T18S, R26E): Stokes Mountain and Deer Creek (Sec. 20, T22S, R28E) Murdock and Webb 1966: 281). These two localities east of Visalia and north of Lindsay may prove, upon further investigation, to be spots where Yokuts Indians quarried jasper (Heizer and Treganza 1944: 314).

The function of this thin, crude crescent toolform remains a mystery. It is possible that the abrasive composition of chrysoprase may be more suitable for working bone implements than other chert materials. Their occurrence is essentially limited to the early shorelines.

DEBITAGE (possible)
(chip, reduction flake, flake, spall, waste, detritus)

Debitage is lithic waste from tool manufacture—all manner of debris that was struck off by a knapper during manufacture and maintenance of flaked artifacts.

Heavily dominated by chert materials, densities of debitage scatters occur near all Tulare Lake collection areas. Lithic scatters are particularly dense in Locus 2 and near the southern end of Locus 5, a zone that has yielded artifacts belonging to later occupations. A few handstone fragments, a stone mortar, shell beads (Olivella biplicata), and baked clay pottery shards (intrusive to the region) were collected in this area, some of which may belong to a Pinto occupation. Pinto points were collected here and further south near Dudley Ridge.

DENTICULATE (probable)

Denticulates are toothed implements, usually flaked unifacially. They are known from habitation sites and are associated with fluted pointmakers. They also occur at quarry-workshops, suggesting that this distinctive implement may have been used for heavy-duty tasks such as the manufacture of stout wooden and bone implements.

Several specimens are shown here (Figure 20).

Denticulates are present in most large Clovis and Folsom assemblages and in the Agate Basin phase at the Agate Basin type-site.

DISC – bone (possible)

The Lindenmeier Folsom site yielded several carved bone discs with fine incising around their peripheries. Turtle plastron was the raw material used for at least one specimen. Incising was executed with care, apparently on one face only.

An artifact that is close in form and perhaps analogous in function to Folsom discs is the ovoid, incised bone object reported by Frison and Stanford from the Agate Basin component at the Agate Basin site, Wyoming (1982: 172).

It has been thought that discs may have been counters or markers for a game (Wormington 1957: 37).

An ovoid polished bone object (47 mm long x 12 mm wide x 4.5 mm thick), similar to the Agate Basin specimen, was found on Dudley Ridge (Figure 21). Incisions, more pronounced on one edge, are confined to the margins.

Until this report, known only for the Folsom phase and perhaps the Agate Basin phase. Agate Basin is in eastern Wyoming. The Agate Basin phase occurred in the terminal Paleo Early Archaic transition.

DRILL (probable)
(perforator)

In common usage, drills are a bifacial-flaked implement with a pronounced projection that is used for perforation. In use, a drill might rotate or twist in only one direction or back and forth depending upon the device propelling it. Several styles of Paleoindian drills exist. Most abundant, are specimens that resemble miniature projectile

Figure 20: Denticulates (saws).

Figure 21: Disc (bone).

points; some may even be fluted or basally thinned.

Several styles of drills have been recovered from Tulare Lake (Figure 22).

Drills are abundant at Clovis and Folsom sites but much rarer in the Agate Basin and later Paleoindian phases. They are common in Plano assemblages of the Northeastern woodlands.

EXPEDIENT TOOL (possible)

Expedient Tools are an object that was used as a tool showing little or no modification of its natural form. Expedient tools are often found at large, communal kill-sites. Boulder hammers used to smash massive bones at suspected proboscidean kills also may be deemed expedient tools.

They are likely present at most animal kill-sites but these artifacts must be interpreted with caution.

FLAKE KNIFE (probable)

A thin flake having fine, normal, continuous unifacial retouch along one or more margins (usually lateral margins).

Flake knives, which may have functioned in a similar manner to side scrapers, lack bold unifacial retouch, characteristic of scrapers.

Figure 23.

FLESHER (possible)

This was a tool used for scraping fresh hides—often made from a section of animal long bone or rib. The working edge may be toothed.

The specimen shown here (Figure 24) was fashioned from chert and has a bulb removed from one side leaving a deep scar that provided placement for the user's fingertips.

This is a rare implement and well known only for the Clovis and Folsom phases of the High Plains.

FOSSIL SHARK TEETH (possible)

Four small teeth from Carcharodon, a shark that lived during the Tertiary Period, were recovered from the shorelines and several more were found near the same locations by local collectors. Shark teeth occur in some abundance nearby in the Kettleman Hills region and Shark Tooth Mountain, north of Bakersfield. They have not been reported from regional Indian sites of more recent age.

Although conjectural, it is reasonable to suggest that shark teeth were picked up by hunters and employed to tip dart shafts, used as butchering implements, or may have been ornaments or talismans. The specimens are quite small (less than 4.5 cm); however, some Carcharodon teeth found in Florida exceeded eight inches (personal communication Raymond T. Rye II, Smithsonian Institution 1982).

GRAVER (probable)

Strictly speaking, a graver is a flake or blade with a small, sharp projection that has been created by unifacial retouch.

Many gravers have been found at Tulare Lake. Sharp projections are positioned on the ends of several combination scraper forms (Figure 25).

They are found in every Paleoindian phase.

GREAT BASIN STEMMED SERIES POINT (probable)

Amsden (1937: 51-98), first described the Lake Mohave variant with a long, tapering stem, produced by shouldering the point (usually very slightly), just below the center of its vertical axis. This results in a generally diamond-shape form, with more shoulder than blade. This form is not highly standardized, wavering frequently between the oval on the one hand and the Silver Lake type on the other.

It is a highly variable, stemmed-lanceolate projectile point type assigned to the Great Basin Stemmed series. These points have an elongated and slender design, weak shoulders and heavy lateral grinding with lenticular to biconvex cross-

Figure 22: Drills.

Figure 23: Flake Knives.

Figure 24: Flesher.

Figure 25: Gravers.

section and include very large stemmed points with long tapering stems and large, unstemmed, leaf-shape points on through very short blades exhausted from re-sharpening (Justice 2002).

An extensive stemmed point occupation (Lake Mohave period) occurred in the Dudley Ridge vicinity. Since Clovis and Lake Mohave co-occur at several other western locations, they may have overlapped or closely followed one another in the region. Bedwell (1970: 90) described this type point as belonging to the Western Pluvial Lakes Tradition. The WPLT may have evolved from Fluted Point Tradition antecedents as woodlands and deep lakes gave way increasingly to grasslands and shallow lakes after 12,000 BP (Moratto 1984: 103).

Numerous Lake Mohave type points, assigned to the Great Basin Stemmed series, have been collected. They occur only on the early southern shorelines of Tulare Lake (Figures 26-27). They are typically thought to be time markers of the early Holocene.

Lake Mohave and Silver Lake points are known in nearly every region of the Great Basin and many early California sites. The age of the Lake Mojave type generally is from ca. 9,000 to 6,000 B.C. overlapping the Paleoindian and Early Archaic periods (Justice 2002: 91).

HAMMERSTONE (probable)
(boulder hammer, hammer-anvil)

Hammerstones are a piece of rock, usually a cobble of tough material that bears evidence of percussion.

These battered cobbles were collected from early shorelines (Figures 28-29).

They are expected at most sites in all Paleoindian phases.

HANDSTONE (possible)

Handstones are a grinding stone that was handheld and generally moved across a larger, stationary stone that rested upon the ground.

HUMPY (probable)
(awl, flake shaver, groover, slug, slug scraper, *limace*, turtleback scraper, narrow side scraper, unifacially flaked drill, boat)

Humpies (local name first used by collector Leonard Van den Enden) are a narrow, slug-shaped, unifacial, flaked stone tool having steep edge angles and a high dorsal surface that is often rounded. They are presumed to have been hafted in socketed handles and used as a chisel, whittling, or shaving implement. They were used on hard substances such as bone, antler, ivory, and wood (Grimes and Grimes 1985). Hard service caused breakage and frequent re-sharpening.

Wear pattern analyses indicate that Tulare Lake humpies (Figure 30) were used in light-duty woodworking tasks (Sampson 1991). They were manufactured from prepared cores (initially by percussion followed by unifacial pressure retouch) creating steep edge angles. Dorsal surfaces of humpies vary from rounded to steeply angled. Some were flattened by percussion, presumably to facilitate hafting. Several broken blades appear to have broken from end shock caused by forces excessively applied and several others have undergone rework creating a spur on one end.

It is likely that this unique tool was designed with use of both ends in mind—when one end became to dull for efficient use, it may have been turned end-for-end and re-hafted in the same socketed handle. A bone handle (Figure 31) was found at Locus 5. Humpies may have been hafted in this fashion.

Like Clovis and Clovis-like points, based on the distinctive, mottled colors and waxy luster of high-quality chert materials used, this artifact shows evidence of purposeful heat treatment, probably to enhance flaking.

Humpies are present in most large Folsom, Clovis, and other fluted point Paleoindian assemblages.

Figure 26: Great Basin Stemmed series points.

Figure 27: Great Basin Stemmed series points.

Figure 28: Hammerstones.

Figure 29: Hammerstones.

Figure 30: Humpies (limaces).

Figure 31: Hafted Humpie (replica).

HYBRID TOOL (probable)

Not unlike classifying artifacts in most assemblages, the analyst is left with a few implements that do not seem to fit standard typologies (Figures 32-33) – Tulare Lake is no exception.

The small slug-shaped implements, though bifacial, probably should be included with the humpies. The two crescentics are likely "spoke shaves." One end of the scraper-like tools may have been used as a chisel and the other end for gouging. They are well crafted and occur only on the ancient shorelines.

KNIFE (probable)

(backed knife, flake knife, Mungai Knife, shouldered knife, sickle, unifacial knife, utilized flake)

Knives are implements of variable form and finish used with a slicing motion to cut substances. Knives may be classed as bifacial, unifacial and unretouched. Each class may be further sub-divided according to form and even what materials were cut. Only a few types are exclusive to the Paleoindian era. The square knife and fluted knives are typical Paleoindian forms, but are hardly common.

Figure 34-top is a square knife, typical of the Adams fluted point Site, Kentucky (Gramly 1992: 36). The elegant chert blade in the middle was found at Locus 2 and the large-thin blade at the bottom came from Locus 5. A triangle-shape variety with a thin straight converging blade and horizontal straight base (Figure 35) were found at Locus 5. The large blades shown in Figures 36-37 were recovered from Locus 2. Two small triangular blades (Figure 36) were found at Locus 5 and may have served as thumb-and-forefinger knives.

As a class, knives are present in every Paleoindian phase.

PINTO PROJECTILE POINT (not in tool kit)

The Pinto point is a medium to large sized, narrow, auriculate point. Shoulders can be tapered, horizontal or barbed. Bases are either deeply bifurcated with parallel to expanding ears or tapered with a concave basal edge.

Most of the examples in this sample were found at Locus 2 and on the upper elevations of Dudley Ridge and not on the ancient shorelines where most of the Paleo specimens were recovered (Figure 38). At China Lake, they are traditionally thought to be middle Holocene markers although they now appear to have an origin in the early Holocene (Byrd and Rosenthal 2006).

The dating of the Pinto type has been a problem for many years. The vast majority of radiocarbon dates and contexts indicate the type appears toward the end of the time frame of the Western Pluvial Lakes Tradition at ca. 6,000 to 5,000 B.C., extending in duration to around 3,000 B.C. or somewhat later (Justice 2002: 134).

PLANE (probable)

(scraper plane)

Planes are a massive, thick uniface with very steep to nearly vertical scraper retouch, presumed to have been used in planning wood and other hard substances. The flat ventral face occasionally will exhibit polish from use.

Large planes are limited in the sample (Figures 39-44), merging downward in size to keeled scrapers. Figure 40 displays a fine cutting edge. Figures 39-top view and 40-cutting edge view weighs 340 g. Figures 41-42 weighs 667 g. Figures 43-top view and 44-profile, a well crafted specimen of a green apple chromium-colored variety of chrysophrase, weighs 328 g.

They are widespread in the Clovis phase and its temporal equivalent in Alaska; but are also present at late Paleoindian Plano sites.

PREFORM (probable)

Preform is a term usually reserved for a biface that was designed to have become a projectile point or knife. It was shaped and thinned to a degree that its ultimate form can be surmised.

Figure 32: Hybrid tools.

Figure 33: Hybrid tools.

Figure 34: Knife blades.

Figure 35: Knife blades.

Figure 36: Knife blades.

Figure 37: Knife blades.

Figure 38: Pinto projectile points.

Preforms may have served as scrapers before they were fashioned into projectile points or knives (Figures 45-46).

Preforms are reported from fluted point assemblages across North America and later phases, as well.

PRISMATIC BLADE (probable)

Prismatic blades are a removal from a core that has a length at least twice its width. A pronounced single or double arris runs parallel to the main axis making the cross-section triangular or quadrilateral. They were not chipped to shape but, napped from a prepared core and used as struck off, with varying amounts of re-chipping along the edges.

These specimens are exceptionally sharp and could have been used effectively as butchering implements (Figures 47-48).

These blades are widespread in fluted point assemblages, particularly Clovis, as well as Pre-Clovis (?) "Beringian" assemblages (West 1983: 372), Dry Creek and Walker Road sites in central Alaska, assigned to the Nenana Complex (Goebel, et al. 1991) and Brazilian sites of Clovis age and older (Gruhn 1991).

REAMER (probable)

(perforator, drill)

A bifacially flaked perforator with a broad point; a large drill that may have been hand-held.

Many reamers have been recovered from Tulare Lake (Figure 49).

An uncommon implement known primarily from Eastern fluted point sites.

SCRAPER (probable)

Less distinguishable are scrapers of various sorts that follow. They are tools usually made on a flake-blade. Their use as graving tools or some other function probably occurred after life as a scraper had ended. Many specimens have a broad

Figure 39: Plane (top).

Figure 40: Plane (cutting edge).

Figure 41: Plane (top).

Figure 42: Plane (profile).

Figure 43: Plane (top).

Figure 44: Plane (profile).

Figure 45: Preforms.

Figure 46: Preforms.

Figure 47: Prismatic blades.

Figure 48: Prismatic blades.

Figure 49: Reamers.

Figure 50: Circular scrapers.

flake-channel across the top, possibly to serve as a thumb-hold or to provide a more secure grip. Others function well as thumb-and-forefinger scrapers. It is probable that there was no rigid function division of scraper types and most were multipurpose.

The Clovis tool kit includes a variety of tool classes of various kinds, including large side scrapers made from flakes or blades struck from prepared cores, end scrapers (often with a graver spur opposite the working edge and trimmed bulb of percussion), concave scrapers or spokeshaves, combination scrapers, gravers, and a host of expedient flake tools, some of which are made from biface thinning flakes (Justice 2002: 73).

Tulare lake scrapers are truly a mixed lot, dominating the tool sample, and may be described as a series of adaptations of primary flakes struck from cores. Knappers used the best attributes of selected flakes allowing these to determine the final form of the evolving implement.

Scrapers are found in every Paleoindian phase.

CIRCULAR SCRAPER (probable)
(discoidal scraper)

Somewhat circular and flat with scraping edge uniformly slanted around the whole periphery sometimes having a broad flake-channel across the very top to serve as a thumb-hold.

Several small Tulare Lake examples suggest thumb-and-forefinger use (Figure 50).

COMBINATION ENDSCRAPER/SIDE-SCRAPER (probable)

Scrapers of this hybrid variety are usually classed as either side scraper or end scraper according to the habit of the analyst.

(Figure 51)

They are likely present but unrecognized in most Paleoindian phases. They occurred at the East Wenatchee Clovis site, Washington.

CONCAVE SCRAPER (probable)
(spoke shave, notch)

Usually unifacial, this artifact exhibits one or more broad concavities on its edges that have been created by scraper retouch. It is felt that concave scrapers were used to plane shafts and other curved surfaces in the manner of a spoke shave. Any slender-round object, such as a dart shaft or a bone awl, could be smoothed down to good advantage with this implement.

(Figure 52).

END SCRAPER (probable)

These scrapers are unifacial tools, usually made on a flake-blade or blade, with a broad working edge opposite the bulbar end.

These are the most common of the scraper family from Tulare Lake (Figures 53-56). Note the robust size of the examples in Figure 53. Bulbar surfaces are usually unflaked sometimes showing cortex. These implements were hafted and, probably, cross-bound with animal sinew (Figure 56). Their large size, though small ones also occur, suggests heavy-duty wood and bone working.

KEELED SCRAPER (probable)

Keeled scrapers are unifacial-flaked stone tools, usually an end scraper, with a ridge or arris that runs along its main axis. This ridge is present on prismatic blades that have been struck from blade cores; indeed, most keeled scrapers are blade tools.

Several large specimens from the region may have been planes used for smoothing shafts or bone implements (Figure 57).

POINTED SCRAPER (probable)

Pointed scrapers are end and side scrapers that have been worked to a definite point, often rather rounded.

Figure 51: Combination Endscraper-Sidescrapers.

Figure 52: Concave scrapers.

Figure 53: End Scrapers.

Figure 54: End Scrapers.

Figure 55: End Scrapers.

Figure 56: Hafted End Scraper (replica).


Figure 57: Keeled Scrapers.


Figure 58: Pointed Scrapers.

On most Tulare Lake specimens, the generally rounded point does not seem sharp enough to have been used as a graver (Figure 58).

SIDE SCRAPER (probable)

Side scrapers are a unifacial tool, usually made on a flake, with removals (retouch) on one or both lateral edges. Tools with fine, normal, continuous unifacial retouch called *raclettes* are sometimes lumped together with side scrapers. In addition, some analysts make no distinction between denticulate (denticulate side scrapers) and side scrapers unless the teeth are quite pronounced.

(Figure 59).

SPURRED SCRAPER (probable)

Spurred scrapers are a unifacially, flaked stone tool having a spur created by retouching. The most common form of spurred scraper is an end scraper with a spur at the intersection of the working end and a lateral edge. Much rarer forms are spurred side scrapers or end scrapers with a spur at the bulbar end.

A *distinctive feature of this group of scraper is a well-developed groove-point (Figure 60). This implement would serve nicely for fashioning dart shafts—groove-point to loosen bark from shafts and cup shafts for spur engagement, scraping edges to remove bark and smooth shafts. The spur could also have served as a scarifier for decorative wood and bone engraving.*

TULARE LAKE WIDESTEM POINT (square stemmed variant) – (not in tool kit)

This variant includes both wide and narrow stem examples with edge grinding common but not present on every example. It includes soft hammer percussion followed by pressure thinning and shaping of the haft element. Thinning detachments are usually in groups and extend across the haft element to the short triangular blade.

Eighty-one examples,32 of which are of obsidian, (Figure 61) were collected from Locus 2, 4 and the southern end of Locus 5 where most of the artifacts belonging to later cultural groups occur. These widestem points are near-identical, in form, to Borax Lake Widestem points (widestem variant) from Northern California; however, it remains to be conclusively demonstrated that they belong to the Borax Lake pattern. Until such time they are adequately examined and studied, I shall refer to them as Tulare Lake Widestem points.

This type projectile point appears during the latter part of the Early Archaic period and exists for essentially all of the Middle Archaic period, 6,000 to 3,000 B.C. and is diagnostic of the Borax Lake pattern of the North Coast ranges (Justice 2002: 107-108).

WRENCH (probable)
(shaft wrench)

The wrench is a bone or antler implement with a cylindrical hole at one end. Wrenches are assumed to have been used for straightening wooden shafts or bone fore shafts, perhaps thrusting spears or javelins.

Nearly identical tools are known from European Paleolithic sites of the Aurignacian to Upper Magdalenian periods where they are termed *"batons de commandement."* It has been suggested that such devices were employed to remove the natural bow in long pieces of ivory and antler, from which points were made. Points to be straightened would first have been heated to made them pliable (Leroi-Gourhan 1989: 120).

A mineralized antler with a 17.6 mm hole bored through its center was found at Locus 9 (Hopkins 1991). Since the modified area and remainder of the artifact are equally mineralized, alteration, no doubt, took place when the specimen was in a green state. The diameter of the perforation fits nicely with bone foreshafts used for hafting fluted stone projectile points to lance shafts recovered from Anzick, a Clovis burial site in southwestern Montana (Lahren and Bonnichsen 1974). The Tulare Lake specimen (Figure

Figure 59: Side Scrapers.

Figure 60: Spurred Scrapers.

Figure 61: Tulare Lake Widestem points.

Figure 62: Wrenches.

62-left) could have been used for straightening such bone foreshafts.

Another considerably old fragment (Figure 62-right) with a 17 mm wide perforation was found near Sand Ridge, about eight miles south of Locus 9.

Occurrence: Known only from the Clovis phase of the fluted point tradition.

CONCLUSIONS

Artifacts in this sample are undated surface finds from eroded shoreline sites by the author. Most are problematic since they do not fulfill conditions upon which most archaeologists insist. The often concentrated nature of the discoveries and possible mingling of materials belonging in more than one time period makes it difficult to determine, with any degree of certainty, what kinds of artifacts accompanied the diagnostic projectile points. Nonetheless, from the evidence and in some cases pure conjecture or perhaps fanciful speculation, it can be suggested that certain items formed most of Tulare Lake's Paleoindian tool kit.

While it is recognized that problems and limitations are imposed by the lack of solid cultural associations, an imperfect but suggestive pattern emerges from the jumble of surface discoveries at Tulare Lake that may have belonged to Paleoindian hunters. However, before definitive statements regarding these people and their equipment can be made, far more extensive and detailed study of the region and the artifacts will have to be done.

Which migration route or routes were used for travel into and through the Tulare Lake Basin? Chances are, the first inhabitants came from Great Basin desert regions, possibly the Lake Tonopah and Mud Lake locality in the Big Smoky Valley of west central Nevada. This region once contained Pleistocene lakes Toiyabe and Tonopah where Elizabeth and William Campbell collected similar artifacts during the 1930s. Loranne Pendleton (1979) focused her Master's thesis on an analysis of Palaeoindian bifaces in the Campbell's Tonopah collection and Philip Wilke's response, after examining Tulare Lake Concave-Base points (personal communication 1991) was:

> Great Basin Concave Base series points from the Campbell collection, Lake Tonopah, Nevada are identical to the Hopkins collection of Western Fluted Points from Tulare Lake.

A migration route for Paleo hunters may have followed a southerly course from the Lake Tonopah locality along the eastern side of the Sierra Nevada Mountains through Owens Valley, and then west along the Kern River drainage to Tulare Lake. Three basally thinned Concave Base points made of chert were recovered in Kern County (one from the Old Kern Lake basin and two others from Buena Vista Lake) which follow this drainage route north to Tulare Lake (personal communication Terry Slaughter 2007). These points strongly resemble the concave base assemblage from Tulare Lake.

Thirty three (N = 33) obsidian artifacts from Tulare Lake identified by X-ray fluorescence as originating from California and Nevada sources may arguably support this suggested migration route. Eleven (N = 11) Concave Base points (1 Napa Valley, 4 Coso: West Sugarloaf, 1 Mono Glass Mountain, 1 Casa Diablo: Lookout Mountain, 1 Casa Diablo: Sawmill Ridge, 1 Mount Hicks, Nevada and 2 Queen, Nevada), eight (N = 8) Lake Mohave points (5 Coso: West Sugarloaf and 3 Casa Diablo: Sawmill Ridge), one (N = 1) lunate crescent from Coso: West Sugarloaf, ten (N = 10) eccentric crescents (3 Coso: West Sugarloaf, 6 Casa Diablo: Sawmill Ridge and 1 Casa Diablo: Lookout Mountain), one (N = 1) Silver Lake point from Coso: West Sugarloaf, and two (N = 2) Tulare Lake Widestem points (1 Casa Diablo: Sawmill Ridge and 1 Casa Diablo: Lookout Mountain) are included in the sample selected for analysis (Garfinke et al., this volume).

What happened to the Tulare Lake Paleo hunters? Quite likely, they were forced to change their way of life as increased aridity and declining resources of the large-bodied animals, upon which they primarily depended for their livelihood, died off—victims to rapidly changing environmental conditions. Some investigators claim that humans over-harvested the large animals to extinction (the "overkill" hypotheses). Conceivably, human hunters did play a role in wiping out certain species; but there is no convincing proof. The Paleoindian hunters probably were forced to adapt to the transformed conditions of the local environment or they migrated elsewhere.

To pass from one mode of life to another could not have been easy for them. A more settled lifestyle of a "gathering and small-game hunting" way of life demands a very different temperament and outlook from that of big-game hunters.

ENDNOTES

In this monograph, I have pieced together archaeological information about Tulare Lake, much of which has been reported by colleagues in earlier accounts. Consequently, it will be a review for some and, hopefully, helpful and informative to those who may not have had access to previous reports (i.e., local collectors). I have also included a practical guide for identifying Paleoindian artifacts from Tulare Lake.

In the past, numerous artifacts have been removed from ancient Tulare Lake sites, ending up in local collections. Some have been lost or discarded and others mixed (without provenience recording) with artifacts produced by later inhabitants of the region. Sadly, researchers studying the sites will not see most of these artifacts. I hope that this account might bring the professional and avocation archaeologists into closer harmony, patience, and cooperation with one another as they pursue a common goal of understanding all that went on in Tulare Lake's ancient past.

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I would like to thank Richard Gramly for allowing me to employ data from his publication *Guide to the Palaeo-Indian Artifacts of North America*.

Table 1 **Tulare Lake's Paleoindian Tool Kit**

Probable Element	Number	Figure	Possible Element	Number	Figure
Abraders	N = 034	2	Atlatl Engagement Spurs	N = 083	3-4
Awls (mineralized bone)	N = 006	5	Awls (stone)	N = 038	6
Bifacial Cores	N = 004	8	Bifaces	N = 005	7
Burins		none	Blanks	N = 042	9
Choppers	N = 033	11	Celts	N = 009	10
Clovis and CB Points	N = 173	12 & 13	Cores	N = 024	14
Crescents (lunate)	N = 141	15	Disk (incised bone)	N = 001	21
Crescents (winged)	N = 105	16-17	Expedient Tools		none
Crescents (eccentric)	N = 052	18	Fleshers	N = 002	24
Crescent Scrapers	N = 045	19	Fossil Shark Teeth		none
Denticulates	N = 015	20	Handstones		none
Drills	N = 029	22			
Flake Knives	N = 034	23			
Gravers	N = 019	25			
GBS Points (Lake Mohave)	N = 246	26-27			
Hammerstones	N = 046	28-29			
Humpies (lamices)	N = 108	30-31			
Hybrid Tools	N = 071	32-33			
Knives	N = 058	34-37			
Planes (scraper)	N = 005	39-44			
Preforms	N = 054	45-46			
Prismatic Blades	N = 103	47-48			
Reamers	N = 020	49			
Scrapers (circular)	N = 100	50			
Scrapers (combination)	N = 019	51			
Scrapers (concave)	N = 050	52			
Scrapers (end)	N = 161	53-56			
Scrapers (keeled)	N = 088	57			
Scrapers (pointed)	N = 095	58			
Scrapers (side)	N = 089	59			
Scrapers (spurred)	N = 118	60			
Wrenches	N = 002	62			
Total	N = 2123			N = 204	

Table 2 **Early Tulare Lake Projectile Points (not a element of Paleoindian tool kit)**

Projectile Point	Number	Figure
Tulare Lake Widestem Points	N = 083	61
Pinto Points	N = 133	38
Total	N = 216	

Table 3 **Witt Archaeological Locality - Provenience Data (USGS Dudley Ridge Quadrangle)**

Locus Number	Township	Range	Length (E-W) (approximate)	Width (N-S) (approximate)	Elevation (approximate amsl)*
1	T235	R20E	100m (110 yd)	300 m 330 yd)	190
2	T235	R20E	200 m (220 yd)	300 m (330 yd)	193
3	T235	R20E	300 m (330 yd)	300 m (330 yd)	192
4	T235	R20E	550 m (605 yd)	100 m (110 yd)	193
5	T235	R20E	600 m (660 yd)	550 m (605 yd)	190
6	T235	R20E	550 m (605 yd)	250 m (275 yd)	190
7	T235	R20E	300 m (330 yd)	300 m (330 yd)	190
8	T235	R20E	100 m (110 yd)	300 m (330 yd)	190
9	T235	R20E	300 m (330 yd)	550 m (605 yd)	190

Table 4

Partial Distribution of Assemblage - Witt Archaeological Locality

Locus	CB Points (sample - %)	GB Stemmed (LM) Points (sample - %)	Lunate & Winged Crescents (sample - %)	Eccentric Crescents (sample - %)	Crescent Scrapers & Hybrid Tools (sample - %)	Humpies *(Limaces)* (sample - %)	Choppers (sample - %)	Scraper Planes (sample - %)	Misc. * Tool Forms (sample - %)
1	3 / 1	15 / 6	5 / 2	0 / 0	0 / 0	2 / 2	5 / 16	1/2	67 / 8
2	4 / 2	38 / 15	31 / 13	18 / 38	5 / 4	37 / 34	8 / 25	0 / 0	75 / 9
3	9 / 5	12 / 5	7 / 3	10 / 21	0 / 0	17 / 15	0 / 0	0 / 0	15 / 2
4	0 / 0	10 / 4	15 / 6	7 / 15	0 / 0	0 / 0	0 / 0	0 / 0	10 / 1
5	60 / 35	66 / 27	149 / 60	4 / 8	88 / 76	31/ 29	8 / 25	1 / 20	446 / 54
6	50 / 29	61 / 25	23 / 9	2 / 4	20 / 17	2 / 2	3 / 9	0 / 0	125 / 15
7	7 / 4	13/ 5	9 / 3	0 / 0	3 / 3	2 / 2	4 /13	1 / 20	23 / 3
8	16 / 10	6 / 3	2 / 1	4/8	0 / 0	0 / 0	3/9	2 / 40	5 / 1
9	24 / 14	25 / 10	5 / 2	3 / 6	0 / 0	17 / 16	1 / 3	0 / 0	57 / 7
Total	173 / 100	246 / 100	246 / 100	48 / 100	116 / 100	108 / 100	32 / 100	5 / 100	823/ 100

* Includes abraders, gravers, hammerstones and scraper forms.

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Chapter 2

Ancient Stones of Black Glass: Tracing and Dating Paleoindian Obsidian Artifacts from China and Tulare Lakes

Alan P. Garfinkel, Jerry N. Hopkins, and Craig E. Skinner

Abstract: *Archaeological sites within the Great Basin and California appear to demonstrate that human occupation occurred in late Pleistocene and early Holocene times from ca. 12,000 to 6,000 B.C. A prominent locality for Paleoindian material is China Lake. Thousands of artifacts dot the fossil shoreline on the desert floor of eastern Kern County at the interface of the Mojave Desert and the Great Basin near Ridgecrest (Davis 1978).*

In Central California, projectile points hypothesized to date from these periods have been discovered in abundance at the Witt locality (CA-Kin-32) on the southwest margins of Tulare Lake in Kings County in the southern San Joaquin Valley (Dillon 2002, Moratto 2000; Riddell and Olsen 1969; Wallace 1991). Some of these artifacts are basally thinned, Concave Base points (over 500). These projectiles are similar to Clovis points but are often smaller, somewhat thinner, are pressure rather than percussion flaked, and, most often, lack the distinguishing flutes (Rondeau 2005a, 2005b; Rondeau et al. 2007; Wallace 1991; West et al. 1991). The range of variation for these points, typically assigned to the Great Basin Concave Base Series, has not been clearly defined. The Tulare Lake points appear to be a local variant of this same tradition.

Until recently, no direct dates for the flaked stone materials found at either locality have been published (yet, see Basgall 2003, 2005a, 2005b). An indirect means of obtaining such temporal parameters is the use of obsidian tracing and hydration dating. Thirty-eight (38) artifacts from China (n = 5) and Tulare (n = 33) Lakes were chemically characterized to source and analyzed for their hydration measurements. Results of these studies indicate that obsidian hydration dating is a useful tool even for very ancient artifacts of volcanic glass. Obsidian tracing and dating indicate that Concave Base points are partly contemporaneous with Clovis age artifacts, although they have a far lengthier duration dating from ca. 13,500 to 10,000 years cal before present (BP). Great Basin Stemmed Series points are of more recent age dating from ca. 11,000 to 7,000 years cal BP. Eccentric crescents are apparently coeval with both Concave Base and Great Basin Stemmed Series points and have a lengthy temporal span from 13,500 to 7,000 years cal BP.

Tracing studies of the early obsidian implements from Tulare Lake, in this study, indicate that Concave Base tradition foragers were far more mobile than the Great Basin Stemmed Series cultural expression. Obsidian originated in no less than six (6) different source localities from 100 to 250 miles distant. These late Pleistocene hunter-gathers traversed enormous foraging territories and either directly accessed or traded for volcanic glass and fused shale from the Napa Valley, Casa

Diablo, Coso, Mount Hicks, Mono Glass Mountain, Queen, and Grimes Canyon sources. Later, early Holocene Stemmed Series peoples had a smaller, more limited foraging radius and more protracted mobility patterns procuring only Coso and Casa Diablo volcanic glass sources.

INTRODUCTION

Within California, the attribution of Clovis-like materials and their purported association with the earliest time frames for aboriginal occupation has remained somewhat conjectural (cf. Arnold et al. 2004: 43). Arnold et al. (2004), in recently assessing the current state of our knowledge, reminds us that most of these "Paleoindian material(s) from California are surface artifacts that are nearly impossible to accurately date." Admittedly, in the general region where China Lake is located we have precious few reported obsidian hydration rim measurements (and until recently, no radiocarbon assays) on Concave Base points (CB), Clovis-like fluted points, and crescents. Likewise, in the Tulare Lake collections the authors believe that there were no obsidian dates at all.

In an effort to expand this data-set and provide some limited resolution, with respect to the age of these assemblages, flaked stone artifacts manufactured from obsidian (particularly those artifacts that are presumed to be temporally diagnostic of late Pleistocene and early Holocene age) were gathered from these two areas. These artifacts are reviewed here and the results of obsidian studies are discussed in some depth.

OBSIDIAN HYDRATION BAND GROWTH AND WEATHERING

It has been acknowledged that there often are problems obtaining hydration rim measurements on artifacts of presumed Paleoindian age. Many times, researchers simply do not attempt such analyses believing that their efforts will be in vain and that analysts will routinely find that these artifacts exhibit no visible hydration bands, diffuse hydration rims, or bands of variable width (cf. Sutton and Wilke 1984; Zimmerman et al. 1989). It has been assumed that environmental conditions cause degraded surface characteristics for these artifacts and these conditions effect the formation and sustainability of the diffusion fronts. It is plausible that the hydration readings could manifest variable widths or be smaller than expected due to the effects of erosion and that bands may have formed, eroded, and re-developed over the many thousands of years that the artifacts lay on the surface of the ground.

Discussions with Tim Carpenter at Archaeo-Metrics indicated that he has developed a new method of obtaining hydration rim values from weathered specimens based on his observation and measurement of hydration rinds from unweathered internal cracks. He has had considerable success in obtaining relatively valid and accurate obsidian hydration measurements on such ancient artifacts, even on artifacts with severely eroded surfaces. He has determined that making cuts in these specimens oriented to take advantage of cracks (step fractures) developed as a function of the techniques of their manufacture can often reveal internal hydration bands. Fluting or thinning of points often creates internal hinge fractures that allow hydration rims to exist even when the more exterior surface hydration bands are highly eroded.

Surface erosion and severe wear are evident on many of the artifacts examined for this study. The specimens from China Lake were far more eroded than those from Tulare Lake. Sandblasting and water tumbling had, no doubt, affected the surface morphology of many of the items. Most specimens had flake scar arrises that were severely rounded and abraded and the fluted forms had the greatest degree of surfical weathering. It was thought that detection of hydration measurements on the internal cracks emanating from the hinge fractures might provide a more representative and authentic measure of their age, and, accordingly, this strategy was pursued.

OBSIDIAN DATING AND EFFECTIVE HYDRATION TEMPERATURE (EHT)

Most researchers attempting to refine the obsidian dating technique have come to recognize the importance of factoring in the mean annual temperature in the area from which the archaeological remains were recovered. Integrating what has come to be known as effective hydration temperature (EHT) into the equation has done much to explain the variability in hydration measurements. Recent research by Rogers (2006a) has aided in further refinement of obsidian dating and has re-evaluated the calculations and methods used for effective hydration temperature (EHT) adjustments (Rogers 2006b, 2007a, 2007b).

Many factors affect EHT and cause it to fluctuate through time. Among these are paleoclimatic change, pedoturbation (buried versus surface contexts), site aspect, vegetation cover, latitude, and elevation. Consequently, EHTs are simply estimates influenced by a wide variety of environmental factors. The preferred strategy is to develop obsidian hydration and radiocarbon pairs for each locality and period since a single formula rarely provides reasonable age estimates for all times and places.

The source specific hydration rates employed here have mostly been developed from research in eastern California in the southern Owens Valley and vicinity (e.g., Lubkin Creek for Coso, Mono Basin for Casa Diablo, and the Volcanic Tablelands for Queen). The EHT for the southern Owens Valley has been estimated at 20.4 degrees centigrade (Rogers 2007a for Lubkin Creek). A little lower in elevation but quite similar in thermal regime and precipitation is the Coso Volcanic Field and China Lake areas with a proxy indicator from the communities of Ridgecrest at 19.3 degrees centigrade or Inyokern at 21.1. Remarkably, the EHT estimate for Tulare Lake using the Hanford area as a proxy (about 45 miles from the Witt Site), is almost identical to the southern Owens Valley at 19.9. Consequently, EHT adjustments between the source specific rates for Coso, Casa Diablo, and Queen from eastern California to Tulare Lake are rather minor (Table 3). Judging from the similarity in the ranges, means, and standard deviation measurements (provided here) for chronologically diagnostic projectile point series, these areas exhibit virtually the same hydration measurement metrics and are in most cases statistically indistinguishable (see Table 8).

Most researchers, until recently, adjusted for EHT referencing Lee's work (Lee 1969) and estimated that each degree of difference in EHT was equivalent to a 6% adjustment. Basgall, using that procedure and an empirically derived estimate, suggested that his Fort Irwin Coso hydration measurement was about 10% smaller than those exhibited at lowland sites (< 5,000 feet amsl) in the southern Owens Valley and in the Coso Volcanic Fields (Basgall 1990). Nonetheless, examination of the range, mean, and standard deviation for the stemmed series points of Coso obsidian from Fort Irwin compared with those from Tulare Lake and Coso region suggests that there is very little difference between hydration measurements with respect to stemmed series points from Fort Irwin and those from other areas examined here (Table 8).

Other researchers are now recognizing that air temperature does not always correlate uniformly with differences in radiocarbon age and hydration means (Rosenthal 2005). Such temperature correction (EHT adjustments) appears to improve results more dramatically where EHT variation is of greater extremes. In this study, we have chosen to use obsidian hydration dating equations without any adjustments for EHT for the source-specific obsidian dating equations that we apply. We believe that the resulting estimates are reasonable approximations given all the factors that enter into the hydration process and the resulting age attributions are simply a rudimentary means of attaching estimated dates to those hydration values.

COSO OBSIDIAN HYDRATION

One of the most widely traded obsidians in California is toolstone quarried from the Coso obsidian sources in eastern California, southern Inyo County (Ericson 1977). Coso volcanic glass has been recovered from prehistoric sites as far west as the Channel Islands and east to San Bernardino County near the town of Baker at Lake Mojave in the eastern Mojave Desert (Warren and Ore 2006). Coso obsidian has been the focus of intensive academic studies and may be one of the "most thoroughly investigated obsidians in North America" (Gilreath and Hildebrandt 1997: 10).

Coso obsidian hydration rims are exceptional in that they provide a bigger yardstick than any other source in California. Significantly, Coso is one of the fastest hydrating obsidians in the world (Craig Skinner personal communication 2007; Chris Stevenson personal communication 2007). Rims in the 22 to 27 micron range on presumed early Holocene and late Pleistocene age artifacts have now been reported (Basgall 2004; Byrd 2006; Gilreath and Hildebrandt 1997; Warren and Ore 2006).

Many empirical and experimental hydration equations have been developed for Coso obsidian (see Garfinkel 2007). These rates have met with varying degrees of success. Basgall's 1990 hydration rate is one of the most widely used formulas. It allows researchers to factor in the EHT (effective hydration temperature) in the area from which the archaeological remains were recovered. The rate does explain much of the variability in the measurements. Yet, a number of researchers have cautioned and the rate developer himself even agrees that this equation over-estimates the age of some materials. The rate particularly misrepresents early Holocene and late Pleistocene artifacts having rim measurements larger than 10 or so microns, as is the case for some (n = 8) of the Coso obsidian artifacts in the present sample (cf. Delacorte 1999; Gilreath and Hildebrandt 1997; Rosenthal et al. 2001).

One of the reasons for the excessive age attributions is that hydration/radiocarbon age pairs dating to this time are rare (however, see discussion below) and so, secure dates for this period are difficult to establish. Additionally, associated radiocarbon dates are not routinely calibrated and, as such, many of the current Coso hydration equations under-estimate the true age of the older obsidian hydration rims by as much as 1,000 to 2,000 years (Fiedel 1999). To help alleviate some of these problems, Basgall and Hall (2000) presented a revised Coso obsidian hydration rate equation based on an expanded corpus of hydration measurements and radiocarbon pairs that include some larger rims and earlier radiocarbon dates. That rate is:

$$Y = 659.21 - 516.04x + 155.02x^2 - 4.56x^3$$

Where Y is the age in radiocarbon years before present (present = AD 1950) and x is the hydration measurement in microns.

Unfortunately, details regarding the derivation of that equation have yet to be presented in full. However, that equation does produce reasonably valid age estimates (uncalibrated radiocarbon dates) in conformance with some of the associated radiocarbon ages for a suite of hydration rims spanning the last 8,000 years (Tables 2 and 4). The rate also provides somewhat more accurate late Pleistocene and early Holocene age attributions than the earlier one (cf. Basgall 1990). However, this newly revised rate still attributes excessive ages for the largest Coso hydration measurements. Calibrated ages about perhaps two to five thousand years greater than would be considered reasonable result when applying this rate on artifacts with rims of 10 or more microns (see Tables 2 and 4).

Admittedly, obsidian hydration measurements are not amenable to great precision and yield only a general indication of age and not an "absolute" date. However, even radiocarbon determinations result in sigma values and calibration issues that only allow for bracketed age ranges rather than single fixed points in time. So, even the most absolute of chronological assays still, to some degree, provide only a relative date.

Volcanic glass scientists generally expect that the largest hydration measurements are apt to produce much greater variability in their hydration rim measurements than the smaller readings (greater variation and larger standard deviations). Given this variability, single hydration rims are rarely reported with calendar-specific dates. Normally, a number of readings are averaged and attempts are made to identify them with significant associations and correlations with an assemblage of artifacts (e.g., certain time-sensitive projectile point types or a sample of readings on debitage thought to date an associated cultural deposit) in order to provide some measure for dating them. It has become the practice among some obsidian researchers to view the mean and a single standard deviation above and below the average as a useful approximation of the age of a projectile point type (cf. Basgall and Hall 2000; Haynes 2004). Using that approximation, the hydration measurements and time spans (Table 1) can be reconstructed that would be characteristic of Coso obsidian point types in the lowland Coso Volcanic Field areas in and about China Lake and the Coso Range of eastern California.

Several observations concerning the Coso obsidian hydration rate can now be made that are critically important to our understanding of the most reasonable hydration equation for dating this toolstone when attempting to estimate the age of artifacts from the late Pleistocene and early Holocene. From inspection of the lowland Coso obsidian hydration data from eastern California (Owens and Rose Valleys), Pearson (1995) was one of the first to recognize that the first micron of Coso hydration represents approximately 125 years and that each micron of additional hydration takes approximately 50 years longer to form than the preceding micron. Furthermore, current evidence favors the position that upon reaching about 9 microns the hydration of Coso obsidian actually speeds up and takes half the time to grow a hydration band of one micron than during the preceding period (Table 1). During the time span represented by hydration rims in the 6.4 to 8.4 micron range, each additional micron of hydration takes on average about 1,250 years to accumulate. However, during the time frame represented by the 10 to 16 micron range the rate at which each additional micron forms is on average only about 500 to 575 years per micron. It also appears that for the very largest rim measurements (16 to 20+ microns), each additional micron is added on average in only about 500 years. Basgall (1990) also recognized this fact and observed that the Coso rate flattens out for the most ancient ages associated with the largest hydration measurements.

One might conclude from this pattern that Coso obsidian characteristically accumulates the first few microns of hydration rather quickly then slows down, as Pearson (1995) observed, as additional microns of hydration accumulate. Then, as a larger hydration band is produced and grows to a size in excess of 9 microns, additional band thickness is added at a much faster rate than previously - in fact, at a rate that is apparently almost twice as fast (Table 1).

The physical process for the development of a hydration band of Coso obsidian, especially at the largest rim measurements, is difficult to understand. None of the many hydration equations developed for Coso obsidian (Nathan Stevens personal communication 2006) has resulted in an acceptable equation that provides reasonable ages for middle and late Holocene hydration rims (<10 microns) while simultaneously giving relatively accurate dates for early Holocene and late Pleistocene hydration measurements (10-20+ microns) (cf. Rogers 2007a). Further, the Coso hydration process cannot be compared or modeled with most other obsidians since they follow other patterns and do not achieve the large rim sizes of Coso hydration measurements. Most other obsidian sources only accumulate, at most, 10 to 13 microns of hydration over the entire span of North American prehistory at ca. 14,000 years. Coso obsidian grows rims twice that size over that same time.

The reason Coso obsidian hydration measurements might be better for examining the more ancient artifacts is that all hydration readings are subject to significant errors. Observation error is about plus or minus 0.2 microns. Additionally, given the vagaries of hydration measurements due to erosion of the rims, effects of temperature, and other unknown factors all acting on the physical dimensions of the diffusion front, a bigger measure allows for a bit more wiggle room and greater variability can be encompassed in the sigma with larger rims and a faster rate. Hence, a bigger yardstick allows each micron to represent only a smaller segment of time. Other obsidians track only, at most, 10 to 12 microns over 14,000 years with each micron at the earliest age representing a millennium or more. Coso obsidian grows hydration bands that at the earliest time spans equate 500 years or less per micron for rims approximately 15 to 20 or more microns. Why this is so is unclear. However, such a pattern does help explain the anomalously old ages derived by previously developed rate equations for large rimmed Coso obsidian artifacts.

THE "COSO CONUNDRUM"

Another potential confounding element has recently been discovered that could affect our efforts at establishing the age of early Coso obsidian artifacts. Fredrickson et al. (2005) and recent work by Tom Origer (personal communication 2007) revealed that Coso obsidian may not be as uniform a source as original perceived. It may be that sub-source differences, not addressed through past chemical characterization studies, play a significant role in differing rates of hydration. This would be problematic for most researchers attempting to establish a single hydration rate for Coso as multiple rates might in fact apply.

This phenomenon was first recognized when Casa Diablo and Coso obsidian of purportedly similar ages were discovered with nearly identical hydration rim measurements (Fredrickson et al. 2005). Given the very different hydration rates for these two obsidians, a potential problem with the Coso rate was recognized. Induced hydration experiments were conducted that supported a different hydration pattern for "Colossal Quarry" Coso obsidian from Sugarloaf Mountain versus "lag" deposits of Coso obsidian found away from the primary high quality sources. The primary quarry at Sugarloaf Mountain may grow rims more slowly than lag deposits. In addition, the former may have been a variety of obsidian used more recently in time. In contrast, the lag sources may be types that produce very large hydration measurements and are apt to have been exploited at a much earlier date.

At this point, much of the above is still conjectural but both empirical and experimental data do support the hypothesized pattern. Nevertheless, since we are dealing here with Coso artifacts having some of the largest rims ever recorded, these implements would most likely have been acquired from only the lag quarries that grow exceptionally thick rims (assuming that the Coso sub-source model of differing hydration patterns is ultimately supported).

COSO HYDRATION DATING: AGE ESTIMATIONS FOR EARLY HOLOCENE/LATE PLEISTOCENE HYDRATION RIMS

Extensive research in eastern California has provided a robust database of obsidian hydration measurements and associated radiocarbon determinations. Researchers agree that several Coso hydration rates all work reasonably well for hydration measurements attributable to the middle to late Holocene (Basgall 1990; Basgall and Hall 2000; King 2000; Onken 2001; Pearson 1995; Rogers 2007a). The central problem has been that all rates provide excessive ages for the largest Coso hydration measurements. Very thick Coso hydration rims imply great antiquity. However, it is notoriously difficult and few models seem to work well to provide consistent and reasonable ages with these late Pleistocene and early Holocene assemblages. Given the lack of sound radiocarbon obsidian hydration measurement correlations, some other means must be developed to date these artifacts.

One of the things we are trying to do here is develop some method of attaching an age to Coso obsidian artifacts with very thick hydration measurements. These artifacts with very large rinds produce excessively old ages when diffusion equation rate models are fitted to the calibrated radiocarbon age-rind pairings. Although less theoretically acceptable, empirical efforts might be justifiable for practical archaeological application where gross estimates on an archaeological assemblage is the objective (as is the present case).

Site	Number	Hydration Rims	RC Dates	Mean Calibration RC Age	Reference
INY-4554	93	10.1±1.4	6,740±90 7,010±100 7,780±90	7,698	Gilreath and Holanda (2000)

Note: Data taken from Gilreath and Holanda (2000:41). Chauvenet's criterion applied and four outlier values are excluded (2.4, 17.8, 18.0, and 18.4 microns). Coefficient of variation for this tightly clustered sample is 0.14, argued to be representative of a single population.

A large sample (n = 93) of Coso hydration measurements and several (n = 3) associated radiocarbon assays are available from a site near Owens Lake in eastern California that might help serve as a baseline (see box, above).

If we assume that 10 microns roughly conforms to 7,700 calendar years ago (calibrated radiocarbon age) as the above data might suggest, then it appears that each additional micron of hydration (above 10 microns) accumulates almost twice as fast at a range of 575 to 500 years per micron (see Table 1). If we take the average of the three largest estimates of rim growth in years per micron for Concave Base, Great Basin Stemmed, and Pinto points, that would give us a mean accumulation of 543 years per micron. Accordingly, each successive micron of hydration added would be equivalent to that estimate. A simple projection (really a *pro-rata* allocation) of that estimate provides the following rough yardstick of estimated ages with the accompanying hydration measurements and age equivalents extrapolated for these very large Coso hydration readings. These measures would apply only in the lowlands of eastern California and in other areas that are environmentally similar with roughly comparable effective hydration temperature (EHT) estimates (see box below).

A simple equation to convert these large rims (Coso hydration measurements of 10.0 or more microns) to calendar ages would be the following:

$$Y = 7{,}700 + 543(x - 10.0)$$

Where Y is the age in calendar years before present (present = AD 1950) and x is the hydration measurement in microns.

Admittedly, this equation and method is simple-minded, rather primitive, and not theoretically in alignment with the diffusion equation for the

"Coso Thick Rim Yardstick"

Rims (microns)	Age Estimate (Calibrated Radiocarbon Date / Calendar Age)
10.0	7,700
11.0	8,243 (±760 years per micron)
12.0	8,786 (±760 years per micron)
13.0	9,329 (±760 years per micron)
14.0	9,872 (±760 years per micron)
15.0	10,415 (±760 years per micron)
16.0	10,958 (±760 years per micron)
17.0	11,501 (±760 years per micron)
18.0	12,044 (±760 years per micron)
19.0	12,587 (±760 years per micron)
20.0	13,130 (±760 years per micron)
21.0	13,673 (±760 years per micron)
22.0	14,216 (±760 years per micron)

hydration process. In fact, one could argue quite cogently that this "rate development" is rather nearly circular thinking. Nevertheless, it does seem to work relatively well and provides some reasonable ages for these large rims, which is our primary objective here. They say that "the proof is in the pudding"—therefore, as more and better chronometric data bearing on this question is made available to researchers, we expect to develop a more refined and elegant hydration dating equation.

As a quick and independent check of our rough method of age determinations (see Table 2), we can compare our estimates with the hydration-radiocarbon pairs for early Holocene and late Pleistocene Coso hydration rims from feature contexts at Fort Irwin (Basgall 1993; Basgall and Hall 1991, 1992; Hall 1992). As is clear from this comparison, large hydration readings are apt to give somewhat inconsistent results and these data points are not always in sequential order—where larger mean rim values necessarily equate with more ancient ages. Nevertheless, even given the vagaries of the hydration process, there is a reasonably good fit between our Coso estimates and the mean calibrated radiocarbon age. Our projections are consistently neither over nor under estimates but render dates that are a little bit of both. The error rates vary from an under estimation of 1,500 years to an over estimation of 1,500 years with two estimates providing ages a little less than a millennium in error—being too old.

CHINA LAKE

Emma Lou Davis discovered early cultural materials from China Lake. These artifacts are primarily flaked stone and include a number of formalized implements. The total collection is rather large. Davis estimated that classifiable tools numbered more than 5,347 pieces. Small fractions of these materials were Paleoindian projectile points and obsidian artifacts were only a miniscule fraction of this assemblage. It is generally acknowledged that a preference for non-obsidian toolstone is characteristic of many (if not most) early Holocene/late Pleistocene age flaked stone assemblages. Later cultural assemblages are predominantly obsidian. Five artifacts were identified as early hunting implements of obsidian (Tables 4 and 9).

Provenience for China Lake Specimens

Davis (1978) indicated that the materials we reviewed and analyzed here were:

> Within the large area of Section 28 (1 statute mile square), a number of fossil microenvironments are represented, each of which was suitable for different activities. Mammoths 1 and 2 are probably remains of kill and butchery work. Hunts, drives and stalks were confined to more distant grasslands, but the marshes were used as natural traps for big animals that were either driven there or stampeded while drinking. Birding and foraging were the activities of the marshes, streams, and shallows. Processing of large animals took place along the nearest shore, whereas manufactures of portable objects was largely done in camp. These camps were on dry, slightly higher terrain, of which Stakes 1, 22 and 25 are good examples. Test excavations have already been made at Stake 1 and we know that there are artifacts buried under the sand resting on or in the strong paleosol which dates somewhere between 11,000 and 7,000 years B.P.
>
> This part of the collection was made while we were scouting around, before we had decided on the techniques and extent of the mapping program... Therefore, artifacts from Section 28 are interesting but are an uncontrolled collection. They seem to represent the whole range of Paleo-Indian tools characteristic of this valley.

Great Basin Concave Base and Fluted Points

Over time, it has become evident that there exists a class of projectiles that are large, lanceolate specimens with concave bases that date to the early Holocene and perhaps to the late Pleistocene as well. These bifaces are very similar to the Humboldt series (Garfinkel and Yohe 2005), yet they are often basally ground and sometimes exhibit grinding along their lateral margins. These points have been classified and given the name of either Black Rock Concave Base or Great Basin Concave Base (CB) and have been suggested to date ca. 11,000-13,500 cal BP. (Clewlow 1968; Fiedel 1999; Justice 2002; Pendleton 1979). These points have often been mistaken and mislabeled as classic Clovis points. In the Far West, most often these points *do not* exhibit the standard features and characteristics of classic Clovis points, often lacking true bifacial flutes and other characteristic elements (Warren and Phagan 1988; Rondeau et al. 2007). There seems to be considerable disagreement regarding their age and possible cultural associations in that they may be more akin (in age and technological features) to points labeled elsewhere as Plano, Plainview, Midland, or Goshen (Rondeau et al. 2007: 141). As Justice (2002: 80) has noted, classic Clovis assemblages in interior North America contain unfluted basally thinned lanceolate projectile points that would be easily included as representative of the Black Rock or Great Basin Concave Base type. However, these points from California and the Great Basin are ill defined in terms of their temporal and cultural affiliation.

Nevertheless, Concave Base forms of this very early type are recognized in Long Valley (Basgall 1988), Mono Basin (Hall 1991), Rose Valley (Borden 1971), Coso Range (Basgall 2003, 2004, 2005a, 2005b, 2007; Gilreath and Hildebrandt 1997), China Lake (Davis 1978), Sherwin Summit (Eerkens and King 2002), Bridgeport Valley (Halford 1998, 2001), Black Rock Desert (Clewlow 1968), Tulare Lake (Riddell and Olson 1969; Wilke 1991), and Lake Tonopah (Pendleton 1979; Tuohy 1984). Two points from two sites in Kennedy Meadows (TUL-897/KM-2 and TUL-899/KM–4) in the far southern Sierra Nevada Mountains at an elevation of nearly 6,000 feet (amsl) have also been assigned to this category (Garfinkel 2007; Gold 2005). Obsidian hydration rims on these two points manufactured from Coso obsidian (at 11.4 and 12.2 microns) have been equated with dates of 9,507 and 11,250 calendar years BP using a source-specific, temperature-adjusted hydration rate (Garfinkel 2007; Gold 2005). Such dates are roughly commensurate with prior estimates for the age of these forms (see Fiedel 1999; Justice 2002).

There has been some question concerning the age of Concave Base points (CB) and also some potential confusion concerning their ontogeny (Davis 1964; Glennan 1971; Jackson 1985; Jennings 1986; Justice 2002: 93). These points are thought by some to have preceded the Great Basin Stemmed (GBS) Series points of Lake Mojave and Silver Lake types. Such a determination is based in part on obsidian studies from Hanging Rock Shelter and Cougar Mountain Cave (Layton 1972a, 1972b: 28). A CB obsidian point from Hanging Rock Shelter exhibited a hydration measurement of over 10 microns and is the largest hydration reading for any point recovered from that site. Other possibly associated dates on these forms are suggestive of an age from 10,000 to 13,500 calendar years (Fagan 1975).

Within the China Lake collection, we identified a CB point (UAMS-5, Figure 1), attributed by trace element analysis to the Coso source (West Sugarloaf sub-source), and that point exhibited a hydration rim of 14.8 microns (Table 4). Emma Lou Davis reported that this point was found in the general vicinity of her Mammoth 4. If the mammoth and the point were deposited contemporaneously, that would certainly be of considerable interest. Davis (1978: 17) indicates that a radiocarbon date was calculated (UCLA-1800) at 18,600 ± 4,500 radiocarbon years before present on the ivory of Mammoth 4. Six pounds of ivory were assayed and the large sigma value was indicated as characteristic of all fossilized materials from China Lake. Both the mammoth material and the point were located at China Lake in Township 25 South, Range 40 East, in the Northeast quarter of Section 28 at an elevation of slightly less than 2,171 feet (amsl).

If our projected estimates for the thick rimmed Coso obsidian points are relatively correct (14.8 = 10,306 years cal BP) and if the date applied to the mammoth is also generally accurate, then the obsidian flaked stone point would have been deposited more recently than the death of the mammoth (mammoth dated at a minimum age of 14,100 rcybp or about 16,000 years cal BP). That minimum age for the mammoth is considerably older than the revised dates now suggested for the earliest inception of the Clovis Complex in interior North America at 11,050 rcybp (Waters and Stafford 2007).

A second CB point (Figure 1) was identified to the general provenance of Section 28 (A-19) and has a larger hydration band of at least 18.4 microns. It has been chemically characterized to the Coso source field and the West Sugarloaf subsource (Table 1). The point is highly weathered (sand blasted) yet appears to have been unifacially fluted. However, we cannot assert that this is the case with absolute certainty due to the great degree of damage and abrasion the point has experienced. Our thick rim Coso age estimator would provide a date of 12,261 years cal BP.

One other Coso obsidian, Paleoindian point has been previously examined and a hydration rim measurement reported (Tuohy 1969: 170-171; 1984, Figure 5m). That point was chemically characterized to source and identified as coming from one of the Coso Volcanic Field sources and exhibited a hydration measurement of 15.7 microns. It was discovered lying on the edge of Lake Tonopah in Nevada. From the description and metrics, it is a bifacially fluted, Clovis-like form. This hydration measurement is in accord with the range of readings that would be predicted for CB points derived from the general environs, elevation, and thermal regime of the lowland Coso Volcanic Field area.

Fluted Points

A heavily sandblasted, apparently bifacially fluted point base was also found in the same general area as the other materials that have undergone study at China Lake (T25S, R40E, Section 28, Catalogue Number A-320, Figure 1). It has a surprisingly small hydration band of 10.3 microns and was determined to have been quarried from the Saline Valley obsidian source. No hydration rate has yet been developed for that source. Saline Valley lies northeast of the Coso Range, some 50 miles distant.

Crescents

A crescent of obsidian was discovered in the adjacent area of Section 21 (A-512, Figure 1) and was identified through XRF study as having been manufactured from an unknown source of obsidian and has a hydration measurement of 15.4 microns. Given this large measurement, all obsidian dating equations would indicate a late Pleistocene/early Holocene age. Another crescent of similar form and location (A-45) did not reveal a hydration band under analysis and was manufactured from a similar source of obsidian that has no known geographic source.

Great Basin Concave Base (CB)

Two new obsidian hydration measurements on CB Coso obsidian points are now available from China Lake that range from 14.8 to 18.4 microns. We can also add to the small sample the two Concave Base points previously identified in the Gilreath and Hildebrandt (1997) study in the nearby Coso Volcanic Field. It is therefore possible to obtain a more refined chronological estimate for the expanded suite of four (4) China Lake/Coso Range Concave Base hydration rims using our rough estimations for thick Coso obsidian hydration rims. Extrapolating from the hydration measurements using the mean and a single standard deviation from the average as a general age range for those points, suggests a mean age of 11,446 years cal BP and a range from 9,546 to 13,727 cal years BP (Tables 1, 4, 5, 6 and 9).

Given the small sample of Coso hydration measurements (n = 4), it is difficult to ascertain the precise chronological range represented by these early points. However, if the rims do in fact even roughly represent the relative ages of these forms then, that range of hydration measurements would seem to support the notion that these style points endured for some time (perhaps for three or four thousand years) and have a much lengthier tenure than that recently reported for the classic Clovis Complex suggested now as lasting, at most, for only a few centuries (Waters and Stafford 2007).

Recently, Mark Basgall (2003, 2004, 2005a, 2005b, 2007) revisited Pleistocene China Lake with an eye toward updating and refining the early work of Emma Lou Davis (1974, 1975, 1978). Basgall's initial report (2003) on his efforts indicates that he was able to obtain three radiocarbon dates within the vicinity of Davis' collection areas. Two dates were obtained on a spring-related peat stratum: 9,870±50 and 10,010±110 rcybp and a single date of 8,390±130 rcybp was assayed on an artifact-bearing paleosol. Those dates when calibrated provide a range of 9,000 to 12,000 cal years BP and, as such, would be in general agreement with the chronological position suggested here for CB points in the China Lake area. Our estimate would place Concave Base points in the range of 10,000 to 13,500 years cal BP (see below).

Dating Stemmed Series vs. Concave Base and Clovis-Like Fluted Points

The relationship between GBS points (cf. Lake Mojave and Silver Lake) and CB / Clovis-like Fluted points has been unclear (cf. Beck and Jones 1997). These artifacts often co-occur, but are also identified in distinctively different microtopographic associations. As Basgall (2003) has noted, there are three alternatives that might explain these patterns: (1) the two assemblages are truly of differing age and are only conflated (mixed together) due to overprinting of recurrent occupations; (2) they are of comparable age but have separate (cultural) origins; or (3) they are contemporaneous elements of a single adaptive pattern. Growing evidence from eastern California seems to support the notion that these expressions are manifestations of two distinct depositional events of differing age there and that the Concave Base and fluted forms are the oldest expressions and the stemmed series points are younger (see discussion below). Our research bears on this question.

The small suite (n = 4) of Coso obsidian hydration measurements provides some new evidence supporting the differentiation of stemmed series points versus basally thinned and fluted Concave Base points. Coso obsidian is an especially good yardstick for such an evaluation since it produces the largest hydration reading measurements of any obsidian in California. It can be noted that the stemmed series points have an associated suite of largely non-overlapping hydration rims with a mean that differs significantly from the CB forms. The mean for the GBS points is consistently in the range of 13.0 microns while the mean for CB forms is four microns greater at about 17.0 microns (Table 5).

Figure 2 presents a t-test for the data set. The t-value for the entire data set is 2.063 with a probability of .007959, supporting the hypothesis that the mean hydration values for GBS and CB are statistically different. Although the sample size for the CB is very low (n = 4), nonetheless, we would conclude that the two point types were used at different periods of time.

Recent research by Waters and Stafford Jr. (2007: 1125) allow for the possibility that Clovis and GBS Series artifacts might be coeval in part at Bonneville Estates Rockshelter, Nevada (Goebel et al. 2006). It seems reasonable, given the metrics presented here, that there is indeed some limited overlap in the dating of these two early assemblages. Willig et al. (1988: 10-11) suggested a brief overlap of only two hundred years in Western Clovis and GBS Series points. The spread of hydration readings for these two forms, the range in rim measurements, and the conversion of rim measurements to approximate

Figure 1: Concave base points. Bottom row, left to right: VAMS-5, A-19, A-320. Middle: lunate crescent, A-512. Top, crescent shaped item, A-45.

dates presented here and below does not seem to support such a brief overlap but one of much greater duration perhaps at a minimum of one to two thousand years. We agree with Haynes (2004) in his rough approximation for the age of Stemmed Series points in the Great Basin and suggest that these forms, most likely, date from ca. 8,000 to 11,000 calendar years before present (see further discussion below).

Given the overlap in hydration ranges for the CB and the few examples of more Clovis-like points, it seems likely that the CB points continued in use (after the termination of the classic Clovis forms), but appears probable that these points were the most distinctive flaked stone expressions for some of the earliest populations occupying North America and were initially employed ca. 13,500 years cal BP.

TULARE LAKE

One of us, Jerry Hopkins, has been an avid avocational archaeologist for many years and has been a student of the prehistory and history of the Tulare Lake region for more than 50 years. Through Hopkins' investigations, we were able to access his unique collection of Paleoindian materials, including obsidian artifacts from the Witt locality near Dudley Ridge (see Hopkins, this volume).

Provenience for Tulare Lake Specimens (Witt Locality)

The majority of the flaked stone assemblage was found on the surface of the fossil shorelines at elevations between 190 and 195 feet (amsl) in Township 23 South, Range 20 East, in various sections. This contour marks a level at which Tulare Lake stood for a considerable time span during the late Pleistocene/early Holocene, well below the 210 foot shoreline of more recent lake high-stands that would have placed these earlier shorelines under water.

Ages of Tulare Lake Obsidian Artifacts

Based on their obsidian hydration measurements, it appears that CB and fluted projectile points are at least partly contemporaneous and the oldest artifacts recovered from Tulare Lake. Both forms are most likely variants of the same technological and cultural tradition. The CB points differ only slightly from the classic Clovis points recovered from the Plains states. As mentioned earlier, it may be that most of these CB points are

Figure 2. Data from Coso Volcanic Field and China Lake.

Point Type	N=	Mean	St. Dev.	SE Mean	CV
GBS	21	12.9	2.7	0.6037	.21
CB	4	16.9	3.5	2.0207	.21

T= 2.063 P=.007959 Pooled Standard Deviation=7.3709

The metric data for each suite of readings presented here includes mean, standard deviation, number of measurements, and the coefficient of variation (CV). The latter measure is calculated by dividing the standard deviation by the mean and is useful in comparing multiple samples with varying means (Blalock 1979: 84). The CV provides a useful statistic to evaluate a sample's relative homogeneity. Tightly clustered readings, presumably, represent a single chronological period and have been recently defined as having a CV of 0.25 or less (Gilreath and Hildebrandt 1997). Such is the case with respect to the samples described here for both the GBS series and the CB points.

Key: GBS = Great Basin Stemmed, CB = Concave Base. Data for GBS and CB measurements from Gilreath and Hildebrandt (1997) and the present study.

more aligned with forms labeled as Plano, Plainview, Midland, or Goshen. However, true look-alike Clovis forms with all the classic recognized features are found at Tulare Lake at the Witt locality, though they number far fewer than previously estimated. Still, dozens of such examples are known from private collections including the Hopkins assemblage (Rondeau 2005a, 2005b; Rondeau et al. 2007). The number of such points discovered at the Witt locality is still, in fact, far greater than that at any other archaeological site where fluted points have been discovered within California.

Age of Concave Base and Fluted Points

Coso

Four (n = 4) Concave Base and fluted points of Coso obsidian derive from the Witt locality at Tulare Lake (Figure 3). The first of the smaller rimmed specimens (D30943; 9.0 microns) is unifacially fluted and the second small rimmed CB artifact (DRL6GF1; 5.2/9.1) is basally thinned. One of the large rimmed examples (D41199; 19.8 microns) is simply thinned and the other artifact (DRL6GF2; 11.4/11.7/12.7/14.0 microns) is bifacially fluted, edge ground, and also exhibits channel scratching. We are uncertain of why the former two specimens bear such modest hydration measurements. We suspect that these measures do not validly represent the antiquity of these pieces, since we have other specimens of differing glass that all support the interpretation that these stylistically distinct specimens are in fact late Pleistocene and early Holocene in age.

Dismissing these two anomalously small rimmed artifacts as outliers or the products of more recent episodes of reworking and scavenging, the largest rimmed specimen would equate with an age of about 13,000 calendar years BP (13,021 calendar years based on our Coso thick rim estimator presented above) and for the other artifact, its largest rim (14.0 microns) would equate with an age of 9,872 years cal BP). Significantly, the small sample of thick-rimmed CB Tulare Lake points has a mean that is identical to that of the Coso Volcanic Field CB finds.

Casa Diablo

Two (n = 2) CB points (Figure 3) of Casa Diablo obsidian (different sub-sources) were recognized from Tulare Lake (D30950, 6.1 microns and D41262, 12.1 microns). The two obsidian hydration measurements match the end points in the range of readings for similar CB points of Casa Diablo obsidian recovered from the Komodo site in eastern California (Basgall 1987, 1988). Using the unadjusted Casa Diablo (Hall and Jackson 1989) obsidian hydration rate to convert the rims to radiocarbon ages provides a range of 3,522 rcybp and 12,301 rcybp. Given that the smaller rim is so distinctly at odds with our other supporting data, we would tend to view that recent age as anomalous or a statistical outlier. The late Pleistocene date is more in line with the other dates from large rimmed CB points manufactured from a variety of different obsidian sources located throughout California. When the derived radiocarbon date using the Hall and Jackson (1989) equation is calibrated, it would appear to result in a date of ca. 14,500 years cal BP.

Queen

Two (n = 2) CB points (Figure 3) bearing flutes on both faces and appearing very similar to true Clovis material on the Plains were identified at Tulare Lake (D41036, 10.7 microns; D41179, 7.9/6.1/5.5 microns). The source specific Queen obsidian hydration rate uses the formula:

$$Y = 82.74\ (x)^{2.06}$$

where x = micron measurement and Y = age in radiocarbon years (Basgall and Giambastiani 1995: 44).

That rate was developed for the Volcanic Tablelands of the Owens Valley. The latter point with multiple rims appears to have been scavenged and reworked so frequently it is doubtful that any of these readings represent its true age.

Even the largest rim reading at 7.9 microns would provide an age of only 5,845 rcybp.

The other point with the larger hydration measurement (D41036, 10.7 microns) would provide an uncalibrated age of 10,920 rcybp and that date would convert to a calendar age of approximately 12,900 years cal BP. Such a date is quite close to our expected age for true Clovis points in the interior of the United States. Recent study (Johnson et al. 2007) of a high elevation (8,200 feet amsl) find in the Sierra Nevada in Fresno county reported on a nearly complete classic Clovis point manufactured of Queen obsidian that was bifacially fluted on its concave base. That point provided a similar size obsidian hydration measurement, when adjusted for EHT, of 11.1 microns. The point was argued to have an estimated age of 13,500 years cal BP (Johnston et al. 2007).

Napa

Surprisingly, one (n = 1) Tulare Lake CB (Figure 3) was crafted from obsidian derived from the Napa glass source in northern California (D41272, 8.4 microns). This is the northernmost source and the farthest distant obsidian source (235 miles to the northwest) represented within the Witt locality at Tulare Lake. We believe this artifact may represent one of the southernmost examples of aboriginal use of Napa Valley obsidian documented archaeologically. Two rates are often used to provide age estimates for Napa obsidian hydration measurements (Origer 1982; Rosenthal 2005). Rosenthal's recent efforts (Rosenthal 2005) are perhaps the most rigorous attempt at developing a source-specific hydration dating equation. Using 33 radiocarbon-hydration pairs from throughout the Central Valley, his Model A provided the best approximation of calendar dates for hydration rim suites within the last 3000 years of prehistory. Rate A provides that:

$$Y = 148.7\ x^2$$

where Y is a date in calibrated radiocarbon years and x is the hydration measurement in microns.

At 8.4 microns the estimated calendar age for the artifact would be 10,493 years cal BP.

Others (Mono Glass Mountain, Mt. Hicks)

Finally, two (n = 2) additional CB points (Figure 3) emanate from volcanic glass sources that do not have well-developed source-specific hydration dating equations. A unifacially fluted CB point (D41101) exhibited a hydration measurement of 10.8 microns and was traced to the Mono Glass Mountain source in eastern California in Mono County. The other CB point was derived from the Mt. Hicks source and manifested a dual rim of 6.0 and 12.9 microns (D411100). If these two obsidian sources exhibited hydration rates comparable to most of the other sources recognized in California (except for Coso), the larger rims of 10.8 and 12.9 would by those measures support an early Holocene or even perhaps a late Pleistocene age for these specimens.

Mono Glass Mountain has an obsidian hydration rate developed for the source reported by Overly (2003). Applying that rate to the hydration rim of 10.8 for the CB point (D41101) would result in an excessively ancient and unreasonable radiocarbon age of 26,000 years.

Based on recent communication from Tim Carpenter, Mount Hicks obsidian is said to have a hydration rate the same as Casa Diablo and perhaps also that of Bodie Hills obsidian (Tim Carpenter personal communication 2007). We would argue that the larger hydration measurement would presumably date the original time of manufacture for the CB point (D411100). The Casa Diablo rate provides an uncalibrated radiocarbon age for the 12.9-micron rim of 13,827 rcybp. If that date was calibrated it would appear rather too old and unreasonably ancient, but nevertheless indicating a date probably of late Pleistocene age.

Figure 3: Concave Base points. Bottom row, left to right, bottom to top: D30943, DRL6GF1, D41199, DRL6GF2, D30950, D41262, D41036, D41179, D41272, D41101, D411100.

Age of Great Basin Stemmed Points

Coso

Six (n = 6) GBS points (Figure 4) of Coso obsidian from the West Sugarloaf sub-source were identified (D31069, D1150, D31063, D31068, DRL6GF4, and DRL6GF10). These artifacts have rims of 11.8/14.6, 10.0, 9.5, 12.3, 6.1/10.4/11.9 with two outliers both at 6.1 microns. Excluding the smallest rims and incorporating both measures from the dual rimmed specimen would provide an average for that small sample (n = 7) of 11.5 microns and a standard deviation of 2.3. Using our rate for thick Coso rims, we would calculate that this average rim measure to equate with 8,514 years cal BP. Using a single standard deviation above and below the mean provides an age range from ca. 9,763 to 7,266 years cal BP for these GBS points.

Casa Diablo

Three (n = 3) GBS points (Figure 4) were fashioned from Casa Diablo obsidian (D1552, 10.1; D1047, 10.0; D1019, 9.7). These artifacts range from 9.7 to 10.1 microns. This small collection has a mean of 9.9 microns and a standard deviation of .2. The mean rim measure equates with an age of 8,528 rcybp (Hall and Jackson 1989). Correcting that age provides a date of ca. 9,500 years cal BP. Applying the mean plus one standard deviation above and below the average gives us an age range of ca. 9,200 to 9,800 years cal BP.

Age of Tulare Lake Widestem Points

Widestem (WS) points of obsidian are somewhat common at the Witt locality at Tulare Lake. Within the Hopkins collection, there are 81 examples of this style and they are manufactured from both the locally available chert (n = 46) and imported non-local obsidian (n = 35). Nearly identical forms are known from Northern California and were identified at the Borax Lake Site that appear to overlap in age with both fluted points and crescents, but continued to be employed until a much more recent era and discontinued at ca. 6,000 years cal BP. Therefore, with an eye toward identifying whether these morphologically similar forms from Tulare Lake and the Witt locality are of similar age to the other late Pleistocene and early Holocene materials recovered from Borax Lake, we analyzed a small sample (Figure 4) of these artifacts (n = 2).

Both WS points were analyzed to determine the geographical source of their obsidian. Both were acquired from Casa Diablo but from different sub-sources. The first (DRL6GF8) was from Lookout Mountain and did not have a readable hydration rind. The other derived from Sawmill Ridge (DRL6GF9) and exhibited two hydration rims of 9.6 and 11.0 microns. Assuming that the larger rim dates the initial manufacture of that point and that the smaller rim is a product of reuse, then the 11.0 micron reading would equate with an age (using the Hall and Jackson 1989 rate without any adjustment for possible temperature differences) of 10,336 rcybp. Correcting that radiocarbon age into calendar years provides a calibrated mean age of 11,505 years cal BP.

Age of Eccentric and Lunate Crescents

Bifacial and unifacial crescents are not uncommonly associated with early Paleoindian materials thought to be commensurate in age with Clovis and Great Basin Stemmed Series sites (Justice 2002: 74). In the Far West, a number of researchers have identified crescents and attributed them as part of the flaked stone assemblage of "Clovis" hunters (Davis and Shutler 1969; Heizer and Hester 1978). Nevertheless, in California crescents have defied adequate dating. Among the only examples associated with a datable stratigraphic context are those reported from the deeply buried soil at CA-KER-116, Buena Vista Lake (Fredrickson and Grossman 1977; Hartzell 1992). Associated radiocarbon dates on freshwater mussel shell for that lowermost stratum ranged between 7,175 and 6,450 years cal. B.C. Some researchers have argued that crescents are distinct technologically from fluted Paleoindian technologies and that most evidence would indi-

Figure 4: Great Basin stemmed points. Bottom row, left to right: D31069, D1150, D31063, D31069, DRL6GF4, DRL6GF10, D1552, D41047, D1019. Tulare Lake Basin widestem points: DRL6GF8, DRL6GF9.

cate that they were in use primarily from 6,500 to 8,500 years cal BP (see Fenenga, this volume).

However, other data from the Borax Lake Site in northern California supports the position that crescents are at least in part coterminous with fluted points (Meighan and Haynes 1968, 1970; White 2002). Obsidian hydration measurements on fluted projectile points, stemmed points, and crescents from the Borax Lake Site support substantial temporal overlap as these stone implements uniformly exhibit hydration measurements that range between 8.0 and 9.7 microns and are interpreted as dating from ca. 10,000 to over 13,000 years cal BP.

Crescents are sometimes referred to as "Great Basin Transverse Points" since it was thought that they might have been hafted lengthwise and used as bunts in the hunting of waterfowl. Alternately, use wear analysis reveals that they may have functioned as a knife or scraper similar in form to an Inuit's women's knife or *ulu*.

Eccentric Crescents

Coso

Three (n = 3) eccentric crescents (Figure 5) of Coso obsidian were identified from Tulare Lake (L10874, D21528, and D31023). All had distinctive chemical signatures matching the trace element profile for the West Sugarloaf sub-source. Almost four microns separates the smallest and largest rim measurements providing a range from 7.9 to 11.7 microns. These three data points provide a suite of readings with a mean of 9.2 microns, standard deviation of 2.1, and coefficient of variation of .23. Since the lower range in hydration measurements is less than 10.0 microns, we used the Basgall and Hall (2000) rate to estimate the average age of these three artifacts. That lower range (7.9 microns) provides an estimated age of 6,078 rcybp or ca. 6,975 years cal BP. The uppermost range of 11.7 microns provides an age estimate of 8,623 years cal BP. Therefore, the Coso obsidian eccentric crescents might best be estimated at an age of 7,000 to 9,000 years cal BP. This would be largely commensurate with the GBS points identified from Tulare and China Lakes.

Casa Diablo

Seven (n = 7) eccentric crescents (Figure 5) of Casa Diablo obsidian were also identified from Tulare Lake (D41010, 13.5; D41219, 3.7/11.7; D41017, 10.1; D30931, 10.1; DRL6GF7, 11.0; DRL6GF11, 3.5, 10.3; DRL5GF5, 7.6). All were chemically fingerprinted as manufactured from volcanic glass from the Sawmill Ridge (n = 6) and Lookout Mountain (n = 1) sub-sources from the Casa Diablo obsidian field. The hydration measurements on six of these artifacts revealed a range of measurements from 10.1 to 13.5 microns (Table 9). The artifact with the 11.7-micron measurement must have been subject to reuse since it revealed a much more recent and smaller secondary rim of 3.7 microns. Similarly, another eccentric crescent with a 10.3-micron reading apparently was used more recently and exhibited a smaller secondary reading similar to the other artifact with a dual reading at 3.5 microns. Additionally, a third aberrant reading was derived from another eccentric that was either an eroded rim or the product of secondary use and scavenging.

Disregarding the rim readings smaller than 10.1 microns, these six eccentric crescents have hydration measurements with a mean of 11.3 microns and a standard deviation of 1.61 microns. Assuming that the Casa Diablo hydration rate developed for eastern California (Hall and Jackson 1989) can be applied without significant temperature adjustments to these Tulare Lake specimens, then that 11.3 micron measurement would equate with a radiocarbon age of about 10,857 rcybp (12,840 years cal BP). Estimating the chronological position using the mean and a single standard deviation provides an age range from 9,200 to greater than 13,500 years cal BP.

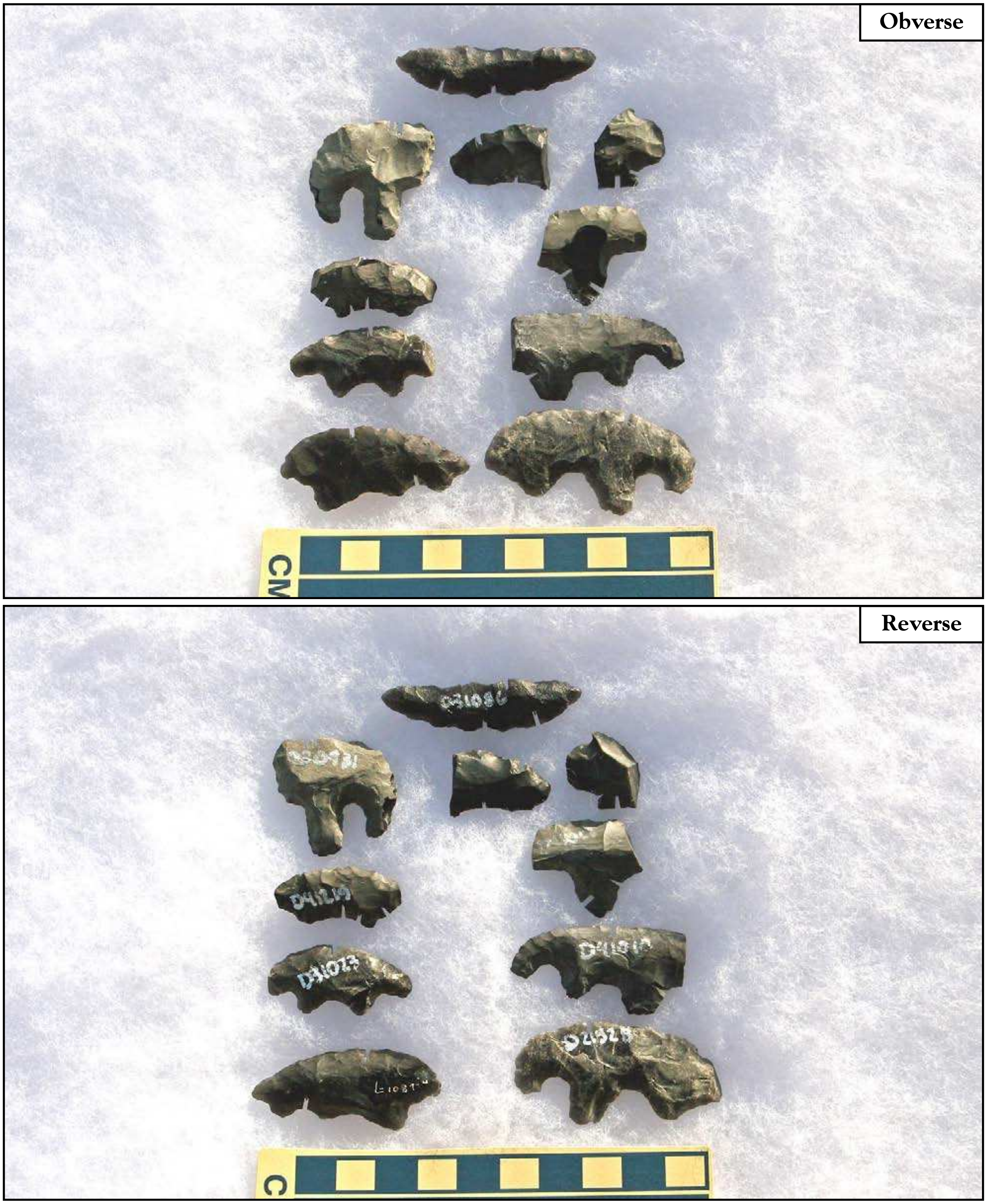

Figure 5: Eccentric crescents Bottom row, left to right, bottom to top: L10874, D21528, D31025, D41010, D41219, D30931, DRL6GF7, DRL6GF11.

Lunate Crescent

Coso

One (n = 1) bifacially flaked lunate crescent (D31086, 6.1) was traced to the West Sugarloaf sub-source within the Coso Volcanic Field (Figure 5). It had a surprisingly small hydration measurement of only 6.1 microns. That rim would convert to a more recent age than most of the other crescents of only 2,245 rcybp (Basgall and Hall 2000). This anomalous reading is probably best viewed as a statistical outlier or perhaps a manifestation of reworking of an older piece.

CONCLUSIONS AND GENERALIZATIONS

Thirteen (13) obsidian Concave Base and fluted points provided hydration measurements and source determinations. The hydration metrics for many of these artifacts (n = 9; 69%) support an early Paleoindian age. Hence, this assemblage apparently represents a time range from about 10,000 to 13,500 years cal BP with the majority (n = 7; 54%) of our age estimates and source-specific obsidian dates approaching the earliest millennia dating to that period.

Nine (9) Great Basin Stemmed obsidian points were analyzed from the Witt locality at Tulare Lake. Hydration measurements and source-specific obsidian age estimates indicate a distinctly more recent assemblage than the CB points. Date estimates overlap the CB temporal range only slightly suggesting a time span for the GBS assemblage from ca. 7,000 to 11,000 years cal BP. Many researchers posit just such an age for GBS Series points and our small sample supports those prior estimates and would fit quite nicely within that period.

Eleven (11) obsidian crescents of two types were examined. The rarest and most unusual are the eccentric crescents (n = 9). These artifacts were apparently coeval with the temporal range of both CB and GBS points. The earliest examples (n = 5) were almost exclusively manufactured of Casa Diablo obsidian from the Sawmill Ridge locality. Obsidian dates attest that these specimens date from ca. 9,000 to 13,500 years cal BP. Eccentric crescents of exclusively Coso obsidian have a more recent time frame. They are estimated as dating from ca 9,000 to 7,000 years cal BP.

Three (3) other crescents of more ordinary form were also noted. One specimen from China Lake bore no visible hydration rim and another from a similar provenience could not be traced to source but had a very large hydration rim (15.4 microns). That measure, if recognized for any of the known obsidian sources in California, would provide ages suggesting an early Holocene if not late Pleistocene date. One lunate crescent of Coso obsidian came from Tulare Lake had a surprisingly small hydration measurement of 6.1 microns. That anomalously small reading may owe to scavenging or reworking of this artifact. A Tulare Lake Widestem point of Casa Diablo obsidian apparently dates to ca. 11,500 years cal BP based on the largest hydration measurement exhibited on the specimen.

Results of these studies, in general, indicate that obsidian hydration dating can be a useful tool even for very ancient and heavily weathered artifacts of volcanic glass. Obsidian tracing and dating indicate that Concave Base points are partly contemporaneous with Clovis age artifacts, but they have a far lengthier duration dating from ca. 13,500 to 10,000 years cal (BP). Stemmed series points are of more recent vintage dating from ca. 11,000 to 7,000 years cal BP. Eccentric crescents are apparently coeval with both Concave Base and Stemmed Series points and have a temporal span from 13,500 to 7,000 years cal BP.

Geochemical trace element studies of obsidian procurement from Tulare Lake indicate that Concave Base tradition foragers were far more mobile than the Great Basin Stemmed cultural expression. Obsidian originated in no less than six (6) different source localities from 100 to 250 miles distant. These late Pleistocene hunter-gatherers apparently traversed enormous foraging territories (cf. Jones et al. 2003) and either directly accessed or traded for volcanic glass from the Napa Valley, Casa Diablo, Coso, Mount Hicks, Mono Glass Mountain, and Queen obsidian sources, and fused shale from the Grimes Canyon toolstone source. Later early Holocene stemmed series foragers had a smaller, more limited foraging radius and more protracted mobility patterns accessing only Coso and Casa Diablo volcanic glass sources.

If these chronological assessments are generally accurate, with respect to the temporal placement of these early assemblages, this has significant and far-reaching implications for the study of the early peopling of the Americas. A lengthy tradition of distinctively thinned or fluted Concave Base points appears to have endured far longer than the Clovis expression in the more eastern portions of the United States. This Clovis Tradition is now believed to have lasted for only 200 – 500 years (Waters and Stafford 2007). The number of CB and fluted points recognized from Tulare Lake is easily in the hundreds and exhibits a far greater profusion than any other location exhibiting fluted points in California and contains one of the largest Paleoindian assemblages in North America (cf. Dillon 2002).

Dillon noted that there were probably more fluted points at the Witt locality than all other fluted point finds combined for California (Dillon 2002: 16, Table 1). Rondeau et al. (2007) believes that statement is in error and that many, if not most, of the fluted points from the Witt locality are rather simply thinned or at some variance from typical Clovis points from the interior of the United States (see Rondeau 2005a and 2005b). Nevertheless, the Tulare Lake CB and fluted points are at least early Holocene in age, definitely Paleoindian, and obsidian dating evidence would lead us to argue that they are most likely, in part, fully contemporaneous with the earliest dates for Classic Clovis points. If that interpretation is correct, this pattern would be indicative of an area of origin or node of in-migration into California.

Current knowledge now reflects the view that ethnically mixed early peoples from northern and eastern Asia moved into the Americas not exclusively via Beringia, but at an earlier date traveling via watercrafts along the shores of the west coast of the United States (Erlandson et al. 2007; Moratto and Chartkoff 2007). This initial in-migration took place some two to three millennia before the opening of the ice-free corridor. Therefore, California would have been one of the first sites for initial colonization of the Americas. Such an inference implies a different migration path moving from the west to the east. Perhaps the Tulare Lake CB and Fluted point assemblage could represent a considerable and concentrated locus of early Paleoindian activity that fueled the more far reaching, spatially expansive, and accelerated dispersion of slightly later classic Clovis populations. Such an initial migration and movement of early populations might only be substantiated when we can obtain better temporal controls on the earliest prehistoric assemblages recovered from the Far West.

ENDNOTES

(1) Alexander K. (Sandy) Rogers, in a recent personal communication (2007) has independently studied the physical processes of Coso hydration dating. He estimates the actual velocity of the front of hydration on very old obsidians is on the order of 500 years/micron supporting the estimate developed here.

(2) Recent efforts by Rogers (2006a, 2006b, 2007a, 2007b) to reevaluate the entire methodology in which obsidian hydration dating is accomplished are quite laudable. In a paper (in press) he revisits the Coso obsidian hydration rate and provides a new equation and model and incorporates adjustments for the EHT of an archaeological site's location – thermal regime, the depth of the material that was recovered below the surface of the ground – EHT subsurface adjustment, and the effects of the Altithermal. Since all the artifacts described and analyzed here for this study are from surface contexts, the only two adjustments that might be relevant for these materials, vis-à-vis Roger's suggested method, are that for surface EHT and for the Altithermal. As was discussed in the text of this paper, it appears based both on empirical evidence and weather station data the EHT estimate for Tulare Lake and the Witt locality may be quite comparable to that of the Ridge-

crest, Inyokern, and the southern Owens Valley areas. The Altithermal correction would appear to be in the range of 9,470 to 9,920 reducing some of our larger hydration readings (>10.0 microns). Coso hydration rims for CB points might average somewhere between 16.0 and 16.7 microns (instead of the uncorrected mean of 16.9 microns) and have a mean calendar age, based on the new Rogers' Coso physical hydration rate formula (formula: $42.14x^2$ = calendar years BP with present = A.D. 2000), in the area of 11,334 cal years BP. The average uncorrected rim range for CB points (combining the statistically indistinguishable Tulare and Coso samples; n = 6 with outliers removed) would be 13.7 to 20.4. Corrected rims with Rogers' new age estimates would be in the range of 12.6 to 19.3 microns and would convert to ages dating from 6,693 to 15,700 years BP. Obviously that initial age estimate and date of 6,700 cal years BP is far too recent and would be on the order of three millennia too recent (3,000 years too young) and the basal date appears to be a bit too ancient by perhaps two millennia (2,000 years too old). To provide a fair assessment of the rate, the uncorrected rim values as high as 18 microns and his data for the 14 to 16 micron range show considerable spread and he opines that his model should only be used with great caution for these exceptionally large readings (see Rogers 2008).

(3) One of the most well known sites for fluted points in all of California is the Borax Lake Site located in the North Coast Range near Clear Lake. It is interesting to note that all the fluted points coming from that site total no more than 20 such finds (White 1999). There seems to be a good indication at that site for an *in situ* development from the fluted Concave Base forms to fluted Borax Lake Widestem points as both exhibit fluting and basal grinding technology. It is unclear whether the fluted points from Borax Lake are more akin to Clovis or rather Folsom technology since the Borax Lake fluted points appear to have flutes that may be longer than those considered to be characteristic of "classic" Clovis points from the interior United States. Consequently, the dating for those points might be slightly later than the recently revised dating for the Clovis expression based on high-resolution radiocarbon dates from classic Clovis sites (Waters and Stafford 2007).

Table 1 **Comparative Hydration Measurements for Coso Obsidian Projectile Points from the Coso Region.**

Projectile Point Type	Number	Range	Spread (microns)	Mean	SD	CV
Desert Series	12	1.2 - 4.7	3.5	3.0	1.2	0.40
Rosegate	20	3.6 - 6.9	3.3	5.2	0.8	0.15
"Wide" Humboldt Basal-notched Bifaces	33	4.7 - 7.7	3.0	6.3	1.0	0.13
Thin Elko	12	6.0 - 9.3	3.3	7.4	1.0	0.13
Thick Elko	8	8.7 - 18.9	10.2	12.3	3.3	0.27
Pinto	12	9.1 - 21.5	12.4	14.2	4.3	0.30
Great Basin Stemmed	21	8.7 - 17.8	9.1	12.9	2.7	0.21
Concave Base	4	13.4 - 21.1	7.0	16.9	3.5	0.21

Projectile Point Type	Mean & SD	Range w/1 SD	Duration	Spread (microns)	Rim Growth yrs/micron	Speed
Desert	3.0 ± 1.2	1.8 - 4.2	550	2.4	229	Very Fast
Rosegate	5.2 ± 0.8	4.4 - 6.0	1,150	1.6	719	Fast
Wide HBN	6.3 ± 1.0	5.3 - 7.3	1,500	2.0	750	Fast
Thin Elko	7.4 ± 1.0	6.4 - 8.4	2,500	2.0	1,250	Slow
Thick Elko	12.3 ± 3.3	9.0 - 15.6	?	6.6	?	?
Pinto	14.2 ± 4.3	9.9 - 18.5	5,000	8.7	575	Fast
GBS	12.9 ± 2.7	10.2 - 15.6	3,000	5.4	555	Fast
CB	16.9 ± 3.5	13.4 - 20.4	3,500	7.0	500	Fast

Note:
SD = Standard Deviation. CV = Coefficient of Variation.
Humboldt Basal-notched Biface measurements abstracted from Garfinkel and Yohe (2005). Other point type data and obsidian hydration measurement metrics from Gilreath and Hildebrandt (1997). Estimated age ranges (calendar years from AD 1950) are: Desert Series, 100 - 650 BP; Rosegate Series, 650 - 1800 BP; Thin Elko, 1,500 - 4,000 BP; Wide Humboldt Basal-notched Bifaces, 950 - 2450 BP; Pinto, 4,000 - 9,000 BP; Great Basin Stemmed (GBS), 8000 - 11,000 BP, and Concave Base (CB), 10,000 - 13,500 BP. Concave Base mean and standard deviation metrics is based on research conducted on the chronological placement of these point forms. This research includes the following studies: Basgall and Hall (2000), Garfinkel and Yohe (2005), Gold (2005), Haynes (2004), Schroth (1994) and Yohe (1992).

Table 2 **Comparison of Hydration-Radiocarbon Pairs and Hydration Rate Estimates.**

Site	Hydration Mean	C^{14} CalBP	Coso Estimate	Variance
SBR-4966	12.4	8,122	9,003	+881
SBR-4562	12.8	10,769	9,220	-1,549
SBR-5250	14.2	9,328	9,980	+652
SBR-5250	15.4	9,089	10,632	+1,543
Site	**Hydration Mean**	**C^{14} CalBP**	**Basgall & Hall Estimate**	**Variance**
SBR-4966	12.4	8,122	10,769	+2,647
SBR-4562	12.8	10,769	11,021	+252
SBR-5250	14.2	9,328	13,602	+4,277
SBR-5250	15.4	9,089	14,513	+5,424

Note:
Coso Estimate is based on the Coso hydration rate developed in this paper.
Resulting Basgall and Hall (2000) Coso hydration dating equation radiocarbon dates have been converted to mean calibrated calendar ages. The second column are mean radiocarbon dates calibrated to calendar ages. Obsidian hydration measurements have not been adjusted for any EHT changes between the areas where the Coso rate equation was originally developed and the resulting measurements at Fort Irwin. Some researchers have argued that these hydration measurements should be increased by 10% because of differences in temperature from the southern Owens Valley, Coso Volcanic Field, and Fort Irwin. Were we to adjust the hydration rims accordingly, the disparities between the associated calibrated radiocarbon assays and the resulting dates from the Coso hydration dating equation would show considerably greater variance.

Table 3 EHT for Various California Locations.

Eastern California	EHT	Other Areas	EHT
Bishop	17.0	Cajon Pass	17.8
Haiwee	18.7	Hanford	19.9
Independence	19.1	Fresno	20.5
Inyokern	21.1	Tehachapi	15.5
Lubkin Creek	20.5	Malibu	16.9
Lone Pine	13.5		
Mohave	20.3		
Randsburg	20.4		

Note: EHT estimates after Fredrickson et al. (2006) with the exception of Lubkin Creek. That estimate is from Rogers (2006a) and Fort Irwin is from Gilreath and Hildebrandt (1997).

Table 4 China Lake and Tonopah Lake Paleoindian Artifacts.

Catalog Number	Source	Form	Provenience	Hydration Measurement
	Coso***	Fluted	Tonopah Lake	15.7
A-320	Saline Range Variety 1	Fluted	T. 25 S., R. 40 E., Section 28 A	10.3
UAMS-5	Coso*	Concave Base	T. 25 S., R. 40 E., Section 28 A (Mammoth # 4)	14.8
A-19	Coso*	Concave Base	T. 25 S., R. 40 E., Section 28 A	18.4**
A-512	Unknown	Crescent	T. 25 S., R. 40 E., Section 21	15.4 **
A-45	Unknown	Crescent	T. 25 S., R. 40 E., Section 28 A	No Visible Rims

Note:
* Chemically characterized to source via x-ray fluorescence at Northwest Reasearch Obsidian Laboratories. The Coso source identified is the West Sugarloaf subsource.
** Minimum estimate for highy eroded rim. Original rim would have been larger given age and extent of sand-blasting.
*** Measurement provided in Tuohy (1984, illustration Figure 5m, metrics Table 1).

Table 5 Coso Obsidian Hydration Readings for Concave Base Points from China Lake and the Coso Volcanic Field.

Location	Hydration Measurement (microns)	Number	Mean	Standard Deviation
China Lake*	18.4+, 14.8	N = 2	16.6	2.54
Coso Volcanic Field**	13.4, 21.1	N = 2	17.2	5.44
Range for Total Sample	13.4 - 21.1	N = 4	16.9	3.49

Note:
* Hydration measurements from present study.
** Hydration measurements from Gilreath and Hildebrandt (1997).
Coefficient of variation for total sample is .21.

Table 6 **Lowland Coso Hydration Rate Chronology Comparison.**

Sequence	Rim Measurements (microns)	Time Span (cal BP)	Uncalibrated Radiocarbon Ages (Basgall and Hall 2000 Rate)
Marana	≤ 3.7	< 650	641
Haiwee	3.7 - 4.9	650 - 1,350	641 - 1,316
Newberry	4.9 - 7.6	1,350 - 3,500	1,316 - 3,689
Little Lake	7.6 - 16.0	3,500 - 8,500	3,689 - 13,409
Mohave	16.0 - 21.1	8,500 - 13,500	13,409 - 15,951

Note:
Sequence names as per Bettinger and Taylor (1974). Bracketed rim measurements and time spans as interpreted in Gold (2005) and Garfinkel (2007). Time spans are in calibrated radiocarbon dates or calendar years before present (present = AD 1950). The Basgall and Hall (2000) rate ages are uncalibrated radiocarbon ages and, as such, are not directly comparable. The Basgall and Hall (2000) Coso hydration dating equation provides ages in radiocarbon years before present. When calibrated, these ages are from 2,000 to 4,000 years greater than would be anticipated based on other independent chronological estimates.

Table 7 Casa Diablo Obsidian Hydration Readings for Great Basin Concave Base Points from the Komodo Site (CA-Mno-679) and the Witt Site (CA-Kin-32).

Location	Hydration Measurement (microns)	Number	Mean	Standard Deviation
Komodo	5.5 - 12.2	24	9.1	DM
Witt Site - Tulare Lake	6.1 - 12.1	2	8.9	DM
Range for Total Sample	5.5 - 12.2	26		DM

Note:
Komodo site data from Basgall (1988a).
Standard deviations could not be computed.
DM = data missing

Table 8 Comparison of Coso Obsidian Stemmed Series, Great Basin Concave Base, and Fluted Points.

Location	Hydration Measurement (microns)	Number	Mean	Range	SD
		Great Basin Stemmed Series			
Stahl	9.2, 11.3, 15.5, 15.9	4	13.0	9.2 - 15.9	3.3
Fort Irwin	Raw Data Unavailable	11	13.3	10.0 - 16.9	2.5
Coso Vol. Field	See Gilreath and Hildebrandt 1997	21	12.9	8.7 - 17.8	2.7
Tulare Lake	(6.1), 9.5, 10.0, 11.8/14.6 (6.1/10.4/11.9/12.3)	7	12.9	9.5 - 14.6	1.7
		Concave Base			
China Lake and Coso Vol. Field	13.4, 14.8, 18.4+, 21.1	4	16.9	13.4 - 21.1	3.5
		Concave Base and Fluted			
Tulare Lake	(9.0),(9.1), (11.7/12.7/)/14.0, 19.8	2	16.9	14.0 - 19.8	4.1
Lake Tonopah	15.7	1	15.7	na	na

Table 9 Tulare and China Lake Obsidian Artifacts, Sources, and Hydration Measurements.

Catalog Number	Temporary Catalog No.	Obsidian Source and Artifact Form	Collection Area	Hydration Rims (microns)
		Mt. Hicks		
D411100	WALF2	CB	Tulare Lake	12.9, 6.0[AM]
		Queen		
D41036		CB (bifacially fluted)	Tulare Lake	10.7[AM]
D41179	WALF5 - T16	CB (bifacially fluted)	Tulare Lake	5.5, 6.1, 7.9[AM]
		Mono Glass Mountain		
D41101	WALF3	CB (unifacially fluted)	Tulare Lake	10.8[NW]
		Casa Diablo: Lookout Mountain		
D30950		CB	Tulare Lake	6.1[AM]
DRL5GF5		Eccentric Crescent	Tulare Lake	NVR[NW]/7.6[AM]
DRL6GF8		TLWS	Tulare Lake	NVR[NW]/UNR[AM]
		Casa Diablo: Sawmill Ridge		
D41010		Eccentric Crescent	Tulare Lake	13.5[AM]
D41219		Eccentric Crescent	Tulare Lake	3.7, 11.7[AM]
D41017		Eccentric Crescent	Tulare Lake	10.1[AM]
D30931		Eccentric Crescent	Tulare Lake	10.1[AM]
DRL6GF7		Eccentric Crescent	Tulare Lake	NVR[NW]/11.0[AM]
DRL6GF11		Eccentric Crescent	Tulare Lake	3.5[NW]/10.3[AM]
D41262		CB	Tulare Lake	12.1[AM]
D1552		GBS (Lake Mohave)	Tulare Lake	10.1[AM]
D1047		GBS (Lake Mohave)	Tulare Lake	10.0[AM]
D1019		GBS (Lake Mohave)	Tulare Lake	9.7[AM]
DRL6GF9		TLWS	Tulare Lake	NVR[NW]/11.0[AM]
		Saline Range: Variety 1		
A-320		CB (bifacially fluted)	China Lake	10.3[NW]
		Coso: West Sugarloaf		
D41199	WALF1	CB	Tulare Lake	19.8[NW]
DRL6GF1		CB	Tulare Lake	5.2[NW]/9.1[AM]
DRL6GF2		CB	Tulare Lake	11.7[NW]/12.7, 14.0[AM]
D30943		CB	Tulare Lake	9.0[AM]
A-19		CB (unifacially fluted)	China Lake	18.4[NW]

Table 9 (continued).

UAMS-5		CB	China Lake	14.8 NW
D31069		GBS (Lake Mohave)	Tulare Lake	14.6, 11.8 AM
D31068		GBS (Lake Mohave)	Tulare Lake	6.1 NW
DRL6GF4		GBS (Lake Mohave)	Tulare Lake	NVR NW/12.3 AM
DRL6GF10		GBS (Silver Lake)	Tulare Lake	6.1 NW/10.4, 11.9 AM
D1150		GBS (Lake Mohave)	Tulare Lake	10.0 AM
D31063		GBS (Lake Mohave)	Tulare Lake	9.5 NW
D21528		Eccentric Crescent	Tulare Lake	8.1 NW
L10874		Eccentric Crescent	Tulare Lake	11.7 AM
D31023		Eccentric Crescent	Tulare Lake	7.9 NW
D31086		Lunate Crescent	Tulare Lake	6.1 AM
		Unknown Source		
A-512		Lunate Crescent	China Lake	15.4 NW
A-45		Crescent-shaped Item	China Lake	NVR NW
		Napa Valley		
D41272	WALF4 - T8	CB	Tulare Lake	8.4 AM

Note: AM = ArchaeoMetrics Laboratory obsidian hydration measurements completed by Tim Carpenter.
NW = Northwest Research Obsidian Studies Laboratory hydration measurements completed by Craig Skinner.

Key: CB = Concave Base point, GBS = Great Basin Stemmed point, TLWS = Tulare Lake Widestem point, NVR = No Visible Rims, UNR = Unreadable.

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Chapter 3

A Reevaluation of Reported Clovis Points from Tulare Lake, California

Michael F. Rondeau and Jerry N. Hopkins

Abstract: *Hundreds of Clovis points have been reported from the southern margin of Pleistocene Lake Tulare. These reports have stood as an unusually large concentration for both California and far western North America. A collection of 103 reported Clovis points from the Tulare Lake locality was reviewed. Few of those artifacts were found to have the size, shape, or technology generally ascribed to Clovis points. Revision of the reported number of possible Clovis specimens and fluted points in general for California appears warranted.*

INTRODUCTION

The Tulare Lake locality has stood as an anomalous concentration of reported Clovis points in the Far West (e.g., Stanford 2005, N=379). However, widely published reports suggest a much lower total number (Harrington 1954; Riddell and Olsen 1969; Wallace and Riddell 1988). Even so, reported Clovis points have grown in number from 214 (Hopkins 1991) to more than 250 (Hopkins 1993), then to more than 325 (Stepp 1997), and recently to more than 370 (Hopkins 1999). These numbers, however, have been supported largely by assertion rather than by documentation.

The Tulare Lake specimens have been collected from undated surface contexts. Given the importance of such claims to North American research on the peopling of the New World, any claims of Clovis-like finds need to be supported by clear criteria. The study reported below is an attempt to do so. This review is of one of the larger Tulare Lake Clovis collections, that of Jerry Hopkins, is clearly a test case. The study was undertaken as a component of the CalFLUTED project.

BACKGROUND

CalFLUTED, the California Fluted/Lanceolate Uniform Testing and Evaluation Database project, was formalized in 2003 (Rondeau 2003) after half a dozen studies on reported fluted points from California (Rondeau 1998a, 1998b, 1998c, 1998d, 2001, 2005) had raised a number of issues basic to the identification and classification of fluted points in the Far West. Specifically, what is a fluted point? What are its attributes? How do you confirm that a point is fluted?

The CalFLUTED project has proceeded with a multi-pronged approach. This approach has included a series of detailed projectile point analyses; extensive review of Paleoindian projectile point and related literature; talking with a series of recognized experts in the field of Paleoindian studies; as well as the review of fluted points from elsewhere in North America.

To date, the CalFLUTED project has resulted in the viewing of more than two thousand fluted points from around North America and hundreds of other points relating to the Paleoindian period. An extensive review of the literature and meeting with numerous Paleoindian experts had led to discussions regarding point types and other Paleoindian concepts, background histories, specific sites, collection reviews, and flint knapping demonstrations. Forty-three detailed studies of Paleoindian points, mainly from California, Nevada, and Oregon have been conducted or are currently in progress.

While a great deal has been explored, the original issues have proven more complex than would allow for a simple, straightforward resolution. Given the timing and circumstances under which various studies have been allowed and conducted, the project has not always proven to be as uniform or as evaluative as originally intended. More than a year was spent just on a resolution of issues pertaining to the potential presence of Clovis-like points at Tulare Lake. The Tulare Lake study, in many ways, followed similar steps as those pursued by the overall research project, including a focused literature review.

LITERATURE REVIEW

A review of the available literature regarding Tulare Lake Clovis-like points was undertaken (Dillon 2002; Hopkins 1991; Riddell and Olsen 1969; Wallace and Riddell 1988; Wilke 1991). No clear criteria for identifying Clovis-like points were found. The first step in this study was to establish a set of test criteria useful in placing projectile points into a broadly defined Clovis-like type. Additional review of the literature on Clovis points from elsewhere in North America was accordingly undertaken.

This review found that there is a significant degree of variability in form for what has been called Clovis projectile points. This has been long recognized (Haynes 1964; Sellards 1952). However, the variability accepted by some investigators for the Clovis type has called into question the very utility of a continent-wide point type (Roosa 1965). Since that time, the range of what has been placed as a Clovis point has expanded even further. This expansion is part of a historical trend that began by placing fluted points in a Folsom or Folsom-like category. Later in time, there was a switch over to placing most fluted points as Clovis or Clovis-like (Rondeau 2007). The assumption that fluted points in the Far West are Clovis without supporting data has been noted by Beck et al. (2004) and is exemplified by Willig et al. (1988). A notable exception to this trend is Huckell (1982). This trend of highly varied fluted points being assigned as Clovis may in part be supported by the lack of an accepted set of explicit attributes for their identification (Huckell 1982; Warren and Phagan 1988). Even so, a range of descriptive details for the Clovis type was found in the literature. Some were embedded in the description of specific collections and others were provided in summary overviews.

While the following attributes were chosen to be as straightforward as possible, they are often less clear as presented herein. Any given attribute regarding Clovis points may be challenged due to regional variations in morphology and technology, the known presence of unfluted Clovis points, and the fact that Clovis points, like those that followed after, sometimes went through technological and morphological variations because their use life involved various forms of use attrition and subsequent repair. Even so, the following attribute set is presented as a reasonable first approximation for the evaluation of undated surface finds.

CLOVIS POINT ATTRIBUTES

The review of Clovis type descriptions was a major portion of the study. As a result, the following characteristics were found to be more or less consistently recognized as elements of the Clovis projectile point type. These attributes included:

1) a lanceolate shape lacking a stem, notches, or shoulders (Cox 1986; Haury et al. 1953; Haury et al. 1959; Howard 1990; Justice 2002; Wormington 1965);

2) a concave base (Cox 1986; Haury et al. 1953; Haury et al. 1959; Hester 1972; Howard 1990; Justice 2002; Wormington 1965);
3) edge grinding on the lateral margins and proximal edge of the point base (Collins 1999; Cox 1986; Haury et al. 1953; Haury et al. 1959; Haynes 1964; Hester 1972; Howard 1990; Titmus and Woods 1991a, 1991b; Wormington 1965);
4) maximum width at or below the midline (Bradley 1993; Haury et al. 1953; Haury et al. 1959; Howard 1990; Morrow and Morrow 1999; Roosa 1965);
5) basal fluting (Bradley 1993; Collins 1999; Haury et al. 1953; Haury et al. 1959; Howard 1990; Irwin and Wormington 1970; Justice 2002; Roosa 1965; Wormington 1965);
6) the fluted morphology was usually created by multiple flake scars even though these were often of variable size including both percussion and pressure removals (Titmus and Woods 1991a); (Bradley 1993; Haury et al. 1959; Haynes 1964; Howard 1990; Irwin and Wormington 1970; Roosa 1965; Wormington 1965);
7) the flutes seldom extend beyond half the length of the point;
8) flaking patterns on the blade elements were generally horizontal, but most often irregular in pattern (Bradley 1993; Collins 1999; Cox 1986; Haury et al. 1959; Howard 1990; Titmus and Woods 1991a), and
9) they are generally a larger, heavier projectile point when compared to many other point types (Collins 1999; Haury et al. 1959; Hester 1972; Howard 1990; Irwin and Wormington 1970; Wormington 1965).

APPLYING THE IDENTIFICATION CRITERIA

The sorting criteria applied by this study were based on generally typical Clovis attributes of size, shape, and technology as recognized in the literature cited above. An assignment of "Clovis-like" was thought to be appropriate for the Tulare Lake specimens; as they are not known to have actually been manufactured during the Clovis era.

The selected attributes were used as a set of sequential sorting criteria. The first criterion was whether the artifact was fluted. The logic here was simply; if the point cannot be shown to be fluted and is not dated to the Clovis period, there is very little basis for a Clovis-like assignment.

The second cut was concerned with the general morphology or shape of the projectile points. Three separate criterion were used. Was the point generally lanceolate in shape? This excluded points with shoulders, stems, notches, and abruptly blunted point tips. Next, did the point have a concave base? This excluded all other basal forms. Also excluded here, were deep basal concavities as they are generally recognized elsewhere in North America as belonging to post-Clovis fluted points (Alan Bryan personal communication 2005). Finally, the maximum width of the projectile point needed to be at or below the midline of its length to exhibit a typical Clovis-like shape.

The third cut involved technological criteria. Four criterion were used. Was there significant basal grinding? In this case, significant refers to heavy grinding on the lateral and/or basal margins of the specimens that produced edge rounding, if not also polish (Titmus and Woods 1991b). Did the flute scars diverge as they moved towards the tip when viewed in long-section? Fluted points, such as Folsom, are known to exhibit parallel flute scars while the flute scars on Clovis points diverge (Bruce Bradley personal communication 2005). The third criterion was that the flute scars should be two thirds or less of the length of the projectile points. Here, again, it is some late Paleoindian fluted point types from elsewhere in North America that have recognizably longer flute scars than Clovis points. Finally, does the point show evidence of a small "nipple" striking platform for flute flake removal? This is also generally recognized as a late Paleoindian fluted point trait. Clovis points tended to have more extensive platforms, even a beveled basal margin prepared for fluting.

The last cut was size. Were they comparable in size to Clovis points elsewhere? Length is used here as a measure of size. The minimum length of rejuvenated Clovis points has been placed at about 45 mm (Collins 1999), although a longer minimum length is recognized elsewhere (Titmus and Woods 1991a). This measurement is less than the maximum length of some later fluted point types. Therefore, the length measurement cannot be used to exclude points from other non-Clovis fluted types.

FINDINGS

A total of nine artifacts were assigned to the Clovis-like category, 8.7% of the original 103 reported Clovis specimens. These nine Clovis-like specimens included eight identified as fluted points and one non-fluted projectile point specimen. Only 27 projectile points had one or more identifiable flute scars. Seventy-six non-fluted projectile points were identified. Two fluted points, however, were eliminated from the study as their placement at Tulare Lake was questioned. Likewise, one non-fluted point was dropped from the study for the same reason. One other specimen was eliminated as it was a flake and neither a projectile point nor a preform.

A limitation on this study was the fragmentary condition of many specimens that precluded the identification of necessary attributes (Musil 2004). It is important to note that the projectile point term for this study also included possible preform specimens, which in part reflects the reworking of older points. Six were unfinished, one as clearly documenting unfinished repair of the base, and another that may represent unsuccessful refabrication into a different point form. Nearly half of the relevant points appear to have undergone repair or rejuvenation (N=49, 49.9%). This may in part account for the small general size of some of the points. However, a number of these points were made from rather small, thin flakes without extensive flaking. Thirty-two point specimens retained a portion of the ventral surface of the original flake blank.

Further, 81 specimens were found to have some form of thermal alteration. Seventy-nine specimens indicated that they were thermally altered after they had been flaked. This was documented by thermal alteration attributes that overlaid the flaking evidence (Rondeau 1995; Pearson 2002). Only two clearly indicated heat treatment prior to flaking.

Elimination of fluted points from a Clovis-like type included five that met none of the shape criteria. Another 12 had slight to moderate concave bases but no other Clovis-like shape criteria and were eliminated. Two other fluted points met two of the shape criteria and because they also met other criteria, they were considered sufficiently Clovis-like for purposes of this study.

Six fluted points met all of the shape criteria. While these specimens did not meet all of the additional criteria, these specimens were found to be the most Clovis-like points in the Tulare Lake collection.

Only two specimens met all of the Clovis-like criteria. However, these were the two for which their find location was in doubt. They had been obtained from the Ernest Smith collection representing locations around California, Indiana, Ohio, Iowa, New Mexico, Maryland, and Illinois (Hopkins 1991).

One specimen, a non-fluted point, met all three of the shape criteria and retained heavy basal grinding. It also showed what could be the remnant of an earlier channel flute scar termination. Reworking of this specimen was a recognized possibility. It did not meet the length criteria, but was included as one of the most Clovis-like.

DISCUSSION

It also needs to be remembered that a variety of time periods are suggested by the Tulare Lake points placed as fluted, Lake Mohave, Pinto Basin, square stemmed, corner-notched, or contracting stemmed types (Riddell and Olsen 1969). Another study relevant to these research findings, Wilke (1991), studied approximately half of the collection reported herein. Wilke studied 46 specimens; all but three are included in this study. Those three were stemmed points.

In the Wilke study, three specimens were noted to be fluted and three others as being Clovis-like. He concludes that, "In a broad sense, the collection from Tulare Lake is strongly reflective of assemblages usually referred to the Western Pluvial Lakes Tradition (Wilke 1991: 51)."

Justice summarized the Wilke (1991) study in part:

> One study of a surface collection of Clovis and lanceolate projectile points from Tulare Lake, California found no heavy basal grinding on the projectile points. In addition, basal thinning with pressure was typical of the population as a whole and specimens exhibiting robust percussion-induced fluting were rare [2002: 68 and 70].

He also noted Wilke's recognition of the similarity with the Lake Tonopah projectile point assemblage and further stated that "This suggests post-fluted point lanceolate forms are more widespread in the West than once thought (Justice 2002: 70)."

Wilke noted three specimens to be fluted and these three were also classed as fluted by this study. Ten other specimens placed in the fluted point category by the current study were also in the Wilke study collection. The intent here is not to address relative accuracy, but rather to point out the more liberal assignment of points to the fluted class by this study.

OTHER COLLECTIONS

Other Tulare Lake collections also appear in need of reexamination. The Witt Site collection has been reported to have 32 Clovis or Clovis-like points, seven of which were only end thinned (Riddell and Olsen 1969). All have been included in the total of reported Clovis points from Tulare Lake (Jerry Hopkins personal communication 2005). However, photographs in Riddell and Olsen (1969) depict some of those points as non-Clovis types defined by this study.

Nineteen "Clovis" points have been reported for the Van den Enden collection by Wallace and Riddell (1988). Forty-eight Clovis specimens have recently been reported for that collection (Jerry Hopkins personal communication 2005). In 1985 the senior author had the opportunity to view the Van den Enden collection. Fluted points are clearly present in that collection. Many, however, do not appear to be Clovis-like even though one large fluted point is more akin to the classic Clovis form than any in the Hopkins collection. It is clear, however, that a review of other reported Clovis specimens from the Tulare Lake locality appears warranted.

CONCLUSIONS

The problem of the assignment of undated surface finds of high morphological variability to the Clovis type is neither new nor limited to Tulare Lake, but rather a continent wide problem. Tulare Lake may remain the largest concentration of fluted points in California, but they appear to be much more limited in number than previously claimed. Further, a majority of these fluted points cannot presently be shown to have Clovis-like attributes. Some are clearly suggestive of a post-Clovis temporal placement when compared to specimens from elsewhere in North America.[1]

The fluted points in the Far West and California in particular are largely unplaced in time and their variability in form is wide ranging. The presence of western fluted point variants that do not fall into the classic Clovis or Folsom point types has been previously recognized (Huckell 1982; Beck et al. 2004; Touhy 1988), but as yet these variants have not been documented as specific types as has been done elsewhere in North America (Rondeau 2007).

The projectile point collections from Tulare Lake are indeed unique. A range of very early point types, including non-fluted forms, appears to be present. Labeling many of these points as Clovis has obscured a much wider research potential. Carefully pursued methods of archaeological investigation are needed for the study of these projectile points. Scientific skepticism appears appropriate regarding the numbers of claimed Clovis points from Tulare Lake. The use of Clovis and fluted as interchangeable point types, which they are not, has further inflated the number of reported fluted points for California.

The lessons learned from the Tulare Lake analysis are several. First, there remains no clear answer to what is and is not a Clovis point in the Far West, but clearly stemmed points should not be included. Second, the methods for assigning specimens as Clovis and/or as fluted points from the Witt Site, other Tulare Lake sites, and the Trico Site (Dillon 2002) now appears to have greatly over inflated the actual numbers. Third, the actual total of fluted points currently reported for California is seriously exaggerated and in need of rigorous scientific revision.

ACKNOWLEDGEMENTS

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ENDNOTE

(1) The projectile points of the Hopkins collection exhibit a wide range of morphological variation which includes a series of tapering stemmed points that grade into parallel-sided forms, excurvate sided forms, roughly triangular forms, and a few shouldered specimens. A few are missing their base. For the rest, the basal morphology ranges in size and form from generally concave grading into a few straight and convex forms. Likewise, there is a range of end thinning types from clearly fluted points with larger channel scars through pieces with pronounced, unfluted end thinning to specimens with little or no basal flaking. A set of intergrading attributes is recognized. Typological seriation is clearly suggested among many specimens. However, breaking this multifaceted continuum into arbitrary point type divisions is not supported by corroborating data. These points are not segregated by horizontal spatial components, superimposed stratigraphic separations, or by any other relative or absolute dating techniques. Therefore, there remains no temporal or cultural indication of where this "branching-bush" seriation should be subdivided into point types. Further, since even descriptive typologies can take on a life of their own, such a typology appears premature due to its potential to inhibit rather than forward future research.

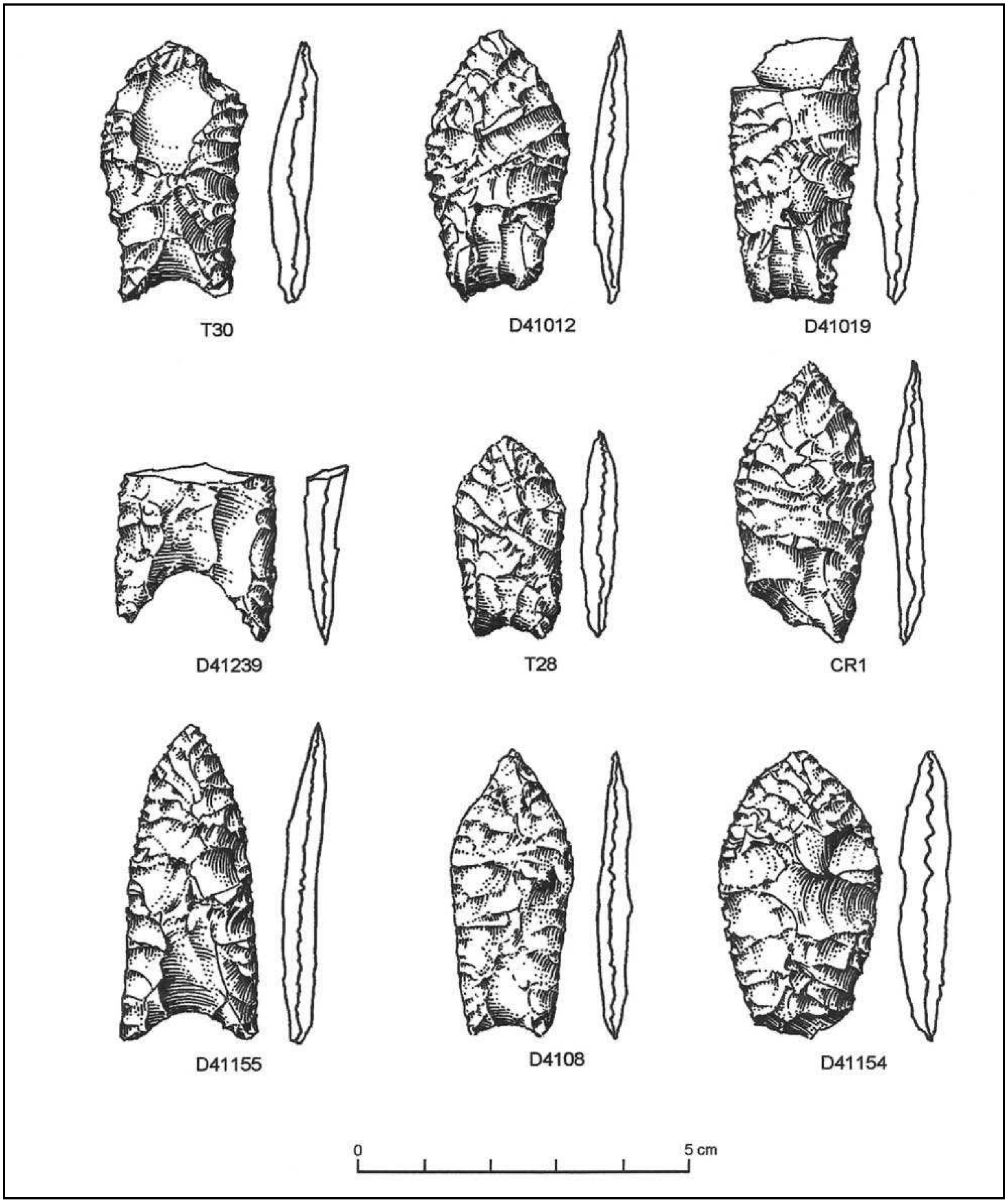

Figure 1. Points from Hopkins Collection. T30 - End Thinned Point; D41012, D41019, T28, D4108 - End Thinned Tapering Stem Points; D41239 - Fluted Point with Deep Concave Base; CR1, D41154 - Tapering Stem Points without Base; D41155 - Clovis-like Fluted point.

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Chapter 4

A Ground Stone "Butterfly" Crescent from Tulare Lake

Gerrit L. Fenenga

Abstract: *Chipped stone crescents are a familiar, but enigmatic artifact well known to students of early western North American prehistory. Ground stone crescents occur in central California but may be unknown to those who work elsewhere. This paper describes a ground stone crescent from the Tulare Lake Basin of the southern San Joaquin Valley that appears to represent a ground stone imitation of a chipped stone crescent. This unusual specimen may shed light on the unexplained issue of crescent function as well as provide evidence that connects early "Western Pluvial Lakes" populations with later prehistoric cultures of central California.*

INTRODUCTION

This report describes an unusual artifact discovered in the Kings County Museum while examining archaeological collections there with the Director, Joyce Hall, Bill and Edith Wallace, Francis Burgess, and Jerry Hopkins in October 1998. At that time, the museum was expanding into a new wing designated to showcase their archaeological collections from the Tulare Lake Basin. Most of this body of material had been assembled by Dr. Frank G. Griffith who came to Grangeville in 1875. Subsequently, he served as constable, deputy sheriff, deputy U. S. Marshall, livestock inspector, and Tulare County Veterinarian. He became a resident of Hanford in Kings County and actively collected Indian artifacts while attending to his veterinary duties on various ranches about the area (Wallace 1998). His collections were made from about 1878 to 1917 and include a representative sample of artifacts typical of surface collections from the Tulare Lake Basin. These include many projectile points, charmstones, ground stone milling tools, and so forth. The entire span of California prehistory is represented in this assemblage as evidenced by a variety of temporally diagnostic artifacts. There is a catalogue for the Griffith collection and for some of the material there is some provenience information such as the name of the ranch or landowner and the date obtained. For other specimens, there are no specific data regarding their origin. Included in this remarkable collection of artifacts are several outstanding specimens. One of these is an extraordinary Western Clovis fluted projectile point made of quartz crystal. Another is the artifact described in this paper which to my knowledge is altogether unique in California archaeology.

DESCRIPTION OF THE ARTIFACT

The artifact may be described as a ground stone effigy or replica of a chipped stone "butterfly" type crescent [see Figure 1 (obverse) and Figure 2 (reverse)]. It is composed of a dark gray, fine-grained, micaceous schist stone and measures

Figure 1: Ground stone "butterfly" crescent from Tulare Lake.

Figure 2: Ground stone "butterfly" crescent from Tulare Lake.

12.9 x 6.5 x 1.3 cm. (1). The specimen is larger than any known chipped stone "butterfly" but otherwise is precise in replicating design features that are unique to that class of artifact. The artifact is complete, although a chip is present along the margin of one edge and there are some minor dings and scratches along each face. It has been ground and polished into shape. The artifact probably originated from a natural flat schist cobble blank that approximated the final shape. The tips of the "wings" of the specimen are bluntly rounded, although facets from shaping the ends converge as slight points or angles at the tips. Although larger and heavier than chipped stone crescents, this is still a relatively delicately made object. It is not made of a particularly durable material and is broad and flat in shape and likely would break if put to any sort of heavy use. Although unique in stylistic details, this ground crescent is similar in size, material, and overall morphology to other ground crescents from California, especially certain examples also known from Tulare Lake.

The object is bilaterally symmetrical with a broad, moderately shallow arc to its concave edge. Generally crescentic in shape, it has a pecked and abraded groove measuring 1.2 to 1.4 cm in width transversing its midsection. This groove is present on both faces as well as across the edges at the centerline on both the inner concave margin and the outer convex margin, forming slight notches on both edges. It also bears two distinct "nipples" along its convex margin. Between these nipples, the outer portion of the convex margin is flattened forming an overall crescent shape which is truncated along the arc of the outside edge. These structural or design elements replicate details that are characteristic of, and unique to, chipped stone "butterfly" type crescents (Figure 3 and Tadlock 1966, Figure 1).

The composite of all these design elements clearly suggest the object was manufactured with the intent of copying the plan form of a "butterfly" crescent into a ground stone form. Chipped stone crescents date to the transitional Paleo-Indian to early Archaic Period and are generally thought to have functioned as "transverse" projectile points, specialized cutting implements of one sort or another, charms, or amulets. Ground stone crescents are a form of charmstone known from certain early and middle archaic archaeological contexts in central California. The melding or crossing-over of these two distinct artifact classes is fascinating and bears on several important theoretical issues in the archaeology of western North America, as will be discussed.

Also occurring with the ground "butterfly" in the Griffith collection, was a fragment of a second ground stone crescent that was made of the same material and exhibited the same degree of workmanship. This specimen is approximately ¾ complete. The missing portion can be reconstructed using the artifact's bilateral symmetry to provide a reasonably accurate estimate of the original size and finished shape (see Figure 4). It originally measured about 14 x 8 x 1.1 cm and the tips of its "wings" have been squared off to produce a very proportionate and symmetrical crescent with a distinct style. Similar ground crescents are already known from several other Tulare Lake archaeological collections. These are relatively thin in cross-section, delicately made, and have a deep concavity to their inner margin. It is not known if these two ground crescents were collected together or were found separately and grouped together in the collection independently. There is no specific provenience information for either specimen in the Griffith collection catalogue.

DISCUSSION

Any discussion of this artifact requires consideration of two entirely different classes of prehistoric artifacts, both of which are familiar to California archaeologists. These are: 1) the early-chipped stone crescents known from many locations in California and the Great Basin and 2) the ground stone crescent-shaped charmstones that have been found in middle Holocene contexts in the southern San Joaquin Valley and San Francisco Bay Region. This particular artifact is an example of the latter class but is of a typologically unique form. As suggested, it appears to represent

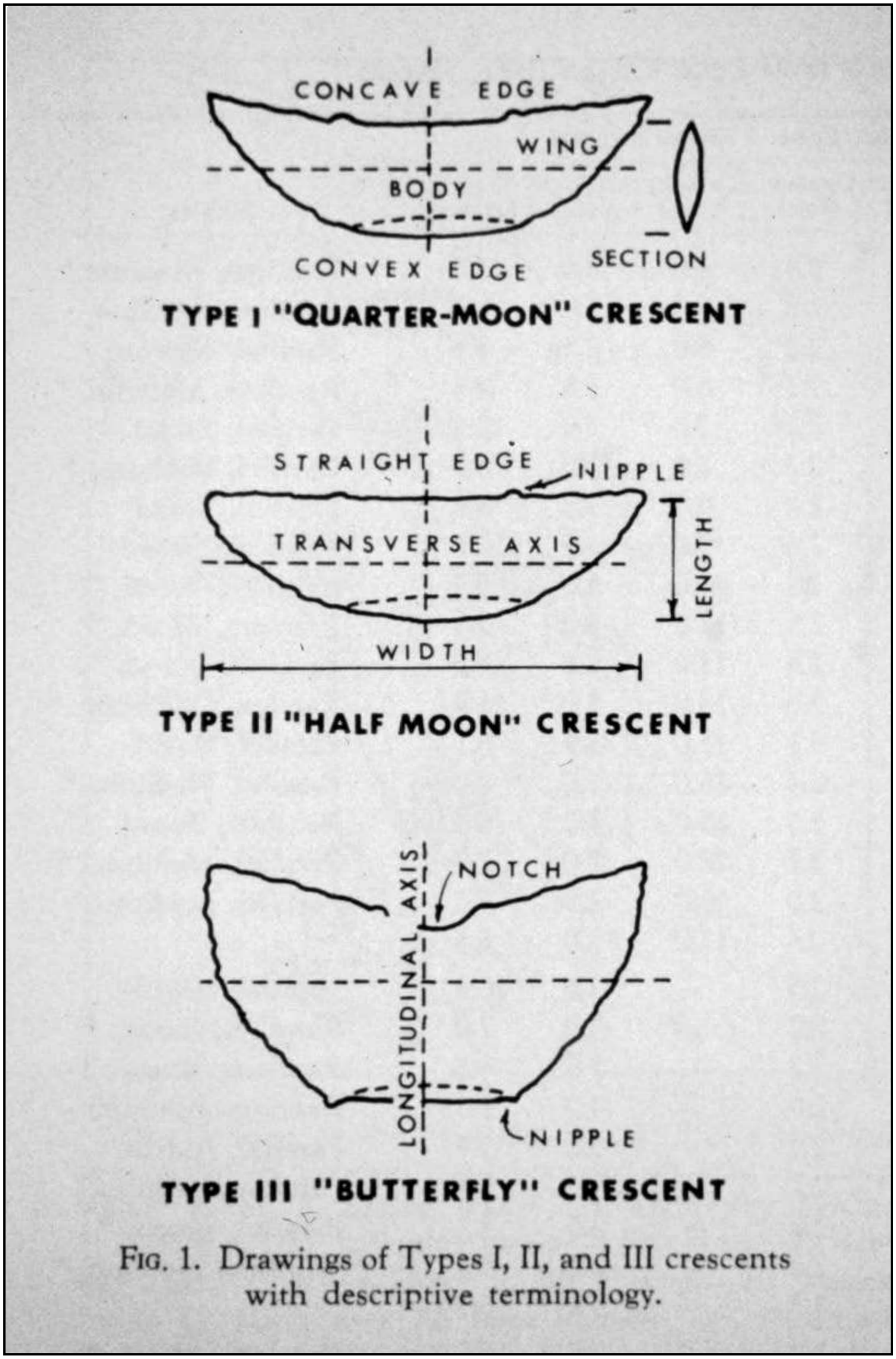

Figure 3: Tadlock's (1966) classification and descriptive terminology for chipped stone crescents.

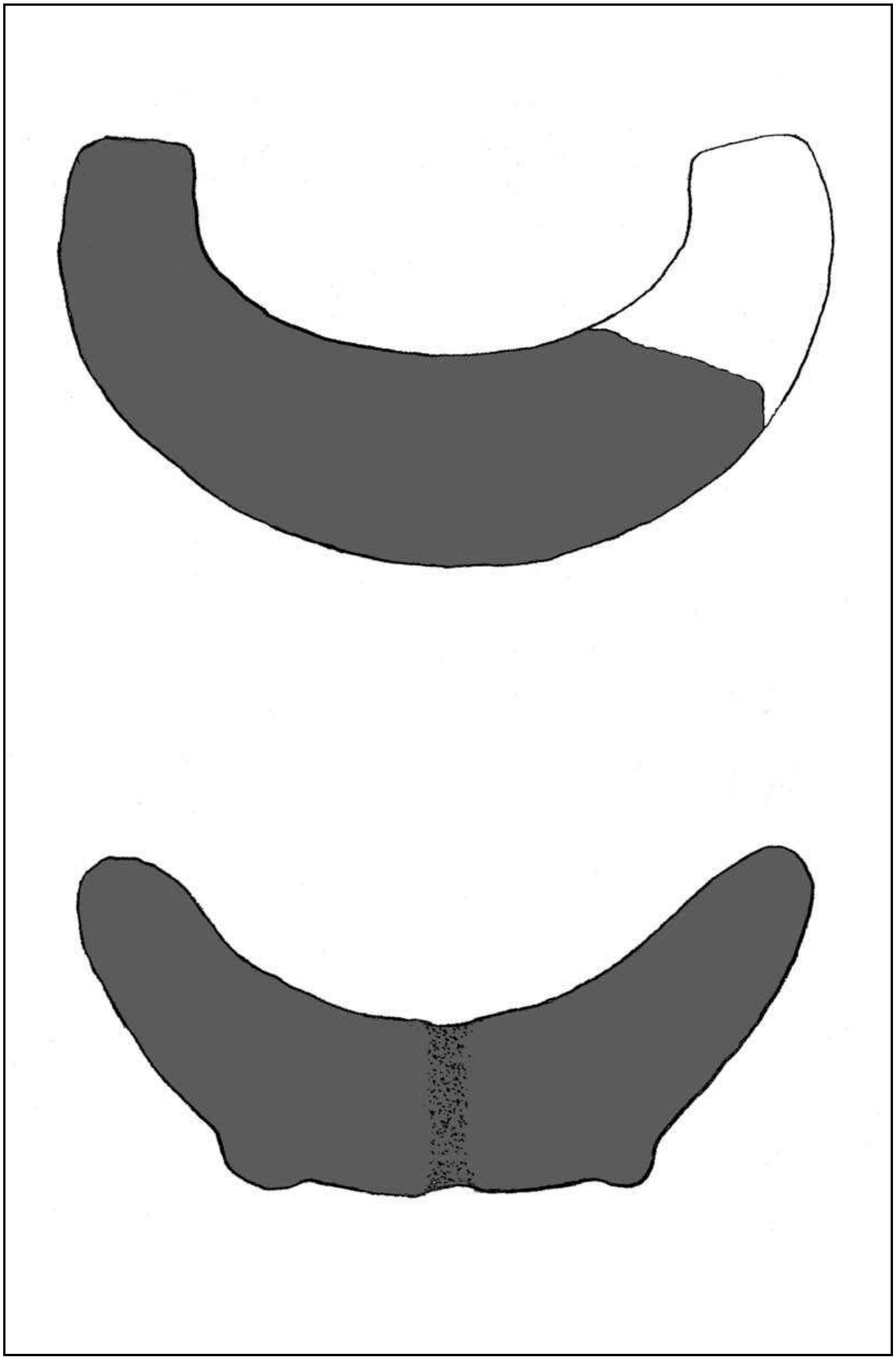

Figure 4: Ground stone crescents in the Griffith collection, Kings County Museum.

a copy of a form characteristic of the chipped stone class of artifact. Consequently, both classes of implements must be understood in order to develop hypotheses to explain this occurrence.

CHIPPED STONE CRESCENTS IN WESTERN NORTH AMERICAN PREHISTORY

Chipped stone crescentic objects have been described in the archaeological literature since the late 19th Century (Wilson 1897). They have appeared incrementally in archaeological literature as new specimens have come to light (Palmer 1905, 1907; Heye 1921; Gifford and Schenck 1926; Harrington 1928; Nelson 1936; Campbell et al. 1937; Harrington 1948; Peck 1955; Jones 1956; Treganza and Bierman 1958; True 1959, 1991; Rogers 1929, 1966; Clewlow 1968; Riddell and Olsen 1969; Butler 1970; Beck 1971; Bates 1972; Fredrickson and Grossman 1977; Davis 1978; Origer and Fredrickson 1980; Kaldenberg 1979; Fenenga 1984, 1985, 1992; Cameron 1987; Hutchinson 1988; Hopkins 1991; Grenda 1997; Wahoff 1998; Bertrando 2004; Erlandson 2005). Additional specimens continue to be discovered as California is developed, including many in buried, potentially datable contexts. For example, specimens recently found in downtown Sacramento came from 22 feet below the modern land surface. Recent development in the interior of southern California has identified several sites with assemblages containing multiple examples of crescents. In 1992, an eccentric chipped stone crescent discovered in northern San Diego County became the first official State Artifact in the United States (Koerper and Ericson 1991).

The first formal descriptions of this class of artifact came in the early part of the 20th Century (Wardle 1913; Rogers 1929). To my knowledge, Gifford and Schenck (1926: 86-87) were the first to recognize the morphological types we today refer to as "crescents" and "butterflies" and to identify them by those terms. In 1966, Louis Tadlock published a landmark paper in which he synthesized all that was known at that time about this distinctive type of chipped stone artifact, by then known from a number of locations in the Great Basin and California (Tadlock 1966). In that survey, he concluded that these distinctive artifacts were associated with very early archaeological contexts, and therefore these could serve as a time marker for early western American prehistory. Because of analyzing a relatively large sample of crescents, Tadlock (1966, Figure 1) also developed a formal descriptive terminology and a crescent typology that recognizes three distinct forms or types (see Figure 3). Several researchers (Mitchell et al. 1977; Jertberg 1978, 1986; Fenenga 1984, 1985; Justice 2002) have done subsequent work on chipped stone crescents. A complete review of the status of current crescent research is beyond the intent of this paper. There are, however, certain relevant points that merit consideration and that can be summarized here.

First, it is abundantly evident that chipped stone crescents are relatively ancient implements belonging to assemblages that date to the early Holocene. The preponderance of specimens that can be dated by either absolute or relative means indicates they were used primarily between about 8,500 and 6,500 years ago. There also is some evidence to suggest, and some scholars believe, that crescent technology may predate 10,000 years ago. However, the origin of crescents, like their function, is unknown. Technologically, they are distinct from fluted point Paleo-Indian technologies and appear to be later and unrelated to them. There is a single reported occurrence of a crescent in a Clovis cache (Tankersley 2002: 89), but they are conspicuously absent from any well-established Clovis assemblage. Technologically, crescents appear unrelated to Clovis, especially crescents with notches, since similar notching is absent in Clovis technology. Chipped stone crescents are also known from later contexts, but these all seem to be related to recycling of older artifacts or to reuse of earlier items. Archaeologists excavating multi-component sites may find little sign of any early occupation unless something as obviously diagnostic as a crescent or a fluted point turns up. Lithic debitage, which might constitute most of an early site artifact assemblage, looks pretty much the same to most archaeologists, regardless of its antiquity. No clear evidence of any use of chipped stone crescents exists during the middle portion of the Holocene. They occur only in early and late Holocene archaeological contexts and their proximal functional use life probably only dates to the earlier of these times (Fenenga 1984: 70-78).

Second, chipped stone crescents are distributed from California into the Great Basin. They do not exist, to my knowledge, anywhere in the American Southwest. Notably, they also do not occur in any of the classic Clovis discovery sites in Arizona or in any of the early Archaic Cochise Culture assemblages. They also have yet to be reported from the Pacific Northwest. Within this distribution, their occurrence is variable with some locations producing numerous specimens and others few or none (Fenenga 1984; Beck and Jones 1997).

Chipped stone crescents represent a formal class of artifact. Typological studies have demonstrated they were designed and manufactured within a prescribed template that resulted in the production of literally thousands of these over the course of their duration in prehistory (Tadlock 1966; Mitchell et al. 1977; Fenenga 1984). There are varieties of distinct subtypes of chipped stone crescents, but all share a mosaic of morphological traits that distinguish the crescent class. These traits include: 1) a bilateral symmetry, 2) a convex (outer) edge, and 3) a straight to convex (inner) edge. Overall, they have a crescentic shape, but many specimens stray from this conventional form—especially some of the eccentric examples.

The crescent class is divided into two basic types. These are *lunate crescents* and notched or *eccentric crescents*. Within each of these categories, there are a number of recognized distinct morphological types and subtypes (Tadlock 1966; Mitchell et al. 1977; Fenenga 1984; Jertberg 1986; Hopkins 1991). The ground stone artifact described in the present report is an unequivocal replica of what Tadlock (1966) identified as a Type III or "butterfly" crescent in his typology. In fact, the Griffith collection specimen matches Tadlock's idealized drawing of the proposed type better than do most real chipped stone examples of this type in existing collections. Either the "butterfly" is an example of one of the distinct subtypes of lunate crescents, or as Justice (2002) proposes, a formal type by themselves that he calls winged crescents. I have chosen to follow Tadlock's terminology here out of historical precedence. Gifford and Schenck (1926: 86) referred to these as "butterflies" as early as 1926 and archaeologists have become accustomed to that term. The classification system designed by Mitchell, et al. (1977) is presently the most useful tool for discriminating between the lunate forms of chipped crescents, but I believe only Hopkins (1991) has used it since it was proposed.

Hopkins (1991) was able to clearly demonstrate that California "butterfly" crescents are morphologically distinct from those of the Great Basin by applying the Mitchell et al. (1977) typology to a large sample (n=116) of Tulare Lake chipped crescents. He found that Biconcave and Semi-biconcave (butterfly) crescents account for about half the specimens from Tulare Lake compared to only about 6% in Nevada (Hopkins 1991: 9). In addition, the biconcave form is not even present in the Nevada sample, but these account for nearly half of the butterfly forms from California (Hopkins 1991: 11, Table 2).

He also made an important observation that relates to the ground "butterfly" from the Griffith collection. In summarizing the results of his analysis, he notes, "The majority of butterfly-shaped crescents from Tulare Lake appear to have been ground across the body width along the centerline of the object (Hopkins 1991: 9)." He also states that smoothing or grinding was most often present on the butterfly forms but was "infinitesimal" on the Concavo-convex "moon-shaped" specimens. The ground "butterfly" exhibits this same very specific technological design feature of chipped butterfly crescents as a clearly abraded groove that encircles the specimen along its midline. This is not a regular design element of ground crescents but also is present on the example Kroeber (1906) depicts from Oakland in Alameda County (2).

Hopkins' work substantiates that typological and other stylistic variation between lunate chipped stone crescent forms varies across geographic space and probably through time, as I did with the eccentric forms (Fenenga 1984, 1992). The meanings underlying the distribution of the various forms through time and space are unknown, although at least 10 different hypotheses can be proposed (see Figure 5), some of which are not mutually exclusive of one another. Without doubt, the biggest problem in crescent studies is the fact that the function (or functions) of chipped stone crescents remains poorly understood. Since we do not know the use or purpose of chipped stone crescents, it is difficult to explain their differential distribution across geographic space. The ground "butterfly" crescent adds an interesting dimension to the functional debate as well as potentially provides insight into other aspects of California prehistory.

GROUND STONE CRESCENTS IN CALIFORNIA PREHISTORY

Ground stone crescents represent an entirely different kind of prehistoric artifact, although they do share a common crescentic profile with chipped stone crescents. The artifact from the Griffith collection, described here, is an example of one of these ground crescents. Ground stone crescents are a rare and unusual form of California charmstone which has a relatively limited geographic distribution. Although they have been identified in the literature for some time (Kroeber 1906 and Rust 1906; Gifford and Schenck 1926; Heizer 1953; Tandy 1962; Conger 1963; Witt 1964; Gerow with Force 1968; Hopkins 1989; Fenenga 1990; Pruett 1991), they have never been formally studied as a class of artifact. They are not identified or even mentioned in any of the major typological studies of California charmstones (Lillard et al. 1939; Beardsley 1954; Davis and Treganza 1959; Ragir 1972; Bickel 1981; Elsasser and Rhode 1996). This is somewhat remarkable, since 1) they have usually been identified as charmstones when they have been described, 2) they occurred at CA-SMA-77 with other charmstone forms that were used in developing the more recent of these classificatory schemes, and finally, 3) Gerow himself should have noticed that these artifacts present one more significant contrast between the Early Bay Culture and the Windmiller Pattern of the Sacramento-San Joaquin Delta, since demonstrating this was the goal of his life's work. Most archaeologists familiar with California archaeology would consider these objects charmstones. If not, I do not know what they would call them. There are similar artifacts from the eastern United States known as "banner stones" and some of these resemble the California ground crescents, especially those classified into the Mississippi Valley crescent or curved pick groups (see Knoblock 1939: 452-455 and 496-499). The stylistic similarity between these is likely incidental and no connection is implied here.

With the exception of the bedrock mortar, charmstones are perhaps California archaeology's most identifiable prehistoric artifact. This enigmatic class of ground stone artifact is characteristic of prehistoric California but is essentially unknown in surrounding regions. In the eastern United States, ground stone plummets and a variety of other objects occur, but these appear to be unrelated, or at least no direct connection can be made between these and California. Central California is renowned for the presence of large numbers of finely crafted charmstones. There are varieties of known regional and temporal types of charmstones, some of which are very distinctive in shape such as the "cogstone" forms found in southern California (Eberhart 1961; Underbrink and Koerper 2006). Ground crescents simply represent another regional style but one that has apparently gone unnoticed by archaeologists.

Ground stone crescents occur in three areas of California. Ethnographically, they are described from southern California, where they are identified with girl's adolescence ceremonies. Archaeologically, they are found in the southern

Figure 5: Some alternate hypotheses to explain morphological variation in chipped stone crescents.

1) Stochastic Hypothesis
   - Variation is random.

2) Sampling Effect Hypothesis
   - Conception of range and nature of morphological variation is distorted due to biased or inadequate sample or sampling.

3) Taxonomic Distortion Hypothesis
   - Classification system is obscuring significant natural groupings, or is otherwise producing artificial patterns in the data.

4) Artistic Representation Hypothesis
   - Different forms are effigy representations which are subject to individual artistic license and/or constraints of the medium.

5) Multi-Functional Hypothesis
   - Different forms (Types or SubTypes) represent different functional tools or objects.

6) Functional Transformation Hypothesis
   - Use-related attrition or re-sharpening of blade or other portion results in the gradual transformation from one form (Type or Subtype) into another.

7) Cultural Identity Hypothesis
   - Forms (Types or SubTypes) represent ethnic, linguistic, other cultural groupings whose identity was expressed in morphological style.

8) Phylogenetic Hypothesis
   - Forms (Types) evolve or change stylistically through time sequentially producing new forms (Types or SubTypes).

9) Multi-phyletic—Multi-functional Hypothesis
   - Several functionally different forms (Types or SubTypes) evolve stylistically through time in parallel.

10) Palimpsest Hypothesis
   - Typological variation is a confused product of multiple functional and non-functional causes. These may reasonably include any mixture of any of the other models.

San Joaquin Valley (especially around Tulare Lake) and in the San Francisco Bay Region. In both these areas, charmstones are relatively abundant and representative of prehistoric artifact assemblages. I am presently aware of 92 examples (see Table 1) of ground crescents in California. A total of twelve or thirteen are reported from the Bay Area (the provenance of the one from Alameda County cited by Kroeber 1906 and Rust 1906 is problematical). Kroeber also describes an unusual specimen from Santa Barbara County. All of the remaining known ground crescents (n = 78 or 79) come from the southern San Joaquin Valley, and all but two of these are reported from the Tulare Lake Basin.

I have developed a classification system for ground crescents (Fenenga 2007) that recognizes three major types based on body proportions. Within these groups, several morphological subtypes can be recognized by stylistic modification or by mode of manufacture. Stylistic variation in ground stone crescents thus includes at least seven different morphological forms and the "butterfly" specimen is but one example. It, however, is unique in form with no other known specimen exactly like it. The relative frequency of different ground crescent types is presented in Table 2.

A possible function for ground stone crescent charmstones in prehistoric central California is suggested by the ethnographic use of crescentic stones in girl's adolescence ceremonies in southern California (Rust 1906: 29-30, Plate VII; Waterman 1910: 286, Plate 21, Figure 1). In a state where ethnology has often served the archaeologist, Kroeber (1906) drew a comparison between the prehistoric archaeological ground crescents and the crescent-shaped stones identified with historic Kumeyaay. Due to obvious time, space, and cultural differences between these occurrences, it is difficult to reconcile what these similarities may mean. Gerow (1968: 73) calls attention to Kroeber's (1923, 1925: 856) hypothesis that the girl's puberty ceremony was quite ancient and formed the basis of later religious developments in California and that stone crescents might be evidence to support this. There is certainly nothing to refute the hypothesis that these artifacts somehow functioned in a manner similar to the ceremonial use described by Waterman and Rust. In this respect, the ground crescents may be gender-related artifacts. However, they may have functioned in any number of other ways.

IMPLICATIONS FOR CALIFORNIA PREHISTORY AND CRESCENT STUDIES

This intriguing and yet enigmatic artifact potentially has significant implications for both California prehistory and for the field of crescent studies in general. The first, and most obvious of these, is the link this artifact provides between the widespread early Holocene chipped stone crescent-making cultures and the ground charmstone-making Early Bay Culture and its equivalent in the San Joaquin Valley. The nature of this linkage is of course unknown. However, if we assume it is lineal and direct, the implications are potentially quite important to our understanding of prehistory. This connection would suggest the Early Bay Culture (as expressed at CA-SMA-77 and CA-SCL-65), represents the direct descendants of the "Western Pluvial Lakes" people (or the regional equivalent cultural manifestation). This hypothesis is not weakened when we look at lithic technology at the University Village Site which is characterized by leaf-shaped points and knives (Año Nuevo Points) that resemble earlier Western Stemmed forms. Previous suggestions have been made about linguistic prehistory and some of these cultural manifestations, but this artifact provides tangible material evidence that may identify an ancestor-descendant relationship. Today, this hypothesis could be pursued with molecular biology and easily resolved.

It is hard to imagine why someone would imitate a chipped stone artifact in a ground stone medium when that eliminates the functional attributes that operationally are associated with flaked stone technology. It is especially difficult to reconcile this behavior with functional hypotheses that credit crescents with utilitarian use such as "transverse projectile points," "tattooing implements," or other sorts of specialized tools, as many have proposed. The replica instead implies some non-utilitarian use may have been accorded these artifacts, and that use continued into the period of the middle Holocene where regional charmstone cults characterize much of the evidence for ceremonialism throughout central and coastal southern California. When I first worked with ground crescents (Fenenga 1990), I believed they had no relationship with chipped stone crescents, although I had considered the idea since I was already reasonably familiar with chipped stone crescents (Fenenga 1984; 1985). The occurrence of this replica "butterfly" ground crescent, however, has made me rethink this subject,

Table 1: Ground crescent charmstones from California.

Provenance or Reference	County	Complete	Frags.	Total
CA-NAP-1	Napa	2		2
Tandy Collection	Marin	2		2
Rust & Kroeber 1906/Holmes 1899*	Alameda?	1*		1*
CA-SMA-77	San Mateo	6	1	7
CA-SCL-65	San Clara		1	1
Holmes 1899*	Calaveras?	1*		1*
Griffith Collection	Kings/Tulare	1	1	2
Mayer Collection/Gifford & Schenck	Kings/Tulare	3		3
Fry Collection/Gifford & Schenck	Kings/Tulare	4		4
Ramos Collection	Kings/Tulare	2	1	3
Crewdson Collection	Kings	1		1
Boston Collection	Tulare Lake	1		1
Slaughter Collection	Kings/Tulare	3	1	4
Roehr Collection	Kings/Tulare	1		1
Seals Collection	Kings/Tulare	3	4	7
Witt Collection	Kings/Tulare	3	4	7
Hopkins Collection	Kings/Tulare	6	5	11
Van Den Enden Collection	Kings/Tulare	9	3	12
Jack Mitchell Collection	Kings/Tulare	4		4
Marion Mitchell Collection	Kings/Tulare	4	2	6
Buddy Jackson Collection	Kings/Tulare	4	4	8
Kroeber 1906	Tulare/Kern	1		1
Pruett 1991	Kern	1		1
Kroeber 1906	Santa Barbara	1		1
Waterman 1910	San Diego	1		1
Rust 1906	San Diego	1		1
Total		65	27	92

* = same specimen

as I suspect it will other researchers. The implications of this artifact clearly bear directly on the functional debate that dominates crescent studies in California and the Great Basin.

If the link suggested by the identical appearance of the early chipped and later ground crescent is in some manner indirect rather than the model of cultural continuity proposed above, it is even more difficult to explain why this artifact was made. There are some known examples of "heirloom" artifacts occurring outside of their normal temporal context, especially in the case of ritual artifacts that may be curated over many generations (Thomas 1976; Fenenga and Riddell 1978). In all cases that I am aware of, however, the "heirlooms" are the original artifact, fossil, or mineralogical curiosity. They are not a counterfeit copy of the real thing. There also are a number of instances in which chipped stone projectile points have been duplicated in other materials, including antler (Bennyhoff 1957), ceramics (Begole 1978), and shell (Jones 1988). In these

Table 2: Ground Crescent Types.

Specimen/Collection	U-Shaped	Crescent	1/4 Moon	Truncated	Butterfly	Millingstone	Natural	Indeterm.	Total
CA-NAP-1		1					1		2
Tandy 1962		1	1						2
CA-SMA-77	2	3	1					1	7
Voy (Kroeber in Rust 1907; Holmes 1899)	1	1							
CA-SCL-65								1	1
Griffith	1				1				2
Mayer (Gifford and Schenck 1926)		2	1						3
Fry (Gifford and Schenck 1926		1	1	1		1			4
Ramos	2	1							3
Crewdson	1								1
Boston 1963			1						1
Slaughter	1	1	2						4
Roehr								1 (n.d.)	1
Seals		1	1	1				4 (n.d.)	7
Witt 1964	1	1	5						7
Hopkins 1989	3	2	5					1	11
Van den Enden	2		7			1		2	12
J. & J. Mitchell		2	1	1					4
M. Mitchell		3	2	1					6
B. Jackson	1		4					3	8
Poso Creek (Kroeber in Rust 1907)		1							1
Pruett 1991						1			1
Santa Barbara (Kroeber in Rust 1907)		1							1
Rust 1906						1			1
Waterman 1910							1		1
Total	14	22	32	3	1	5	2	13	92

Note:
n. d. = no data, information from Hopkins 1989, 2007

cases, the resulting point styles are all late forms, not copies of long out-dated types.

The "butterfly" crescent type also does not seem to be an obvious candidate for replication, given the range of crescent forms available. The specific attributes that identify a "butterfly" or "winged" crescent from a "lunate" crescent are thought to be technological traits related to utilitarian use by most researchers. These include the truncation of the apical portion of the convex margin, abrasion on the edges and faces along the midline, notches on the midline on either edge, and "nipples" on the convex margin. All of these features have been used as evidence of use, hafting, or re-sharpening of working edges by one "expert" or another, including myself (Fenenga 1996). I was convinced, for example, that the "nipples" present on the convex edge of some "butterflies" were the product of re-sharpening, and that these artifacts functioned as a specialized cutting tool perhaps associated with fishing or fowling (see Figure 6). Other forms of crescents might make some sense transformed into groundstone shapes if they were intended to function as charms or amulets. These include the moon-like lunate crescents or the zoomorphic eccentric crescent forms.

If the ground "butterfly" is a replica of a charm, there is no reason not to believe the other ground types might not also be replicas of other chipped crescent types. These, therefore, might represent "moon" effigies in either the waxing or waning stage, presuming they were intended to be realistically representational. Many archaeologists including Malcolm Rogers (1929), Emma Lou Davis (1978), and Hank Koerper (Koerper and Farmer 1987; Koerper and Ericson 1991) have suggested the hypothesis that chipped stone crescents may represent animal or other images. The antiquity of these artifacts would make them some of the earliest representational art in the Western Hemisphere, if this hypothesis were correct. Further, their distribution would suggest they represent an early artistic tradition that was wide-spread through California and the Great Basin. This perspective has significant implications for archeological interpretations that have viewed chipped stone crescents as "transverse projectile points" associated with a particular ecologically-based adaptive pattern, (presumably a behavioral technology related to fowling) or as specialized cutting implements of some sort, or some other functional tool associated with a specific environmental habitat in its specific use. As charms or amulets, these artifacts convey different information about the people who left them for us to find.

SUMMARY

This report has described an unusual form of charmstone from early California and has discussed some of the implications of this artifact to California prehistory. Its unique nature and its relationship to entirely different problems of archaeological concern attests to its significance and, in addition, its heuristic qualities. This singular artifact is of considerable importance to understanding the question of crescent function, a problem that has mystified archaeologists since they were first discovered. Although it does not resolve the issue of function, it alters our thinking about the problem, since the ground stone specimen simply could not function in the manner suggested by any of the strictly functional explanations. It does not have any sharp cutting edges or any properties suited to flight by propulsion. Similar artifacts are usually attributed a ritual or ceremonial function, and there is no reason to think the ground stone crescents were not related to this purpose. The ground "butterfly" crescent presents evidence for a possible connection between the ritual behavior of the middle Archaic and the use of chipped stone crescents during the Paleo-Indian/Archaic transition.

In this paper, I have suggested that the ground "butterfly" represents tangible evidence for a hypothetical link between those very early chipped stone crescent-producing human populations of the terminal Pleistocene and early Holocene that were wide spread through California and the Great basin with those identified in the San Francisco Bay much later in prehistory. There must,

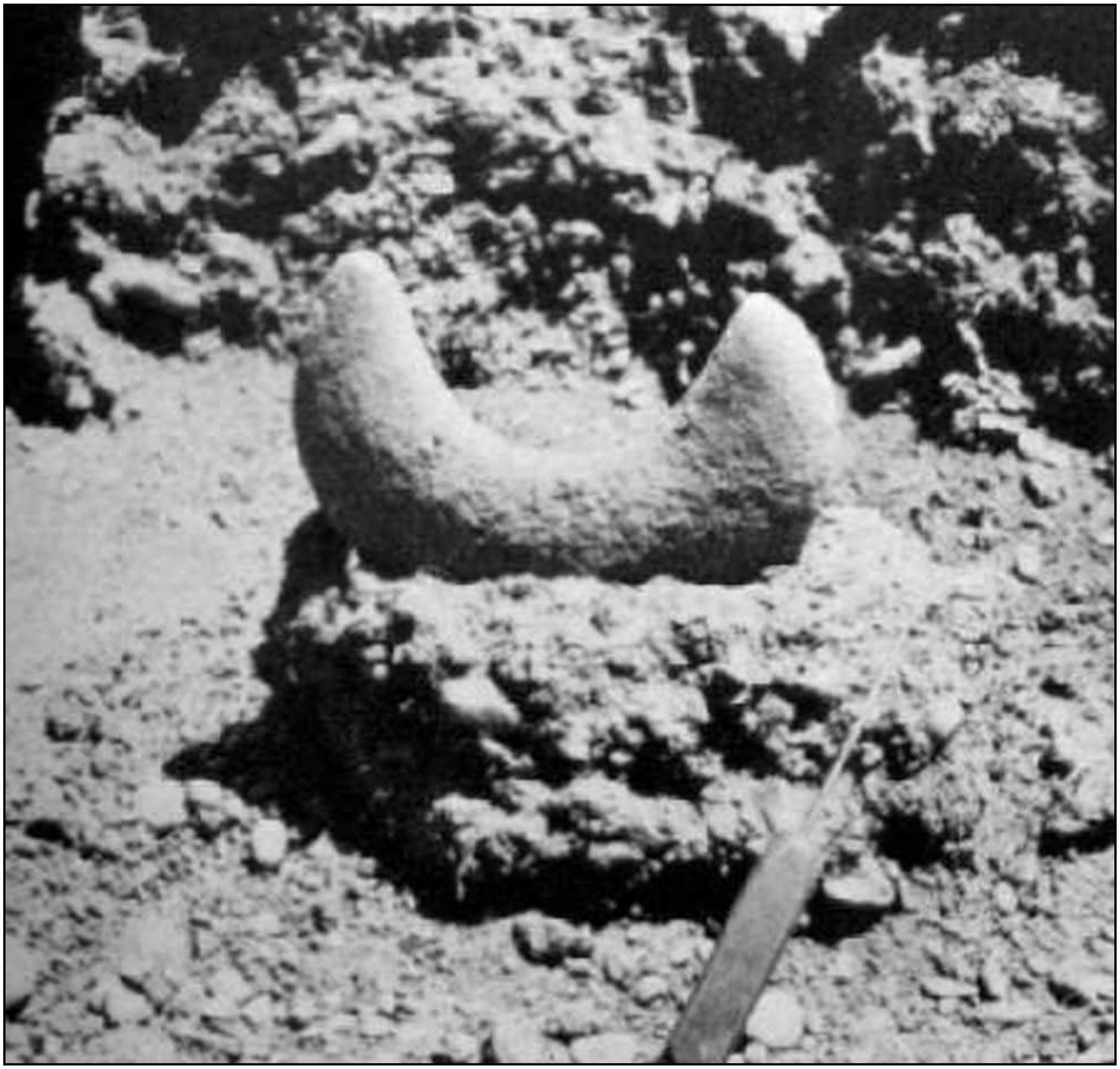

Figure 6: Ground stone crescent as found *in situ* at the University Village site, CA-SMA-77. From Gerow (1968: Plate 2a, p. 197).

of course, be yet unidentified populations that produced the ground crescents in the San Joaquin Valley and perhaps in the Santa Barbara Channel that also derive from these early human inhabitants. This hypothesis might be easily tested today, given the ability scientists have to extract and compare DNA from ancient human skeletal material. The primary candidate for initiating such a study would come from the human remains associated with ground stone crescents at sites where these have been identified. The results of DNA work could then be compared against early skeletal material from the period of chipped stone crescent occurrences in California and the Great Basin. The site, which obviously best meets these conditions, is CA-SMA-77, the

University Village Site in San Mateo County (Figure 6). Unfortunately, Stanford University reburied the remains from this site in the 1990s, although a preliminary assessment of their scientific value by a distinguished team of experts had recommended against this course of action until further study could be made. There indeed are early Holocene human remains, which could have been compared with the Early Bay Culture people. The Spirit Cave burial found near Winnemucca, Nevada, for example, likely represents a person of the "Western Pluvial Lakes Tradition." That discovery is also at risk of reburial, along with the Kennewick skeleton and others, in spite of current court findings in favor of scientific proponents. The enigmatic ground "butterfly" crescent from the early Griffith collection provides a lesson that short-sighted political decision making may lead to lost opportunities for scientific progress. Cultural remains from these distant times of prehistory are not common and are in very limited supply. We should make every effort to treasure them and protect them for future generations of Native Americans who will want to know more about their own ancestry and for others who have an interest in the past.

DEDICATION

Both Bill Wallace and Fritz Riddell invested a considerable amount of their careers investigating privately-made archaeological collections and then reporting on some of their discoveries in various archaeological publications. It is through this process that much of our archaeological understanding has developed for the Central Valley of California (Gifford and Schenck 1926; Hewes 1941; Riddell and Olsen 1969; Wallace and Riddell 1988). Although archaeological data collected in an uncontrolled and unscientific manner have substantial drawbacks, there is (and has been) a great deal to be learned from these collections. This is particularly true when there is a dearth of other material to work with and when specific specimens can be ascertained to be authentic and of local origin. This contribution is dedicated to Fritz and to Bill in the recognition of that concept and in fond remembrance of the times we spent together pouring over archaeological collections and excitingly discussing their contents and research potential.

ENDNOTES

(1) Measurements in this study have been standardized as follows: Length refers to the greatest length in plan view. Due to the convention of viewing crescents lying horizontal with the "wings" up, length is side-to-side. Width is perpendicular to length and is measured by connecting the tips of the "wings" with a line and then measuring from that line to the bottom of the crescent body. Thickness refers to the widest portion of tapering cross-sections.

(2) Gerow (1968) has noted that this artifact appears to be identical to a purported auriferous gravel find from Calaveras County (Holmes 1901); therefore, its location of origin is problematical.

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Glossary

Altithermal: A warm, dry climatic period during the mid-Holocene, dated circa 8,000 to 2,900 BP.

Anathermal: The earliest Holocene climatic age, dated circa 11,000 to 8,000 BP, in western North America; a cool, moist postglacial period that became progressively warmer.

Anthropology: The scientific study of human cultures and their physical traits; includes the the subdisciplines of archaeology, ethnology, linguistics, and biological (or physical) anthropology.

Archaeological Periods: Paleoindian (14,000–8,000 BP), Early Archaic (10,500–5,500 BP), Middle Archaic (5,500–2,300 BP), and Late Archaic (3,500–2,300 BP). These temporal periods are generally characteristic of the prehistoric cultures in the western United States.

Archaeology: The branch of anthropology devoted to the scientific study of past cultures through their material remains. Archaeology seeks to describe and explain the nature and evolution of cultural systems.

Artifact: Any product of human cultural activity; more specifically, any tools, weapons, artworks, etc., found in archaeological contexts.

Asphaltum: Tar or bitumen naturally occurring at the surface of the ground. Native Americans used it as an adhesive for caulking, as a mastic for appliqué work, and for joining parts of a composite artifact.

Assemblage: Refers to a collection or class of artifacts coming from a single defined site, locality or archaeological unit (such as a stratum or component), for example the flaked stone assemblage from the Witt Archaeological Locality. Often an assemblage is time restricted and can therefore be used to reconstruct the changes in prehistoric life ways over time.

Atlatl: An Aztec term for spear-thrower; a wooden device with a handle at one end and at the other a hook or spur that fits into a concavity at the proximal end of a dart (light throwing spear) shaft. The atlatl increases missile velocity by improving leverage during the cast. Atlatls were probably used in California from earlier than 10,000 BP. until their gradual replacement by the bow and arrow after circa 1,500 BP.

Basalt: A dense, fine-grained, tough extrusive igneous rock; a common material in California lava flows. Indians chipped basalt into knives, points, scrapers, and other implements.

Biface: Any stone artifact worked (flaked) on both the obverse (front) and reverse faces, for example, projectile points and knives.

Calendar years: See radiocarbon years.

Calibrated age: See radiocarbon years.

Chalcedony: A hard, light-colored, waxy-lustered rock composed of microscopic (cryptocrystalline) quartz. Knives, drills, projectile points, and other stone tools were often made of chalcedony.

Charmstone: An elongate ground and often polished-stone artifact, normally 5-20 cm in length, fashioned in a spindle, ovoid, phallic, plumb bob, or other shape; may be grooved or plain, perforate or imperforate; often found with burials. The prominence of charmstones in marshy regions has been noted. Their function as hunting charms, bola stones, shamanistic gear, and so forth, is uncertain.

Clovis point: A concave-base, lanceolate projectile point and, or knife, 4 – 12 cm long, with characteristic bifacial flutes extending about half the length of the artifact.

Chert: A flintlike rock composed of chalcedony with variable amounts of clay and other impurities; commonly selected as a raw material for flaked-stone tools.

Coefficient of variation (CV): In probability theory and statistics, the coefficient of variation is a measure of dispersion of a probability distribution. It is defined as the ratio of the standard deviation to the mean.

Cross-dating: Inferring the age of one artifact by comparison with an artifact of the same type previously dated elsewhere.

Cryptocrystalline: A rock texture which is so finely crystalline, that is, made up of such minute crystals that its crystalline nature is only vaguely revealed even microscopically in thin section by transmitted polarized light. Among the sedimentary rocks, chert and flint are cryptocrystalline. Also, a form of diamond, known as carbonado, is cryptocrystalline. Volcanic rocks, especially of the acidic type such as felsites and rhyolites, may have a cryptocrystalline groundmass as distinguished from pure obsidian (acidic) or tachylyte (basic), which are natural rock glasses.

Dart: A projectile resembling a large arrow, normally 1.5 – 3.0 m long, designed to be cast with the aid of an atlatl.

Debitage: Flaked stone debris created as a byproduct of reduction activities in the manufacture of stone tools, also known as waste flakes.

Diagnostic point forms: Projectile points, darts, and thrusting spear types whose morphologies have been found to change through time and may be characteristic of a limited and defined time span.

Effective Hydration Temperature (EHT): Several factors complicate simple correlation of obsidian hydration band thickness with absolute age. Temperature is known to speed up the hydration process. Thus, artifacts exposed to higher temperatures, for example by being at lower elevation, seem to grow obsidian hydration rims faster. As well, obsidian chemistry, including the intrinsic water content, seems to affect the rate of hydration. Once an archaeologist can control for the geochemical signature of the obsidian (e.g., the "source") and temperature (usually approximated using an "Effective Hydration Temperature" or EHT coefficient), then it may be possible to date the artifact using the obsidian hydration dating technique.

Feature: An aggregation of artifacts or a discrete cluster of cultural materials that can be identified as a concentrated area of activity such as a hearth, cairn, house pit, chipping station, etc.

Fluted point: A projectile point or knife distinguished by a longitudinal channel flake (flute) that is removed and runs upward from the base of the point and is exhibited on one or both sides.

Holocene (Recent): The post-Pleistocene geologic epoch characterized by fluctuating but generally moderate climates and modern faunal assemblages; dated circa 11,000 BP to the present.

Hydration rim: When a new surface of obsidian is exposed to the atmosphere, such as during the manufacture of obsidian glass tools, water begins to slowly diffuse from the surface of the artifact into the interior of the specimen. When this hydrated layer, rind, or rim reaches a thickness of about 0.5 microns, it becomes recognizable as a birefringent rim that can be observed as a band by cutting a thin section of the glass artifact and viewing it under a microscope. Hydration rims formed on artifacts can vary in width from less than one micron for items from the early historic period to nearly 30 microns for early sites in Africa.

Lacustrine: Literally lakeside and generally places that have excessive moisture because they are located near streams, lakes, rivers, or marshes.

Lacustrine Deposits: Sediments accumulated in a lake.

Lanceolate: Shaped like a spear.

Locality: A geographical space small enough to permit the assumption of "complete" cultural homogeneity at any given time. In California, the locality corresponds to the area occupied by a few closely related tribelets. Several related localities may comprise a district.

Locus: A portion of an archaeological site that can be segregated and differentiated due to its distinct function and, or temporal placement.

Medithermal: The third climatic age of the Holocene epoch, dated circa 2,900 BP until the present; a period characterized by moderate precipitation and moderate temperatures in the western United States.

Mitochondrial DNA: DNA is present inside the nucleus in every cell of the human body, but it is the DNA of the cell's mitochondria that is most commonly used to trace genetic ancestry. Mitochondrial DNA has been particularly useful with regard to reconstructing the history of human populations because it is inherited strictly through the mother and is present in large numbers in each cell. It may be preserved for thousands of years within the skeletal remains of ancient humans.

Obsidian: Natural volcanic glass. This was the premier material for chipped-stone artifacts in California, where it was obtained from no fewer than 25 separate sources.

Obsidian hydration dating: A method for determining the age of obsidian artifacts or debitage by measuring the thickness of a specimen's hydration rim (layer of water penetration) and comparing the rim depth with the established hydration rate for the particular climatic-geographic area (effective hydration temperature) and type of obsidian.

Paleoindian: The term "Paleoindian" (Paleo = old) is often used to refer to the earliest inhabitants of North America in order to differentiate them from the later peoples. It is used here (in the present publication) to refer to people who hunted animals which are now extinct, to the people who occupied the western United States prior to about 6,000 years ago, and to the makers of the fluted points found in the central and eastern United States. Paleoindians are sometimes characterized as nomadic hunters of megafauna but were also reliant on other sources of protein and various plant foods during the late Pleistocene epoch.

Pedoturbation: The mixing of soils caused by various agents. Faunal pedoturbations includes the effects of ants, earthworms, moles, and rodents. Human induced changes incorporate pedoturbation from tillage (agriculture) and other cultural activities that are ground disturbing actions.

Percussion-flaking: The manufacture of stone artifacts by removing flakes with blows struck by a stone, antler, or bone "hammer."

Playa: A dry lake bed or floor of a desert basin lacking external drainage.

Pleistocene: A late Cenozoic geologic epoch characterized by fluctuating, generally cool climates—often accompanied by glaciations

—and distinctive faunal assemblages; dated from 3 million years ago until circa 11,000 BP.

Pluvial lake: A lake formed during a pluvial period; in this publication, the term refers specifically to late Pleistocene and early Holocene lakes of western North America.

Pluvial Period: A time of increased rainfall and, or decreased evaporation in nonglaciated areas, often coeval with periods of ice buildup elsewhere.

Pressure flaking: The manufacture of stone artifacts by removing flakes with pressure applied with a bone, antler, or other knapping tool.

Radiocarbon years: When radiocarbon dating was introduced, it was assumed that a radiocarbon year was equal to a calendar year. This was based on the assumption that the level of ^{14}carbon in the atmosphere remained constant over time. It was later discovered that radiocarbon dates when compared with calendar year dates derived from ancient tree rings were not equivalent because atmospheric concentrations of ^{14}carbon have fluctuated over time. The correction, or calibration, of radiocarbon dates younger than approximately 15,000 years can be accomplished by means of a calculation based on ancient tree-rings (Bristlecone Pines). This calculation results in a "calibrated radiocarbon age" that is usually expressed as "cal BP" or the calibrated age.

Stratigraphy: The study of cultural and natural strata or layers in archaeological and geological deposits, particularly with the aim of determining the relative age of strata.

Time-diagnostic artifacts: Manmade objects that have been found through archaeological study to change form over time and as such can be used as surrogate clocks to date associated prehistoric remains.

X-ray fluorescence: (XRF) is the emission of characteristic "secondary" (or fluorescent) X-rays from a material that has been excited by bombarding with high-energy X-rays or gamma rays. The phenomenon is widely used for chemical analysis, particularly in the investigation of metals, glass, ceramics and building materials, and for research in geochemistry, forensic science and archaeology. XRF is used to determine the chemical fingerprint or trace element percentages of an obsidian artifact to identity its provenience and geographic source.

Note: Definitions of Paleoindian artifacts discussed in Chapter one are included in the artifact guide portion of the manuscript, not in the Glossary.

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