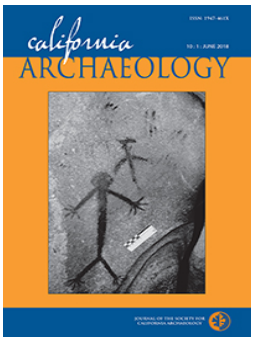

California Archaeology

ISSN: 1947-461X (Print) 1947-4628 (Online) Journal homepage: http://www.tandfonline.com/loi/ycal20

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**To cite this article:** Michael J. Moratto, Alan P. Garfinkel, Jon M. Erlandson, Alexander K. Rogers, Michael F. Rondeau, Jeffrey Rosenthal, Craig Skinner, Tim Carpenter & Robert M. Yohe (2018) Fluted and Basally Thinned Concave-Base Points of Obsidian in the Borden Collection from Inyo County, Alta California: Age and Significance, California Archaeology, 10:1, 27-60, DOI: 10.1080/1947461X.2017.1391476

**To link to this article:** https://doi.org/10.1080/1947461X.2017.1391476

# Fluted and Basally Thinned Concave-Base Points of Obsidian in the Borden Collection from Inyo County, Alta California: Age and Significance

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*California Archaeology*, Volume 10, Number 1, June 2018, pp. 27–60.

***Abstract*** This article describes, classifies, and provides the calculated ages of 14 basally thinned and fluted points of obsidian in the Borden collection from Rose Valley in southern Inyo County, California. With the exception of one item of Fish Springs obsidian, the specimens are all made of glass from geologic subsources in the Coso Volcanic Field. Typologically, the fragmentary and reworked artifacts appear to represent Clovis, or perhaps Clovis-derived, concave-base lanceolate points. Obsidian hydration measurements permit age calculations that range between approximately 13,793 and 11,308 calendar years ago. The calculated ages of the Borden artifacts are consistent with their discovery on landforms associated with Younger Dryas and very early Holocene wetlands. Our research results also suggest that Clovis technology may have persisted longer in California than it did in the southeastern, central, and southwestern United States.

***Resumen*** Este artículo describe, clasifica, y proportiona las edades calculadas de 14 puntos de obsidiana, adelgazados a la base y canelados, en la colección de Borden, de Rose Valley, en el condado de Inyo del sur. Exceptuando un artículo de la obsidiana de Fish Springs, los especímenes son todos de vidrio de subfuentes geológicas en el Campo Volcánico Coso. Tipológicamente, los artefactos fragmentados y reelaborados parecen representar los puntos lanceolados y de base cóncava de la tradición Clovis, o quizás derivados de Clovis. Las mediciones de hidratación de obsidiana permiten cálculos de edad que tienden a variar desde aproximadamente 13.793 a 11.308 años civiles. Las edades calculadas de los artefactos de Borden son consistentes con el descubrimiento de ellos sobre formas de relieve asociadas con campos humedales del Dryas Más Jóvenes y Holoceno muy temprano. Nuestros resultados de investigación también sugieren que la tecnología de Clovis puede haber persistido más tiempo en California que en los Estados Unidos sudeste, central, y suroeste.

**Although scholars have known for decades** that Clovis points occur in ancient archaeological contexts throughout much of North America, the precise age range of the “Clovis culture” (cf. Stanford and Bradley 2012) is still being debated. The widely held view that Clovis assemblages date from ca. 11,500 to 10,900 $^{14}$C yr B.P. (Haynes 2005) has been challenged by Waters and Stafford (2007), who argued that the Clovis era was relatively brief, from ca. 11,050 to 10,800 $^{14}$C yr B.P. This “short chronology” has been criticized and the longer one defended (e.g., Haynes et al. 2007;

Madsen 2015; Prasciunas and Surovell 2015). Moreover, evidence for the persistence of Clovis well beyond ca. 10,800 $^{14}$C yr B.P. has been reported from several North American regions, including the Far West (Beck and Jones 2009, 2010, 2013; Bedwell 1973; Madsen and Rhode 1990; Moratto et al. 2017). Nor is the issue purely temporal, since typology also must be taken into account, i.e., which artifacts are Clovis, or Clovis-like, or derived from Clovis, and what is the age of each (cf. Miller et al. 2013).

In this article, we describe and classify 14 fluted or basally thinned, concave-base, bifacial points (F/BTC-BBPs) of obsidian in the Borden collection from Rose Valley in Inyo County, California. These specimens are among the nearly 600 Clovis and Clovis-like points known to have been discovered in the state (Dillon 2002; Erlandson et al. 2007; Justice 2002; Moratto 1984, 2000; Rondeau 2015; Rondeau et al. 2007). Unfortunately, most of these are surface finds and almost none of them came from buried deposits that could be radiocarbon dated. A second aim of our article, therefore, is to calculate the ages of the 14 F/BTC-BBPs based on geologic source-specific, temperature-adjusted obsidian hydration rates. Our intent here is to shed light on the age of these, and perhaps typologically similar, flaked stone tools in eastern California. Finally, a third goal is to discuss and assess the importance of these distinctive artifacts in the region's early prehistory. With respect to nomenclature, key terms employed in this article are defined below.

## The Borden Collection

Rose Valley in southern Inyo County (Figure 1) was the focus of intensive archaeological survey and collection during the 1960s and early 1970s by Ferris Borden and his wife Helen, under the auspices of the Archaeological Survey Association of Southern California (ASASC). The Borden collection of about 3,700 artifacts, including many Paleoindian items (Rondeau 2009a, 2009b; Stephens and Yohe 2012), vanished and was feared lost after the ASASC and the Bordens parted company. Fortunately, the collection resurfaced in 2008 when a relative of Mr. Borden's offered it to the Maturango Museum in Ridgecrest, California, where it is now held under Accession Number 08.29 (Rogers 2010a, 2010b, 2016).

Given Rose Valley's close proximity to the Coso Volcanic Field (CVF) (Figure 1), it is not surprising that the Borden collection includes many items made of Coso obsidian. A map of the various survey locations is on file at the Maturango Museum, and individual artifacts are labeled with geographic data, such as township, range, section, and sometimes quarter-section. But there are no accompanying notes to reveal exact provenience

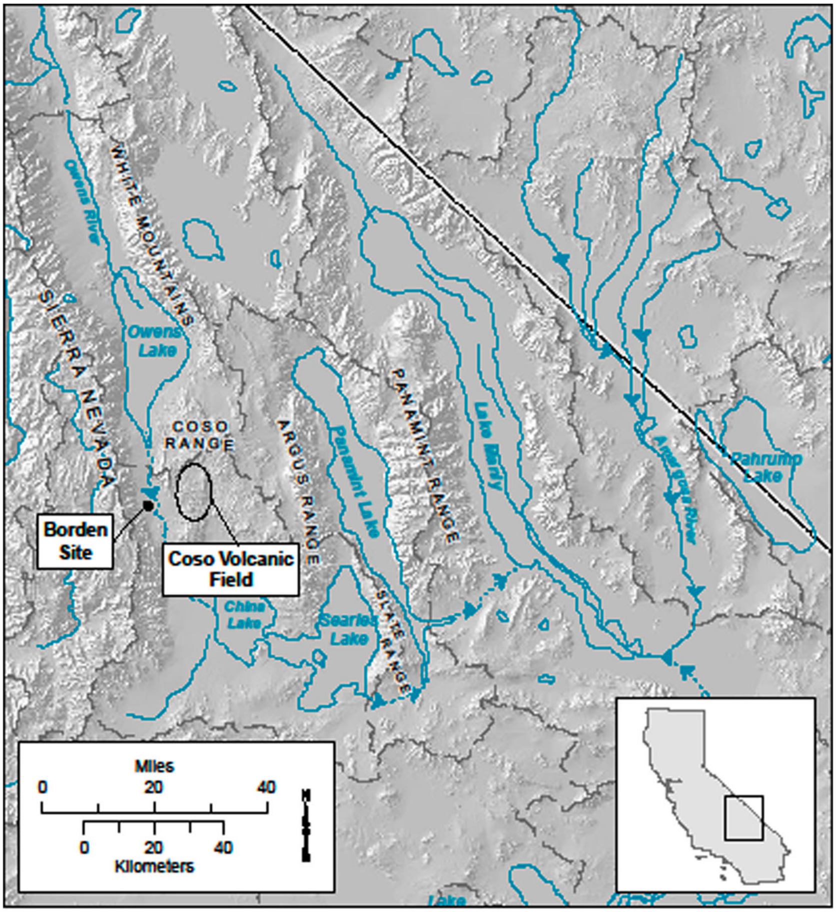

**Figure 1.** Location of the Borden site relative to the Coso Volcanic Field, mountain ranges, water courses, and lake basins east of the southern Sierra Nevada (map by Paul Brandy).

or to describe field methods. Some pertinent information—e.g., that debitage was not usually recovered—may be gleaned from Borden's (1971) report. In that work, he grouped stone tools into four categories based on the extent of chemical and physical weathering due to atmospheric exposure and eolian sandblasting, and proposed a time period for each category: 500–2,000 B.P. (Category I) to 9,000–11,000 B.P. (Category IV). Bettinger (1974) called attention to basic problems with this approach, which has since been replaced by other chronologic methods (e.g., Colman and Pierce 2001; Wagner 1995).

The Borden map shows that artifacts were obtained over a large area of Rose Valley, primarily along old terraces of the Pleistocene Owens River. Within this area is site CA-INY-1799/H near Coso Junction, where the Bordens surface-collected most intensively (Borden 1971; Stephens and Yohe 2012:Figure 2). In 1997, archaeologists from California State University, Bakersfield, resurveyed CA-INY-1799/H, updated the site record, and collected additional artifacts (not considered in this study). A catalog from the 1997 field work is filed at the Ridgecrest Field Office of the Bureau of Land Management.

The Borden collection includes both fluted and basally thinned (as defined below) concave-base forms, as well as Western Stemmed series (Lake Mojave, Silver Lake), wide stem, and Pinto points. Flaked stone crescents, limaces, scrapers, gravers, drills, and knives are also present (Rogers 2010b; Rondeau 2009a, 2009b; Stephens and Yohe 2012; cf. Justice 2002:85–101). These artifacts are of types thought to be of terminal Pleistocene or early Holocene age, among them more than 200 fluted or basally thinned concave-base and Western Stemmed series points (about 70 percent of the temporally diagnostic artifact inventory). Rondeau's (2009a) study and our present paper report only on F/BTC-BBPs of obsidian from the Borden collection. Although there are other fluted and concave-base points in the collection, those artifacts are typically made of non-obsidian materials, such as various types of cryptocrystalline stone (cf. Rondeau 2009b).

## Environmental Setting

Rose Valley lies south of Haiwee Reservoir, north of Little Lake, east of the South Fork Kern River, and west of the Argus Range in southwestern Inyo County (Figure 1). This locality has been assigned variously to the northern Mojave Desert or western Great Basin hydrographic and physiographic province (cf. Grayson 2011; Rosenthal et al. 2017). Elevations in the valley range from ~1032 m amsl at Coso Junction in the north to ~954 m near Little Lake in the south. Local surficial geology is characterized by Quaternary alluvium on the valley floor with Mesozoic granitic rocks and Tertiary as well as Pleistocene volcanics in the adjacent uplands (Jennings et al. 1962; Streitz and Stinson 1974). Especially notable is the CVF, consisting of numerous rhyolitic domes and flows immediately east of Rose Valley (see Gilreath and Hildebrandt 2011:Figure 8.2). The CVF was a major source of obsidian for native peoples over many millennia (Eerkens and Rosenthal 2004; Elston and Zeier 1984; Gilreath and Hildebrandt 1997, 2011; Hughes 1988).

Rose Valley forms the hydrological conduit between Owens Lake to the north and the China Lake and Searles Lake basins to the south. Along the valley margins, a complex series of Pleistocene and Holocene alluvial fans coalesce to form sloping aprons at the base of the Sierra Nevada to the west and the Coso Range to the northeast. At various times during the late Pleistocene, Owens Lake spilled into Rose Valley, creating surface water flows that carved a prominent channel through the valley axis from the southern end of the Haiwee Sill (Gale 1914) to the northwestern edge of Indian Wells Valley (Figure 1). Archaeological remains in Rose Valley are situated mostly along the western side of this old river channel and are associated with an elevated terrace consisting of undifferentiated alluvial wash deposits of late Pleistocene and Holocene age. This same geological unit makes up much of the low-gradient valley floor (Jayko 2009).

Immediately north of the Rose Valley sites, a 6-m-thick, stratified sequence of channel, floodplain, paludal (i.e., marsh), fan, and eolian deposits is exposed in a quarry pit excavated within the former river course. These deposits record a transition from fluvial to marsh conditions at the end of the Pleistocene, and subsequent groundwater recession and regional drying during the Holocene. The basal stratum in the quarry pit consists of coarse sand that grades downward into rounded to subrounded gravels and cobbles characteristic of high-energy water flows within the stream channel. This stratum is overlain by a thin layer of dark, organic-rich silt. The latter marks the transition from high- to low-energy depositional conditions. Meyer et al. (2011) obtained a radiocarbon date of 11,560 ± 50 $^{14}$C yr B.P. (13,395 cal yr B.P.) on the silt stratum, indicating that sustained water flows in that part of the channel had ceased sometime prior to that date (Rosenthal et al. 2017).

Overlying the organic silt is a roughly 3-m thick deposit of white silty sand, including in its upper levels a lace-like network of fine-branching rhizoliths and remains of wetland mollusks (Jayko et al. 2011). Among these are specimens of the freshwater gastropods *Physa* sp., *Gyraulas* sp., and *Lymnaea* sp., which attest to submerged and emergent vegetation typical of ponds and marshes (Jayko et al. 2011). At the top of the silty sand deposit, above the mollusks, is a prominent, organic-rich black mat that is about 20–50 cm thick (Jayko et al. 2008; Meyer et al. 2011); such deposits are formed in marshes or wet meadows (e.g., Quade et al. 1998). Nearly identical radiocarbon dates of 9,980 ± 55 $^{14}$C yr B.P. (11,445 cal yr B.P.) and 10,000 ± 40 $^{14}$C yr B.P. (11,475 cal yr B.P.) were obtained from the black mat (Jayko et al. 2011; Meyer et al. 2011), indicating that wetland environments persisted at this locality into the early Holocene. (The Pleistocene-to-Holocene transition date is generally accepted to be ca. 11,700 cal yr B.P. [Cohen et al. 2013]).

The upper black mat is unconformably overlain by a sequence of loam and loamy sand in which a weakly developed soil has formed. Immediately above this buried soil is a deposit of pale brown, coarse sand that includes a poorly sorted admixture of gravel and cobbles resulting from alluvial processes along the valley axis during the Holocene. Jayko et al. (2011) equated these upper strata to the phreatophyte flat and xerophyte flat units identified by Quade et al. (1998) in the southern Great Basin, showing that groundwater had receded substantially in Rose Valley after the early Holocene.

A recent report by Rosenthal et al. (2017) describes interdisciplinary research focused on the late Pleistocene and early Holocene paleohydrology of the interconnected basins of pluvial Owens Lake and Searles Lake. This report examines

> a broad range of radiocarbon-dated paleoenvironmental evidence, including lacustrine deposits and shoreline features, tufa outcrops, and mollusk, ostracode, and fish bone assemblages, as well as spring and other groundwater-related deposits (a.k.a. "black mats") from throughout China Lake basin, its outlet, and inflow drainages. Based on 98 radiocarbon dates, we develop independent evidence for five significant lake-level oscillations between 18,000 and 13,000 cal BP, and document the persistence of groundwater-fed wetlands from the beginning of the Younger Dryas through the early Holocene (12,900–8,200 cal [yr] BP); including the transition from groundwater-fed lake to freshwater marsh between about 13,000 and 12,600 cal [yr] BP. Results of this study support and refine existing evidence that shows rapid, high-amplitude oscillations in the water balance of the Owens River system during the terminal Pleistocene, and suggest widespread human use of China Lake basin began during the Younger Dryas [Rosenthal et al. 2017:112].

Based on the information presented above and the obsidian hydration ages discussed below, the F/BTC-BBPs from Rose Valley seem to have been associated with wetlands. The points apparently were made and used at a time when water no longer flowed briskly into Rose Valley but when spring seeps, spring ponds, or marsh-like conditions existed in the immediate locale. The occurrence of numerous flaked stone crescents—artifacts typically associated with wetland habitats (Sanchez et al. 2016)—in the Borden collection is consistent with this conclusion.

## Lithic Technology and Description

Examined in this section are 13 basal fragments and one complete, though extensively reworked, specimen (Figures 2 through 5). Rondeau (2009a)

**Figure 2.** Specimens 1 through 7, Face 1. Top row, left to right, Specimens 1 through 4. Bottom row, left to right, Specimens 5 through 7 (photo by Michael F. Rondeau).

**Figure 3.** Specimens 1 through 7, Face 2. Top row, left to right, Specimens 1 through 4. Bottom row, left to right, Specimens 5 through 7 (photo by Michael F. Rondeau).

**Figure 4.** Specimens 8 through 14, Face 1. Top row, left to right, Specimens 8 through 11. Bottom row, left to right, Specimens 12 through 14 (photo by Michael F. Rondeau).

**Figure 5.** Specimens 8 through 14, Face 2. Top row, left to right, Specimens 8 through 11. Bottom row, left to right, Specimens 12 through 14 (photo by Michael F. Rondeau).

described these artifacts in detail and classifies nine of them as fluted and five as "end thinned" (herein, "basally thinned"). He also notes that large labels painted on one face of each specimen, together with heavy weathering of flake scars due to long periods of surface exposure, reduce the amount of recoverable data (Rondeau 2009a:3). The attributes of these points are discussed below (also see Table 1). These 14 artifacts are part of a larger group of fluted or otherwise thinned concave-base points in the Borden collection. Nine other examples and one unfinished fluted biface fragment—made variously of chert, chalcedony, agate, milky quartz, or obsidian—are described by Rondeau (2009b).

Longitudinal thinning is a significant aspect of early lithic technologies in North America and manifests important variability in knapping methods and techniques:

> When accomplished during the course of producing *preforms* (unfinished bifaces whose final form is evident), it is called *end thinning* even when done to a tip rather than a base. When applied so that the finished piece retains the resulting flake scar or scars on its base, it is called *fluting*. While some bifaces have basal thinning, it is not well enough developed and the flake scars are not long enough for it to be considered fluting … . [This technique] is totally developed and nearly universally applied in the Clovis biface technologies. Clovis is the first assemblage where fluting is well established, but by no means the last [Stanford and Bradley 2012:29–30].

All but one of the 14 artifacts are basal fragments (Figures 2 through 5) and thus do not permit reliable determinations of total length, maximum width or thickness, or total weight. Similarly, flute length cannot be measured on specimens where the distal portions of fluting scars have been lost due to transverse breaks. Specimen 4, although extensively reworked, is the only artifact complete enough to provide a total length (50.5 mm); however, the original tool must have been substantially longer, as the blade remnant after breakage was reworked distally to form a small, acutely triangular tip (Figures 2 and 3). The maximum thickness of this "complete" point and the 13 fragments ranges between 5.1 and 8.8 mm, with a mean of 6.8 mm (Table 1). It is probable that the maximum thickness of at least some of the points would have been greater if the original (pre-breakage) artifacts had survived intact.

The 13 fragments represent large bifacial points with shallow to deep concave bases and minimal to pronounced basal ears. Some or all of these artifacts may have been of lanceolate form originally. The rejuvenated

**Table 1.** Attributes of Obsidian Concave-Base Projectile Points from the Borden Collection.

| Artifact | LG | MW | MT | BW | BI | BI:BW Ratio | WT | Flu or BT | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 01 | 29.0<br>Fr | 29.2 | 6.5 | 25.4 | 2.1 | 0.083<br>Fr | 6.3<br>Fr | BF<br>Flu | B Fr, TB, PcF, PsF, D, 1 BE, BG, EG, no Sc, W. Classified as a fluted point by Rondeau (2009a:3). |
| 02 | 23.0<br>Fr | 25.8 | 5.9 | 21.2 | 4.7 | 0.222 | 3.6<br>Fr | UF<br>Flu/UF BT | B Fr, TB, PcF, PsF, 2 BE, BG?, EG?, no Sc?, W. Identified as a fluted point by Rondeau (2009a:4). |
| 03 | 22.2<br>Fr | 24.3 | 5.1 | 23.0 | 6.3 | 0.274 | 3.5<br>Fr | BF<br>BT or Flu? | B Fr, TB, PcF, PsF, 2 BE, BG?, EG?, no Sc?, W. Rondeau (2009a:5) described this fragment as being fluted; the photos seem to show basal thinning; equivocal. |
| 04 | 50.5<br>Rw | 22.4<br>Rw | 7.5<br>Rw | 21.0<br>Rw | 5.7<br>Rw | 0.271 | 7.5<br>Rw | UF<br>Flu/UF BT? | MEF, PcF, PsF, Rw, 2 BE, EG?, W. A substantial portion of the original blade element has been Rw into a stubby triangular point; lateral margins of the basal element also heavily Rw. Original artifact form and dimensions unknown. Rondeau (2009a:6) considers this artifact to be a fluted point. |
| 05 | 33.6<br>Fr | 43.5 | 8.8 | 37.3 | 10.3<br>Rw? | 0.276 | 8.4<br>Fr | BF<br>Flu; also BT? | B Fr, TB, B Rw?, PcF, PsF, 2 BE, EG?, Sc?, W. This is identified as a fluted point by Rondeau (2009a:8). |
| 06 | 33.5<br>Fr | 38.5 | 7.2 | 30.0 | 3.6 | 0.120 | 10.8<br>Fr | BF<br>Flu | B Fr, TB, PcF, PsF, 2 BE, BG, EG, no Sc, no W. This is classified as a bifacially fluted point by Rondeau (2009a:9). |
| 07 | 30.4<br>Fr | 33.5 | 6.6 | ?<br>Fr | 7.4 | ? | 7.5<br>Fr | BF<br>Flu | B Fr, TB, PcF, PsF, 1 BE, BG?, EG?, Sc?, W. Fluting scars are relatively short and steep. |
| 08 | 32.3<br>Fr | 24.4 | 5.6 | 20.2 | 2.8 | 0.139 | 5.3<br>Fr | BF<br>BT | B Fr,, TB, PcF, OF?, PsF, 2 minimal BE, EG?, W. Rondeau (2009a:11) identifies this specimen as an “end thinned” (i.e., BT) point. |
| 09 | 25.4<br>Fr | 26.3 | 5.2 | 21.0 | 6.7 | 0.319 | 3.7<br>Fr | BF<br>BT | B Fr, TB, 2 BE, PcF, PsF, EG?, not Rw, W. Rondeau (2009a:12) identifies this specimen as an “end thinned” (i.e., BT) point. |
| 10 | 30.0<br>Fr | 28.5 | 5.1 | 21.6 | 7.1 | 0.329 | 4.8<br>Fr | BF<br>BT | B Fr, TB, BE, PcF, PsF, not Rw, EG?, W. This point is bifacially “end thinned” (i.e., BT), according to Rondeau (2009a:12–13). |

Continued

**Table 1.** Attributes of Obsidian Concave-Base Projectile Points from the Borden Collection.

| Artifact | LG | MW | MT | BW | BI | BI:BW Ratio | WT | Flu or BT | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 11 | 23.2<br>Fr | 25.9 | 6.3 | 23.0 | 8.1 | 0.352 | 3.6<br>Fr | UF<br>Flu? UF BT | B Fr, TB, PsF, 2 pronounced BE, probable EG, W. BT on one face; possibly Flu on the other. Rondeau (2009a:13–14) identifies this as an "end thinned" (i.e., BT) point. |
| 12 | 33.2<br>Fr | 27.4 | 6.1 | 20.9 | 6.5 | 0.048 | 4.8<br>Fr | BF<br>BT | B Fr, TB, 2 BE, PsF, not Rw, EG?, W. This is classified as an "end thinned" (i.e., BT) point by Rondeau (2009a:14–15). |
| 13 | 23.7<br>Fr | 25.3 | 7.5 | 24.4 | 6.2 | 0.258 | 4.0<br>Fr | BF<br>Flu | B Fr, TB, 2 BE, PcF, PsF, EG?, Sc?, W. Identified as a fluted point by Rondeau (2009a:15–16). |
| 14 | 22.7<br>Fr | 23.7 | 5.9 | ~22.6 | 3.7 | 0.164 | 3.0<br>Fr | BF<br>Flu | B Fr, TB, B Rw?, no BG, EG?, no Sc, W. Rondeau (2009a:15–16) identifies this as a fluted point. |

Notes: Compiled from data in Rondeau (2009a). Metrics are in millimeters and grams.

Key: ? = indeterminate; unknown; B = basal; BE = basal ear(s); BF = bifacial, bifacially; BG = basal grinding; BI = basal indentation; BW = basal width; D = damaged; EG = edge grinding; Flu or BT = basally thinned; Fr = fragment; LG = length; MEF = more than one episode of flaking evident; MT = maximum thickness; MW= maximum width; OF = overshot (outrepassé) flaking; PcF = percussion flaking; PsF = pressure flaking; Rw = reworked, rejuvenated; Sc = scratching; scratched (intentionally); TB = transverse break; UF = unifacial, unifacially; W= weathered; WT = weight.

**Table 2.** Occurrence of Clovis Traits in Specimens 1 through 14 from the Borden Collection.

| **Trait** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lanceolate form | ? | ? | ? | ?/Rw | ? | P | ? | P | P | P | P | ? | ? | ? |
| L 70–235 mm | ? | ? | ? | ?/Rw | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| W 25–65 mm | + | + | – | –/Rw | + | + | + | – | + | + | + | + | – | – |
| T 5–12 mm | + | + | + | +/Rw | + | + | + | + | + | + | + | + | + | + |
| W/T ratio >3.5:1 | + | + | + | –/Rw | + | + | + | + | + | + | + | + | – | + |
| Wt >15 g | ? | ? | ? | ?/Rw | P | P | ? | ? | ? | ? | ? | ? | ? | ? |
| Concave base | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Basal ears | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Bifacial percussion flaking | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| Scratching on flutes | – | ? | ? | ? | ? | – | P | ? | ? | ? | ? | ? | – | ? |
| Overshot flaking | – | – | – | – | – | – | – | P | – | – | – | – | – | – |
| Longitudinal thinning | + | + | + | +/Rw | + | + | + | + | + | + | + | + | + | + |
| Pressure flaking | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Edge/base grinding | + | ? | ? | ? | ? | + | ? | ? | ? | ? | P | ? | ? | ? |
| Comments | FL | FL | FL | FL | FL | FL | FL | BT | BT | BT | BT | BT | FL | FL |
| | Fr | Fr | Fr | Rw | Fr | Fr | Fr | Fr | Fr | Fr | Fr | Fr | Fr | Fr |

Key: ? = indeterminate; unknown; + = present; – = absent; BT = basally thinned; FL = fluted; Fr = fragment; L = overall length; P = probable; Rw = reworked, rejuvenated; T = maximum thickness; W = maximum width; Wt = weight (complete specimen).

point (Specimen 4; Figures 2 and 3) also might have been lanceolate originally. The 13 basal fragments weigh from 3.0 to 10.8 g (Table 2), suggesting that before breakage the complete points might have weighed approximately 10–30 g.

Both percussion and pressure flaking are evident on most of the artifacts. Although Rondeau (2009a) identifies Specimens 8, 9, 10, 11, and 12 as “end thinned” and Specimens 1, 2, 3, 4, 5, 6, 7, 13, and 14 as fluted, this distinction is not always clearly defined, nor is it necessarily significant typologically. While certain artifacts are definitely fluted (1, 2, 6) or basally thinned (10, 11, 12), others are damaged basally (5, 7, 14), or seem to be unfinished (8), or appear to be fluted on one face and basally thinned on the other (4, 13). In this regard, Clovis points can have (1) one percussion flute on each face, (2) a single percussion flute on one face and a percussion flute accompanied by pressure flake removal on the other, (3) multiple flakes removed to achieve a thin base, or (4) various other combinations of percussion and/or pressure flaking intended to thin the base (Morrow 1996:213–214). In addition, weathering has obliterated any trace of basal or edge grinding that might have existed on most of the artifacts, except possibly Specimens 1 and 11 (Rondeau 2009a).

## Classification

An obvious question is whether these 14 artifacts represent "classic" Clovis lithic technology (Fladmark 1980; cf. Miller et al. 2013) or something else. Clovis points are medium to large finished bifaces, typically of lanceolate form with parallel or slightly convex margins and greatest width on the lower (proximal) part of the blade element. They are characterized by bifacial (or less often unifacial) thinning, including flutes extending the full length of the hafting element (and sometimes beyond), a shallow-to-deep concave base, prominent basal ears, and a relatively large width-to-thickness ratio.

Additional traits are high-quality (frequently exotic) toolstone, bifacial percussion flaking that may include distinctive overshot (*outrepassé*) flaking (Bradley 1982; Huckell 1982), "alternating opposed biface thinning" (Bradley 1982), edge finishing by pressure flaking, basal and edge grinding of the hafting element, and occasional scratching or abrasion of flute surfaces, particularly on obsidian points (cf. Bradley et al. 2010; Frison and Bradley 1999:10–35; Gramley 1993:27–36; Justice 2002:67–80; Kohntopp 2010:10–17; Morrow 2015; Morrow and Morrow 1999; Sellards 1952; Smith et al. 2015; Stanford and Bradley 2012:44–53; Waters and Jennings 2015:33–100; Waters et al. 2011:97–112; Wormington 1959:47–84, 263). Nonetheless, as Stanford and Bradley (2012:45) observe, "there is not a single form of Clovis point, and we see variations through time and space" and even within single-component assemblages (also see Ives et al. 2013:155–159; Miller et al. 2013; Stanford and Bradley 2012:Figure 2.6).

As regards metric data, an immediate problem facing those who wish to learn the typical dimensions of Clovis points is that many of them have been re-sharpened, broken and then rejuvenated, or otherwise modified after initial manufacture. A partial solution is to examine specimens found in caches, as they are often complete and presumed to reflect the artifacts' intended form and size (i.e., ideal type). This can be a two-edged sword, however, as cached points may not represent the full range of morphologic variability of Clovis points in day-to-day utilitarian contexts. To address this issue, Smith et al. (2015) distinguished between cached and non-cached finds in their analysis of the geographic variability of Clovis points. We do the same here.

Eighteen complete Clovis points in the Fenn cache of 56 flaked stone tools—discovered ca. 1902, probably somewhere in the "Three Corners" area where Idaho, Utah, and Wyoming meet—range in length between 77.8 and 212.5 mm, in width between 26.6 and 53.8 mm, in maximum thickness between 6.6 and 11.7 mm, and in weight between 18.6 and 156.9 g (Frison and Bradley 1999:107); width-to-thickness ratios are arrayed between 4.0:1 and 5.4:1. Similarly, five intact Clovis points in the Simon cache from south-central Idaho measure 96.0 to 185.0 mm in length, 36.0 to 40.0 mm in width, and 8.0 to 9.0 mm in thickness (Kohntopp 2010:53; Woods and Titmus 1985).

Some of the exquisitely flaked Clovis points in the Richey cache (also known as the East Wenatchee cache) from central Washington are even larger (as much as 232.5 mm long and 65.5 mm wide), but these are of exceptional size (Gramley 1993; Mehringer 1988). Those from the Fenn and Simon caches—as well as the Clovis points from the Anzick cache in Montana (Jones and Bonnichsen 1994; Wilke et al. 1991), Drake cache in Colorado (Stanford and Jodry 1988), and other caches (cf. Kilby and Huckell 2013)—are more typical with respect to dimensions. These cached specimens may be compared to the much larger sample of Clovis points compiled in the *Paleoindian Database of the Americas* (PIDBA; Anderson et al. 2017), although site-specific information and artifact data are not yet available in the PIDBA for California, Oregon, or Washington; however, some data are included for Clovis finds in Arizona and Nevada.

When attributes of the 14 artifacts from the Borden collection are examined vis-à-vis diagnostic Clovis traits (Table 2), we find a strong correspondence with respect to width, thickness, width-to-thickness ratio, concave base, and longitudinal thinning (i.e., fluting and basal thinning). However, 13 of the specimens are fragments, two of which appear to have been reworked, and one is thoroughly rejuvenated. Also, most are heavily weathered, so that the original form (lanceolate?), overall length, initial weight, and presence/absence of flute scratching and edge grinding on the hafting element cannot be determined, with a few minor exceptions (Tables 1 and 2). We agree with Rondeau (2009a) that, before breakage, the tools were large, fluted and/or basally thinned, concave-base points. Their attributes seem most compatible with Clovis points, or perhaps a variant thereof, but the fragmentary nature, reworking, and weathering of the specimens preclude definitive typological assignments.

What we can say with confidence is that these 14 F/BTC-BBPs *do not* represent any of the following types: Folsom (cf. Figgins 1934, 1935; Roberts 1935; Wormington 1959:23–41, 263), Humboldt Concave Base or Humboldt Basal Notched (cf. Clewlow 1968a; Garfinkel and Yohe 2004; Green 1975; Heizer and Clewlow 1968; Thomas 1981), Sierra Concave Base (cf. Moratto 1972:256–258, 1984), or Buchanan Eared (cf. Justice 2002:162–165) [=Eared Concave Base (Moratto 1972:258–259)]. They *do* seem morphologically similar to concave-base fluted points from China Lake (Figure 1; Yohe and Gardner 2016) and from Tulare Lake in the San Joaquin Valley (cf. Hopkins 2008; Riddell and Olsen 1969; Rondeau and Hopkins 2008; Wilke 1991). They also resemble Black Rock Concave Base points from western Nevada (cf. Clewlow 1968b; Justice 2002:80–85; Layton 1970, 1979; Pendleton 1979), although the latter are not fluted. Whether the 14 points examined here should be included in the Western Fluted variant (Miller et al. 2013:215) is equivocal, partly because the concept is not yet well defined and partly due to the great variety of fluted and basally thinned concave-base points found in the Great Basin and Pacific states.

## Obsidian Hydration Dating

The 14 F/BTC-BBPs were submitted to the Northwest Research Obsidian Studies Laboratory in Corvallis, Oregon, for geochemical source determination by energy-dispersive X-ray fluorescence trace element analysis (Skinner 2011). Subsequently, the items were cut and obsidian hydration rims measured by Archaeometrics, Inc., in Woodland, California (Carpenter 2011). In some cases, multiple cuts were made on a single specimen, particularly if the analyst suspected two or more episodes of flaking. However, with the exception of Specimen 4 and possibly Specimens 5 and 14 (see Table 1), any evidence of reworking had been erased by weathering (cf. Rondeau 2009a). Finally, hydration-based ages were calculated at the Maturango Museum (Rogers 2016). The hydration analysis employed temperature-dependent diffusion theory (Rogers 2007) using specific algorithms described in Rogers (2011a). The analytical approach summarized here is described more fully by Rogers (2011c).

Obsidians from the various geologic sources within the CVF hydrate at different rates (e.g., Stevenson and Scheetz 1989). Source-specific analyses have shown that hydration rates are directly proportional to the intrinsic water content of the glass (Rogers 2008a; Stevenson et al. 1998, 2000; Zhang and Behrens 2000; Zhang et al. 2004). For the present study, geologic flow-specific (subsource) hydration rates for Coso obsidian (13 specimens) and for Fish Springs glass (one specimen) were used in age computations (Rogers 2011b; 2016:Appendix A). Thermal parameters were defined by regional temperature scaling, based on a site altitude of 1043 m amsl, which yielded an effective hydration temperature (EHT) of 20.56°C (Rogers 2008b). Long-term surface exposure is assumed for the artifacts, as most of them are weathered to varying degrees (Borden 1971; Rondeau 2009a). Age computations also included a correction for paleotemperature change (Rogers 2010c).

Standard deviations from the calculated age midpoints were computed based on known geochemical properties of Coso obsidian and its hydration process (Rogers 2010a). There are four known sources of potential error in the hydration dating process: (1) inaccurate measurement of hydration rims; (2) rate variability due to uncontrolled intrinsic water in the glass (Ambrose and Stevenson 2004; Rogers 2008b; Stevenson et al. 1998, 2000; Zhang and Behrens 2000; Zhang et al. 2004); (3) errors in reconstructing the temperature history of the depositional context (Rogers 2007); and (4) errors caused by site formation processes (e.g., Schiffer 1987). Because of these variables, standard deviation is usually not a good measure of the accuracy of the age estimate. Sample sizes are generally small, and the uncertainty sources produce at least four degrees of freedom in the errors. The computed ages and standard deviations given below and in Tables 3 and 4 are expressed in calendar years before A.D. 2000 (cyb2k; Rogers 2016).

The points analyzed here consist of a single item made of Fish Springs obsidian and 13 specimens of glass from four separate geologic sources within the CVF: four each from West Sugarloaf (WSL), Sugarloaf Mountain (SLM), and West Cactus Peak (WCP), and one from Joshua Ridge (JRR). Eight of these 14 artifacts yielded obsidian hydration measurements on thin sections from two cuts each, one provided readings from three cuts, and the remaining five specimens had one cut apiece (Table 3).

Among the four artifacts of WSL obsidian, all were identified as fluted points (Rondeau 2009a), Specimen 1 displays rim values of 3.2 and 15.3 μ for which ages (midpoints) of 526 and 12,018 cyb2k, respectively, were calculated. The older date probably marks the time of the point's original manufacture while the younger one possibly indicates when the discarded fragment was reworked. Rondeau (2009a) found no clear evidence of reworking, however, so the origin of the 3.2 μ rim is unknown. The second artifact of WSL obsidian, Specimen 3, has a hydration band of 18.5 μ and a calculated age of 17,572 cyb2k (Table 3).

**Table 3.** Geologic Source and Hydration Data for the 14 Concave-Base Points in the Study.

| Specimen No. | Cut No. | LT | Geologic Source | Mean OH Rim (μ) | Calc Age (yrs before A.D. 2000) | SD (years) | Comments |
|---|---|---|---|---|---|---|---|
| 1 | 1 | FL | West Sugarloaf | 3.2 | 526 | 137 | ? |
| | 2 | | | 15.3 | 12,018 | 3,054 | PTOM |
| 2 | 1 | FL | Sugarloaf Mountain | 15.7 | 7,685 | 1,565 | PTOR? |
| | 2 | | | 24.6 | 18,869 | 3,838 | PTOM?, U |
| 3 | | FL | West Sugarloaf | 18.5 | 17,572 | 4,463 | U |
| 4 | 1 | FL | West Sugarloaf | 14.6 | 10,944 | 2,781 | PTOR? |
| | 2 | | | 14.8 | 11,246 | 2,858 | PTOR? |
| | 3 | | | 14.9 | 11,398 | 2,897 | PTOR? |
| 5 | 1 | FL | West Sugarloaf | 13.0 | 8,677 | 2,206 | PTOR or PTOM? |
| | 2 | | | 13.0 | 8,677 | 2,206 | |
| 6 | 1 | FL | West Cactus Peak | 16.0 | 8,740 | 3,512 | PTOM or PTOR? |
| | 2 | | | 17.0 | 9,866 | 3,964 | PTOM |
| 7 | | FL | Sugarloaf Mountain | 22.1 | 15,228 | 3,098 | PTOM? U? |
| 8 | | BT | West Cactus Peak | 18.2 | 11,308 | 4,543 | PTOM |
| 9 | 1 | BT | Joshua Ridge | 18.9 | 14,938 | 4,534 | ?, U |
| | 2 | | | 20.1 | 19,896 | 5,127 | ?, U |
| 10 | 1 | BT | West Cactus Peak | 14.2 | 6,884 | 2,766 | PTOR? |
| | 2 | | | 20.1 | 13,793 | 5,541 | PTOM |
| 11 | | BT | Sugarloaf Mountain | 20.0 | 12,472 | 2,538 | PTOM |
| 12 | 1 | BT | Sugarloaf Mountain | 9.1 | 2,582 | 528 | PTOR? |
| | 2 | | | 20.3 | 12,849 | 2,614 | PTOM |
| 13 | 1 | FL | Fish Springs | 10.0 | 8,271 | 1,799 | U, UHR? |
| | 2 | | | 21.3 | 37,525 | 8,134 | U, UHR? |
| 14 | | FL | West Cactus Peak | 21.0 | 15,056 | 6,048 | PTOM? |

NOTES: All but the Fish Springs specimen are from the Coso Volcanic Field. Data are from Rogers (2016) and Rondeau (2009a).

KEY: ? = indeterminate, unknown; BT = basally thinned; FL = fluted; LT = longitudinal thinning; PTOM = probable time of manufacture; PTOR = probable time of reworking; SD = standard deviation (after Rogers 2016); U = unreliable; UHR = unreliable hydration rate.

This band might reflect the time of manufacture, but the calculated age is almost certainly too old. Although the age range at one sigma would be 22,035–13,109 cyb2k, and it is conceivable that the true age lies near the low end of

**Table 4.** Hydration Data Related to Times of Tool Production.

| **Specimen No.** | **Cut No.** | **LT** | **Geologic Source** | **Mean OH Rim (μ)** | **Calc Age (Years before A.D. 2000)** | **Age SD (Years)** | **1-Sigma Range (Years before A.D. 2000)** |
|---|---|---|---|---|---|---|---|
| 1 | 2 | FL | West Sugarloaf | 15.3 | 12,018 | 3,054 | 9,864–15,072 |
| 4 | 1 | FL | West Sugarloaf | 14.6 | 10,944 | 2,781 | 8,444–13,200 |
| | 2 | | | 14.8 | 11,246 | 2,858 | Age likely marks the time of extensive rejuvenation |
| | 3 | | | 14.9 | 11,398 | 2,997 | |
| 5 | 1 | FL | West Sugarloaf | 13.0 | 8,677 | 2,206 | 6,471–10,883 |
| | 2 | | | 13.0 | 8,677 | 2,206 | Age probably relates to the time of reworking |
| 6 | 2 | FL | West Cactus Peak | 17.0 | 9,866 | 3,964 | 5,902–13,830 |
| 8 | | BT | West Cactus Peak | 18.2 | 11,308 | 4,543 | 6,765–15,851 |
| 10 | 2 | BT | West Cactus Peak | 20.1 | 13,793 | 5,541 | 8,252–19,334 |
| 11 | | BT | Sugarloaf Mountain | 20.0 | 12,472 | 2,538 | 9,934–15,010 |
| 12 | 2 | BT | Sugarloaf Mountain | 20.3 | 12,849 | 2,614 | 10,235–15,463 |

Notes: All specimens are from the Coso Volcanic Field. Data from Rogers (2016) and Rondeau (2009a). BT = basally thinned; FL = fluted; LT = longitudinal thinning; SD = standard deviation (after Rogers 2016).

this range, we make no such claim. The rejuvenated but "complete" point, Specimen 4 (Figures 2 and 3), shows remarkably consistent rim measurements of 14.6, 14.8, and 14.9 μ, for which the respective calculated ages are 10,944, 11,246, and 11,398 cyb2k (Table 3). While it is possible that all three age values approximate the time of original knapping, it seems more likely that the point was thoroughly reworked ca. 11,398–10,944 cyb2k and that initial manufacture had occurred sometime earlier. The fourth artifact of WSL glass, Specimen 5, has two identical hydration values of 13.0 μ, for which an age of 8,677 cyb2k has been calculated (Table 3). Rondeau (2009a) observed that Specimen 5 might have been reworked, but this is uncertain due to weathering, so the age could be that of either initial manufacture or later modification.

Of the four artifacts made of SLM obsidian, two are identified by Rondeau (2009a) as fluted and two as "end thinned" (i.e., basally thinned; Table 3).

Specimen 2 has hydration rims of 24.6 and 15.7 μ, with calculated ages of 18,869 and 7,685 cyb2k, respectively. The former may be associated with the tool's initial production, but surely the date is much too ancient; even at one sigma (3,838 yr) below the midpoint, it would be 15,031 cyb2k and is thus considered unreliable. The next item, Specimen 7, displays a rim thickness of 22.1 μ, for which an age of 15,228 cyb2k has been calculated. At one sigma (3,098 yr) below the midpoint, this would be 12,130 cyb2k, but once again it would be necessary to manipulate the value to force the date into an "acceptable" range. We prefer to see it as it is: anomalously high. Specimen 11 is also represented by a single hydration band (20.0 μ, equivalent to 12,472 cyb2k), which may indicate the time of original manufacture as no reworking is evident. Two hydration rims on the final artifact of SLM glass, Specimen 12, measure 20.3 and 9.1 μ and correspond, respectively, to ages of 12,849 and 2,582 cyb2k. The former is likely the time of initial production, while the latter possibly marks when reworking was done. This cannot be stated with any certainty, however, as no clear trace of post-production flaking was detected on the weathered biface (Rondeau 2009a).

Of the four artifacts of WCP obsidian, Rondeau (2009a) classifies two as fluted and two as "end thinned" points (Table 3). Two cuts into Specimen 6 revealed hydration bands of 17.0 and 16.0 μ, which equate to calculated ages of 9,866 and 8,740 cyb2k, respectively. Only 1,216 years separate these two values, so they both may indicate the approximate time of initial production. Alternatively, the younger age could pertain to subsequent reworking, except that no such modification was detected during the lithic analysis (Rondeau 2009a). Specimen 8 has a rim thickness of 18.2 μ and calculated age of 11,308 cyb2k, likely the time of initial knapping. Two hydration measurements—20.1 and 14.2 μ, respectively corresponding to ages of 13,793 and 6,884 cyb2k—were obtained on Specimen 10. The former age presumably marks the approximate time of original manufacture. The latter could relate to a time when the discarded piece was scavenged and reworked, but once again the weathered artifact yielded no clear indication of post-production flaking. The fourth item of WCP glass, Specimen 14, has a calculated age of 15,056 cyb2k based on a hydration band of 21.0 μ (Table 3). While this age is surely excessive, the hydration rim probably dates from the time when the artifact was first knapped. It is possible that Specimen 14 was reworked (Rondeau 2009a), although we have no pair of hydration measurements to corroborate that tentative observation.

Specimen 9 is an end-thinned point fragment (Rondeau 2009a) of JRR obsidian with hydration measurements of 21.1 and 18.9 μ and calculated ages of

19,896 and 14,938 cyb2k, respectively (Table 3). The larger value, which may correlate with the time of original knapping, seems much too old. Nor can we account for the significantly younger, but still quite ancient, date of nearly 15,000 years. With respect to accuracy, both dates seem unreliable. Finally, Specimen 13, a fluted point fragment of Fish Springs obsidian, is perhaps the most enigmatic of all the analyzed artifacts in that its hydration measurements of 21.3 and 10.0 μ yielded calculated ages of 37,525 and 8,271 cyb2k, respectively. Perhaps the hydration rate employed for Fish Springs glass (Rogers 2016:10) is unreliable. In any event, we find the ages—especially the older one—inexplicable.

## Discussion

One aim of this article is to determine the ages of the 14 F/BTC-BBPs. Towards this end, we measured the obsidian hydration rims on 24 thin sections cut from the 14 artifacts and calculated the age of each (Table 3). These artifacts represent five geologic sources—Fish Springs and four geochemically distinct "subsources" (JRR, SLM, WCP, and WSL) within the Coso Volcanic Field. Their hydration measurements range between 3.2 and 24.6 μ, with corresponding ages of 526–37,525 cyb2k—an array that initially seems bewildering in its variability. Obviously, not all of the rims mark the time of initial manufacture, so part of our task here is to distinguish the rims linked to original tool production from those that resulted from later reworking or from other causes.

As noted above, we exclude the ages for cuts 13-1 and 13-2 because the Fish Springs hydration rate seems to be unreliable. We also omit the ages derived from cuts 2-2, 3, 7, 9-1, 9-2, and 14, all of which are deemed unacceptably old (14,939–19,896 cyb2k; Table 3). Further, we eliminate the hydration rims on cuts 1-1, 2-1, 10-1, and 12-1, each of which is substantially thinner (younger) than the other measured rim on the same specimen and most likely attests either to reworking a scavenged piece long after initial tool production or to some other unknown factor. This leaves 12 hydration measurements on eight artifacts: cuts 1-2, 4-1, 4-2, 4-3, 5-1, 5-2, 6-1, 6-2, 8, 10-2, 11, and 12-2 (Tables 3 and 4). Of these, the three hydration readings on Specimen 4 are so similar to one another (14.6–14.9 μ = 10,944–11,398 cyb2k) that the mean age (11,196 cyb2k) probably marks the time when the piece was extensively rejuvenated; thus, the date of initial production must have been earlier.

The calculated age midpoints of hydration rims at cuts 1–2, 8, 10–2, 11, and 12–2 are arrayed from 11,308 to 13,793 cyb2k, and the one-sigma age ranges of two other specimens (4 and 6) overlap this same time span (Table 4). As discussed above, the three calculated ages for Specimen 4 (mean of 11,196 cyb2k) appear to mark the time of rejuvenation; however, these ages are so close to the younger end of the range of initial production dates that it seems likely that not much time elapsed between manufacture and reworking of the point. Lastly, the two thin sections from Specimen 5 yielded identical ages of 8,677 cyb2k, which may represent either the time of initial production or reworking. These data suggest that Specimens 1, 8, 10, 11, and 12 were originally knapped at times between approximately 13,793 and 11,308 cyb2k, and that Specimen 4 was first made sometime before about 11,196 cyb2k.

As shown in Table 4, the mean ages of the four basally thinned points (as identified by Rondeau 2009a) range from 11,308 ± 4,543 to 13,793 ± 5,541 cyb2k, and the corresponding ages of the four fluted points are arrayed from 8,677 ± 2,206 to 12,018 ± 3,054 cyb2k. Of the latter artifacts, Specimen 4 is definitely reworked and Specimen 5 may be, leaving only two fluted points (1 and 6) with assumed initial production ages of 12,018 ± 3,054 and 9,866 ± 3,964 cyb2k, respectively. Because the samples are exceedingly small and the one-sigma age ranges overlap, we are unable to demonstrate any significant age difference between the fluted and the basally thinned artifacts.

In his statistical characterization of the 14 subject artifacts (but excluding the hydration values measured at cuts 1-1, 2-1, 10-1, 12-1, and 13-2; see Table 3), Rogers (2016:7–8) reports that: (1) the concave-base points of obsidian, taken together, “exhibit an age of 12,569 ± 4,422 cyb2k, with a probable error of the mean of 1996 years”; (2) the mean age for fluted points ($N = 13$ cuts) is “12,043 cyb2k, with a standard deviation of the means of 3,410 years and a sample standard deviation of 4,477 years”; and (3) the mean age for the non-fluted points ($N = 6$ cuts) is “13,709 cyb2k, with a standard deviation of the means of 1,812 years and a sample standard deviation of 4,301 years.”

Any attempt to compare the antiquity of the Borden concave-base points with those of the Clovis tradition is made difficult not only by inconsistencies among the calculated ages given above but also by the wide range of dates assigned to Clovis artifacts and the current debate among scholars as to the timing of the Clovis floruit. It is increasingly evident that both the upper and lower limits of the Clovis era are being pushed outwards. Regarding the former, for example,

> radiocarbon dates of 13,325–13,440 cal BP from the *El Fin del Mundo* gomphothere kill site in Sonora, Mexico (Hill 2015:6; Sanchez et al. 2014) and 12,800–13,250 cal BP on the Clovis-related Anzick burial in Montana

> (Knudson 2015:13; Rasmussen et al. 2014) support a longer chronology (Madsen 2015:219). Moreover, the Richey (a.k.a. Richey-Roberts) cache of >59 Clovis stone and bone artifacts (Gramley 1993; Kilby and Huckell 2013; Lyman, O'Brien, and Hayes 1998; Mehringer 1988) from East Wenatchee in central Washington was in contact with volcanic ash (Mehringer and Foit 1990) which has been identified as Glacier Peak G/B tephra dating to 11,600 $^{14}$C yr BP—an age, at 2 sigma, of 13,710–13,410 cal yr BP (Kuehn et al. 2009). This date, however, may be earlier than the cache (Beck and Jones 2010:87) [Moratto et al. 2017:268–269].

Regarding later manifestations of Clovis, Miller et al. (2013:215), who define the age range of "Classic Clovis" as from ~13,400 until ~12,700 cal yr B.P., also recognized two principal variants of Clovis: (1) Northeastern Fluted, extending from New York to the Maritime Provinces of Canada, and dating from ~12,700 cal yr B.P. to ~11,900 cal yr B.P., thus overlapping very late Classic Clovis; and (2) Western Fluted, which "shares technological traits with Classic Clovis but also varies in morphology." Age control is said to be very poor for the Western Fluted variant, but, like Northeastern Fluted, "it probably evolved from and is younger than Classic Clovis" (Miller et al. 2013:215). Very few Clovis or Clovis-like points in California have been found in stratified and precisely dated contexts. Recently, however, Moratto et al. (2017) reported radiocarbon dates of 10,200–9,970 $^{14}$C yr B.P. (11,900–11,400 cal yr B.P.) for a Clovis point found deeply buried at a site near Twain Harte in the central Sierra Nevada, suggesting that Clovis technology might have persisted in California well beyond the end date of the "short chronology" proposed by Waters and Stafford (2007; i.e., ca. 11,050 to 10,800 $^{14}$C yr B.P., or 13,250–12,800 to 13,125–12,925 cal yr B.P.).

One or more additional Clovis variants are represented farther north. For example, fluted or basally thinned lanceolate points have been found in stratified contexts at Charlie Lake Cave in interior British Columbia (Driver et al. 1996; Fladmark et al. 1988) and at Alaskan sites (Bever 2006; Goebel et al. 2013; Goebel and Buvit 2011; Hoffecker 2011) that appear to be a millennium or more younger than "classic" Clovis sites. When viewed collectively, these findings suggest that Clovis or Clovis-like technologies persisted in the Northeast, Arctic, Northwest, and Far West for much longer than previously believed. So, while many Clovis components in North America have been dated (Haynes 2005; Miller et al. 2013; Stanford and Bradley 2012; Waters and Stafford 2007; but cf. Fiedel 2015 and Prasciunas and Surovell 2015), the lower and upper temporal boundaries of the Clovis period have yet to be established firmly—at least in some regions of the continent (Moratto et al. 2017:268–269).

For now, the best summation we can offer is that some, perhaps most, of the F/BTC-BBPs of obsidian in the Borden collection seem to be temporally coincident with the broader range of $^{14}C$ ages determined for Clovis and Clovis variant assemblages elsewhere in North America (cf. Beck and Jones 2013; Haynes 2005; Haynes et al. 2007; Stanford and Bradley 2012). This terminal Pleistocene to earliest Holocene dating is also consistent with the obsidian hydration ages calculated for the fluted and/or basally thinned concave-base points, typologically similar to the Rose Valley specimens, that have been recovered from Courtright Reservoir in the central high Sierra Nevada (Johnston et al. 2007), Tulare Lake in the San Joaquin Valley (Garfinkel et al. 2008), and the Borax Lake site (CA-LAK-36) in Lake County (Fredrickson and Origer 2002; Fredrickson and White 1988; Meighan and Haynes 1970; Meighan et al. 1974). Also, five Clovis or Clovis-like points were found recently at China Lake. Two are of obsidian (1 of WCP glass and the other from an unknown source). Neither could be hydration-dated (Yohe and Gardner 2016).

A fluted point base of Coso obsidian found at the Rose Spring site (CA-INY-372), less than 8 km north of Rose Valley, yielded a hydration rim of only 9.2 μ for which an age of not more than 5950 years was estimated, suggesting either that the artifact is not Clovis or that the hydration dating is problematic (Yohe 1992:234–235). More pertinent is a Clovis point base of Bodie Hills obsidian, found in Rose Valley, which displayed a hydration rim of 10 μ (on three thin sections), resulting in an age of 13,500 cyb2k (Binning and Garfinkel 2011). The calculated ages of the Borden artifacts are also consistent with their discovery on the surface of landforms associated with Younger Dryas and very early Holocene wetlands (cf. Rosenthal et al. 2017). Determining whether these fragmentary artifacts represent “classic” Clovis points, or perhaps a local variant derived from Clovis antecedents, would require a larger sample of more complete specimens than was available for this study.

## Conclusions

In this article, we have examined 14 fluted or basally thinned, concave-base, bifacial points that were surface-collected by Ferris and Helen Borden during the 1960s and early 1970s at sites in Rose Valley, Inyo County, California. The artifacts are all made of obsidian, one from Fish Springs and 13 from four geologic subsources within the Coso Volcanic Field: West Sugarloaf (4), Sugarloaf Mountain (4), West Cactus Peak (4), and Joshua Ridge (1). Analyses of lithic technology and morphology indicate that these specimens are either Clovis or Clovis-like points, possibly attributable to the Western Fluted variant.

To date the items, we measured obsidian hydration rims on 24 thin sections cut from the 14 artifacts and calculated an age for each. The measurements ranged between 3.2 and 24.6 μ, equivalent to ages ranging between 526 and 37,525 cyb2k. After eliminating readings deemed too old, too young, internally inconsistent, or otherwise equivocal, the data suggest that Specimens 1, 8, 10, 11, and 12 were originally knapped at times between about 13,793 and 11,308 cyb2k, and Specimen 4 was produced sometime before about 11,196 cyb2k. Given the exceedingly small samples and the overlapping age ranges at one sigma, we found no significant age difference between the fluted and basally thinned points. In general, the calculated ages of these six specimens is partly concordant with the established age range of “classic” Clovis elsewhere in North America but also extend a half millennium or more into the early Holocene.

## *Acknowledgments*

We are grateful to the Maturango Museum for providing access to the Borden collection, Paul Brandy for creating Figure 1, and Michael Rondeau for the photos appearing as Figures 2 through 5. Brian Dillon kindly prepared the Spanish translation of our abstract. We also thank two anonymous reviewers for their helpful comments on the draft, and Terry Jones, Jill Gardner, and Shelly Davis-King for their assistance in publishing this article.

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