



ORIGINAL ARTICLE

Historical dendroarchaeology of two log structures in the Valles Caldera National Preserve, New Mexico, USA



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ABSTRACT

We used dendroarchaeological techniques to determine the year of construction of two historic structures in the Valles Caldera National Preserve of New Mexico, USA. Historical documents date some structures in the headquarters area of the Preserve, but the Commissary Cabin and Salt Barn were lacking conclusive construction dates. Both structures were originally thought to have been built by the Otero family who bought the property in 1899. We found that the structures were built from two tree species, white fir (*Abies concolor* (Gordon) Lindl. ex Hildebr.) and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), surprising given that ponderosa pines are also found in great numbers in the adjacent forest. Tree rings from 20 logs were confidently crossdated both graphically and statistically and provided cutting dates of trees in both structures of 1940 and 1941 when compared against the Fenton Lake reference chronology (Commissary Cabin: $r = 0.69$, $t = 15.54$, $p < 0.0001$, $n = 263$ years; Salt Barn: $r = 0.77$, $t = 11.7$, $p < 0.0001$, $n = 232$ years). By combining the cutting date years and terminal ring attributes, we suggest that both structures were built in the spring or early summer of 1941 using freshly cut logs and logs that had been cut the previous spring (1940, before or during the growing season) and stockpiled. The cutting dates of 1940 and 1941 indicate that these buildings were constructed during the Franklin Bond (1939–1945) era and associated with the transition from sheep ranching to more modern cattle grazing. These new dates provide a more distinct understanding of the cultural resources at the Valles Caldera National Preserve and provide interpretative staff with more accurate information that can be given to the public.

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Introduction

Tree-ring dating of historic-period structures has a long history in Europe (c.f. Hillam, 1992; Baillie, 1995; Hillam and Groves, 1996; Hurni and Orsel, 1996). Dendroarchaeology has also often been applied to dating the years trees were harvested and subsequently used to build historic-period (post-AD 1600) structures in the eastern US (Grissino-Mayer and van de Gevel, 2007; Harley et al., 2011; DeWeese et al., 2012; Grissino-Mayer et al., 2012; Therrell and Stahle, 2012). Numerous studies have also demonstrated that

early Euro-American settlement structures can be dated via tree rings in the American Southwest (e.g. Scantling, 1940; Ames, 1972; Robinson, 1985; Towner and Creasman, 2010). Such studies are discernibly fewer in number in the Southwest not because such structures are lacking, but because researchers have emphasized the importance of dating prehistoric rather than historic structures via tree-ring dating over the decades (Nash, 1999). Dendroarchaeology is an important technique for verifying, confirming, and in some cases, refuting structure dates derived from documentary or oral history sources. In addition dendroarchaeological research yields information on species selection, wood use and modification practices, and repair and remodeling episodes that are rare in documents or human memories (Dean, 1996; Towner, 2002).

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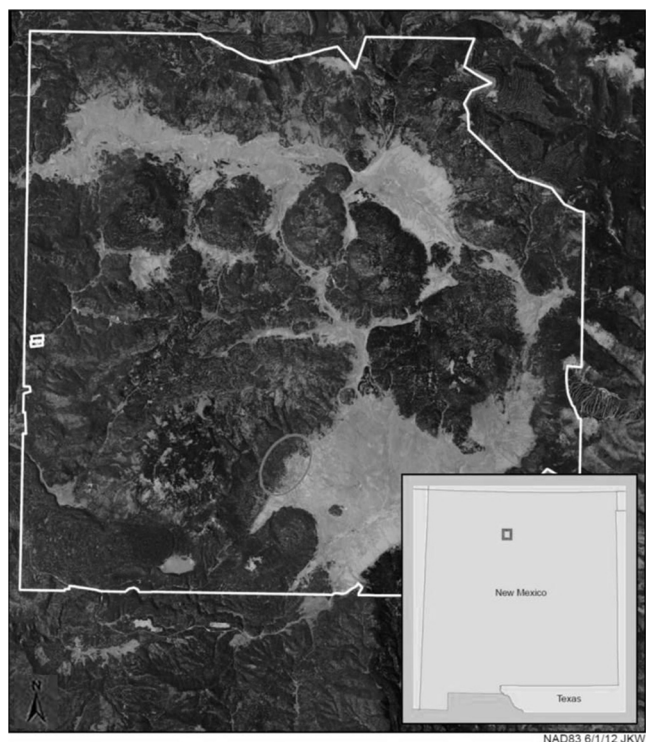


Fig. 1. The Valles Caldera and location of the Baca Ranch Headquarters area (oval).

An opportunity arose in 2012 when the Valles Caldera National Preserve (VCNP) hosted the North American Dendroecological Fieldweek (NADEF) where land managers, researchers, and students from across North America gathered to learn techniques and methods related to dendrochronology. One group at the 2012 NADEF concentrated on teaching and learning dendroarchaeological techniques by applying these techniques to develop dates of construction of two historic structures in the VCNP known as the Commissary Cabin and the Salt Barn. Although historical documents have provided dates for some structures in the VCNP, these two structures were lacking conclusive construction dates and associated historical/socioeconomic contexts. We had two specific objectives in this project: (1) determine the construction dates of these two log structures in the VCNP using dendrochronological techniques to obtain the years of harvesting for the trees used to build the two structures and (2) compare these dates to the known historical documentation for the VCNP to better understand who built these structures and for which purpose these structures may have served.

Setting and historical background

The VCNP is in a volcanic caldera covering 36,219 ha at the center of the Jemez Mountains in northern New Mexico, USA (Fig. 1). The caldera lies between 2400 and 3430 m in elevation and supports ponderosa pine (*Pinus ponderosa* Douglas ex C. Lawson), Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), white fir (*Abies concolor* (Gordon) Lindl. ex Hildebr.), pinyon pine (*Pinus edulis* Engelm.), and juniper (*Juniperus communis* L. and *Juniperus scopulorum* Sarg.). The land has served as pasture for livestock since the 1820s when the Baca family took ownership as a land grant from the Mexican Government. The Baca Location No. 1 land grant has been a working ranch since at least 1860 (Anschuetz and Merlan, 2007) after the area was incorporated into the United States as the territory of New Mexico. Previous investigations into

the historical significance of the Salt Barn and Commissary Cabin centered around their association with *partido* system sheep ranching in the Valles Caldera during the first half of the 20th century. The *partido* system was a system of lending capital, in the form of sheep, at interest. The system persisted in New Mexico from the early 18th century until after World War II (WWII). The *partido* system involved a contract between a *partidiario* (the sharecropper) and a *patron* (owner) who provided a loan of sheep and the use of pasture. The contract required the *partidiario* to return a percentage of the annual increase in the herd and a percentage of sheared wool, as well as compensate losses (Martin, 2003; Anschuetz and Merlan, 2007).

Mariano Sabine Otero, his son Frederico J. Otero, and Frank Bond were the land owners most responsible for the introduction and maintenance of the *partido* system in the Baca Location from the late 19th Century until the end of WWII. The Otero family acquired the Baca Location in 1899, and soon after the Valles Land Company began using the area as summer pasture for livestock (Martin, 2003). In 1909, F.J. Otero sold the Baca Location to the Redondo Development Company, but he and his family continued to lease the pasture until 1917. In 1918, the G.W. Bond and Brothers Company purchased the Baca Location and began making improvements. The Bonds discontinued access to grazing pastures for cattle and horses owned by local Pueblo people but continued to allow traditional uses, such as plant and mineral gathering (Anschuetz and Merlan, 2007). After 1918, Frank Bond amassed large holdings of public and private grazing land which forced many small ranchers and herders to sign *partido* contracts (Anschuetz and Merlan, 2007). By 1939, Frank Bond's son, Franklin, assumed more responsibility for the family's ranching operations in northern New Mexico and diversified their operations by adding cattle. Wool demand declined at the end of WWII, encouraging Franklin Bond to add even more cattle to their grazing operations. In 1945, Franklin Bond's son, Frank Bond, entered into more lease agreements with cattle ranchers who did not continue the *partido* system contracts. The trend to more modern style contracts with cattle ranchers continued through the 1950s, and over the course of the decade the number of cattle at the Baca Location increased by as much as 140% (Anschuetz and Merlan, 2007). After Franklin Bond's death in 1954, outside ranchers leased the Baca Location pasture, and the ranching era ended by 1963 when James Patrick Dunigan purchased the Baca Location. For the remainder of the 20th century, the Valle Caldera was the subject of lawsuits involving Dunigan and various logging interests over logging practices and revenues (Anschuetz and Merlan, 2007), until Dunigan's death in 1980. Finally, the U.S. Government acquired the land as part of the Valles Caldera Preservation Act of 2000, which created the Valles Caldera Trust to protect the Preserve's natural and cultural resources and provide interpretations to the public (http://www.vallescaldera.gov/about/trust/trust_ref.aspx).

The structures

The Commissary Cabin and the Salt Barn are among a number of structures located in the historic district of the Baca Ranch Headquarters of the VCNP (Fig. 2). The Commissary Cabin (LA136351) (Fig. 3) is an east-facing, single-story, single-room rectangular structure located in the Baca Ranch Headquarters historic district which was used as a supply shop for the sheep and cattle ranchers from the area. The cabin was constructed with peeled horizontal logs with saw-cut ends that were joined by double-saddle notching. One notable feature on the south wall of the cabin is a large shuttered window, likely used as an area to transfer goods without entering the building. The main entry on the east side of the cabin

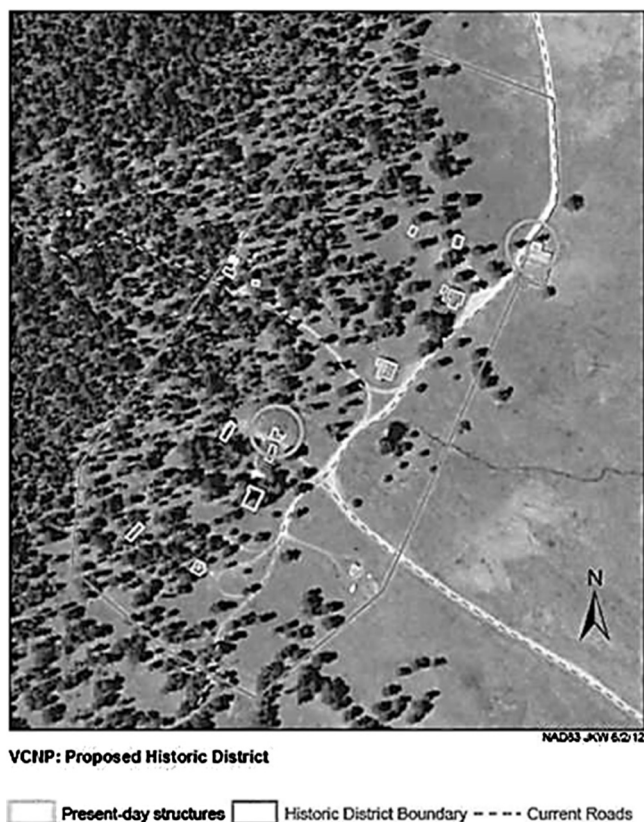


Fig. 2. The historic district of the Baca Ranch Headquarters. The Commissary Cabin (left) and Salt Barn (right) are circled.



Fig. 3. The Commissary Cabin showing the large opening (on the south wall to the left) from which ranch hands could purchase supplies. The sill log supporting the porch is the oldest log sampled for this study with an inside ring of 1675.

is covered with a substantial amount of graffiti written or carved by ranchers and dating from the 1950s to the 1970s. The Salt Barn (LA137539) (Fig. 4) is a south-facing, single-story, double-pen, rectangular structure also located in the Baca Ranch Headquarters area of the VCNP. The barn was believed to be used for storing saddle tack and for stabling horses. The barn was constructed with unhewn horizontal logs with saw-cut ends that were joined by double-saddle notching (Dennison et al., 2007).



Fig. 4. The Salt Barn showing the “middle wall” separating the main tack room on the left from the smaller stable to the right. The oldest tree found in this structure is the large sill log in the lower right corner with an inside ring of 1710.

Methods

Field methods

All logs and core samples were treated as archaeological materials. We visually inspected both structures and recorded detailed information on the location of each log within the structure and specific attributes (estimated number of rings, preservation quality, internal scars present, etc.) that enabled us to select logs most suitable for tree-ring dating. Those logs that displayed >ca. 50 rings and with bark or the outside rings still intact were sampled using a hollow drill bit 1.3 cm in cutting diameter and 25 cm in length attached to a variable-speed electric hand drill. Cores were labeled based on the structure (CC: Commissary Cabin, SB: Salt Barn) and the log number beginning at “01” for the lowermost (“sill”) log. Multiple cores from the same log were assigned a letter following the core number starting with “A” to delineate cores from the same log. We recorded the cardinal direction of the wall from which each core was extracted and whether the core came from the basal (lower) and distal (upper) portions of the tree stem. We also noted the presence/absence of beetle galleries, bark, patination (a “shiny” surface on wood that occurs at the interface of xylem and phloem, just underneath the bark), nail art, and tool marks from debarking, shaping, and notching. Cores with corresponding sample IDs were used to plug the core holes.

Lab methods

The cores were mounted on wooden core mounts and sanded with a belt sander using progressively finer sandpaper beginning with 80-grit and ending with 400-grit until the cellular features on all rings could be easily identified under 10× magnification (Orvis and Grissino-Mayer, 2002). To facilitate measuring and crossdating, we annotated the tree rings by assigning the innermost complete ring on each core the number 1, then marked every tenth ring with a single dot, every 50th ring with two dots, and every 100th ring with three dots (Stokes and Smiley, 1996). We next created hand-drawn skeleton plots that highlighted the narrower rings on each core and used these to begin the graphical crossdating exercise by aligning the common narrow rings observed on each core for each structure (Glock, 1937; Swetnam et al., 1985; Speer, 2010). We also created a master skeleton plot for each structure by “compositing” the narrow rings to a new plot. We measured the tree-ring widths

Table 1
Descriptive statistics for the Commissary Cabin and Salt Barn tree-ring series.

Structure	Years	Dated logs	Segments tested ^a	Segments flagged ^a	Interseries correlation	Mean sensitivity	Corr. w/NM587
Commissary Cabin	1675–1941	11	59	2	0.748	0.319	0.677
Salt Barn	1709–1941	8	46	3	0.689	0.328	0.704

^a Number of segments tested and flagged by COFECHA.

on all cores using a Velmex movable stage micrometer to the nearest 0.001 mm and recorded the measurement with Measure J2X software.

To eventually date these undated series absolutely in time using both the graphical (skeleton plots) and statistical (COFECHA) techniques, we used the NM587 reference Douglas-fir tree-ring chronology (Fenton Lake) obtained from the International Tree-Ring Data Bank (ITRDB). This reference chronology was the most local Douglas-fir chronology and was chosen for its proximity to the structures (<16 km). The software program COFECHA (Holmes, 1983; Grissino-Mayer, 2001) was used to perform the initial statistical crossdating of the undated cores by dating each tree-ring series against all others for both structures. We tested 40-year segments (with 20-year overlaps) on each series by calculating correlation coefficients for each segment. Significant coefficients and the temporal placements suggested by COFECHA were carefully evaluated to ensure they corroborated the results from the graphical comparisons because crossdating has to be convincing both graphically and statistically (Grissino-Mayer, 2001).

After all tree rings from both structures were crossdated, the outermost ring of each core was carefully examined to determine the terminal ring attributes. The following standard symbols for these rings were used (Bannister, 1962; Bannister et al., 1966; Nash, 1999):

B: Bark and a fully intact outer ring are both present (indicating a certain cutting date).

r: The outermost ring is continuous and intact around a smooth surface, but no bark is present (considered a cutting date). The evaluation of a smooth outer surface on the log was made in the field.

L: Patination on wood was observed, indicating the last ring formed is present (considered a cutting date).

v: The presence of sapwood (indicating a near cutting date).

vv: Exterior rings have been removed from the sample by natural (erosion) or cultural (shaping, debarking, etc.) processes; it cannot be determined how far the outer ring is from the true outer surface (a non-cutting date).

++: Although a sample crossdated for a period, a ring count was necessary on the outermost rings because these no longer crossdated for the last decade or more of the ring series.

Results

We extracted cores from 40 logs from the two structures and identified the species of trees used as white fir (21 logs) and Douglas-fir (19 logs). Of the 40 logs, 19 could be confidently crossdated both graphically (skeleton plots) and statistically (COFECHA), representing 15 Douglas-fir and 4 white fir logs. The white fir logs represented younger trees and therefore produced short cores with tree-ring patterns that were more complacent than the Douglas-fir. Both species, however, are responding to the same environmental parameters in this area and crossdate with each other. Martin (2003) earlier suggested that the logs used to construct one of the cabins were made from pine, a reasonable suggestion given the ubiquity of ponderosa pine across the landscape. However, no pines were used in the construction of either structure. The choice of

species used is somewhat surprising because ponderosa pine and Douglas-fir are most common in the vicinity of the structures today while white fir is prevalent only in the higher elevations above and some distance from the two structures.

We extracted cores from 25 logs from the Commissary Cabin. Of those, 12 were white fir and 13 were Douglas-fir. The average interseries correlation for tree-ring series from the Commissary Cabin was 0.67 and the average mean sensitivity (a year-to-year measure of variability) was 0.32. We extracted cores from 15 logs from the Salt Barn; 9 white fir and 6 Douglas-fir. The average interseries correlation for tree-ring series from the Salt Barn was 0.70 and the average mean sensitivity was 0.33. The summary statistics (Table 1) for the Commissary Cabin and Salt Barn strongly suggest successful internal crossdating and a sufficient level of variability due to year-to-year climatic variations suitable for crossdating. Of 105 40-year segments tested by COFECHA in the two data sets, only five (4.8%) were flagged as problem segments (with correlations below the acceptable statistical level) that needed to be reevaluated (Table 1). Visual inspection of the flagged segments, however, indicated correct temporal placements of the assigned dates. A comparison of the two chronologies showed convincing matches with the Fenton Lake reference chronology (Fig. 5). Crossdating the chronology from the Commissary Cabin against the Fenton Lake chronology revealed a statistically significant match that anchored the cabin floating chronology from AD 1679 to 1941 ($r=0.69$, $t=15.54$, $p<0.0001$, $n=263$ years). Crossdating the chronology from the Salt Barn against the Fenton Lake chronology revealed a statistically significant match that anchored the barn floating chronology from AD 1710 to 1941 ($r=0.77$, $t=11.7$, $p<0.0001$, $n=232$ years). The chronologies from the Salt Barn and the Commissary Cabin also crossdated at a high level of statistical significance ($r=0.61$, $t=11.52$, $p<0.0001$, $n=232$ years) for the period common of both chronologies (1710–1941).

Outer ring dates

The Commissary Cabin was constructed over a short period based on cutting dates for the logs that range from 1939 to 1941 (Table 2). Logs with the two 1939 cutting dates (samples NMI-166 and NMI-170) have complete terminal rings indicating the logs were procured sometime after the end of the 1939 growing season, but before the initiation of growth in 1940. Two logs with 1940 cutting dates (NMI-151 and NMI-168) lacked latewood and were cut during the 1940 growing season. Two other logs with 1940 cutting dates (NMI-156 and NMI-160) displayed what appeared to be complete latewood and were likely cut after the 1940 growing season. Two logs with 1941 cutting dates (NMI-162 and NMI-164) had incomplete terminal rings and were procured during the growing season of 1941. Finally, one log (NMI-161) had what appeared to be a complete ring for 1941 and was likely cut after the end of the 1941 growing season.

The outer ring dates for the Salt Barn (Table 3) range from 1940 to 1941 and indicate construction also in the late spring/early summer of 1941. Although no studies have been conducted on the phenology of local tree species, the Douglas-fir growing season in other areas of the Southwest typically begins in early May and ends by late June or early July (Dean and Warren, 1983). By combining

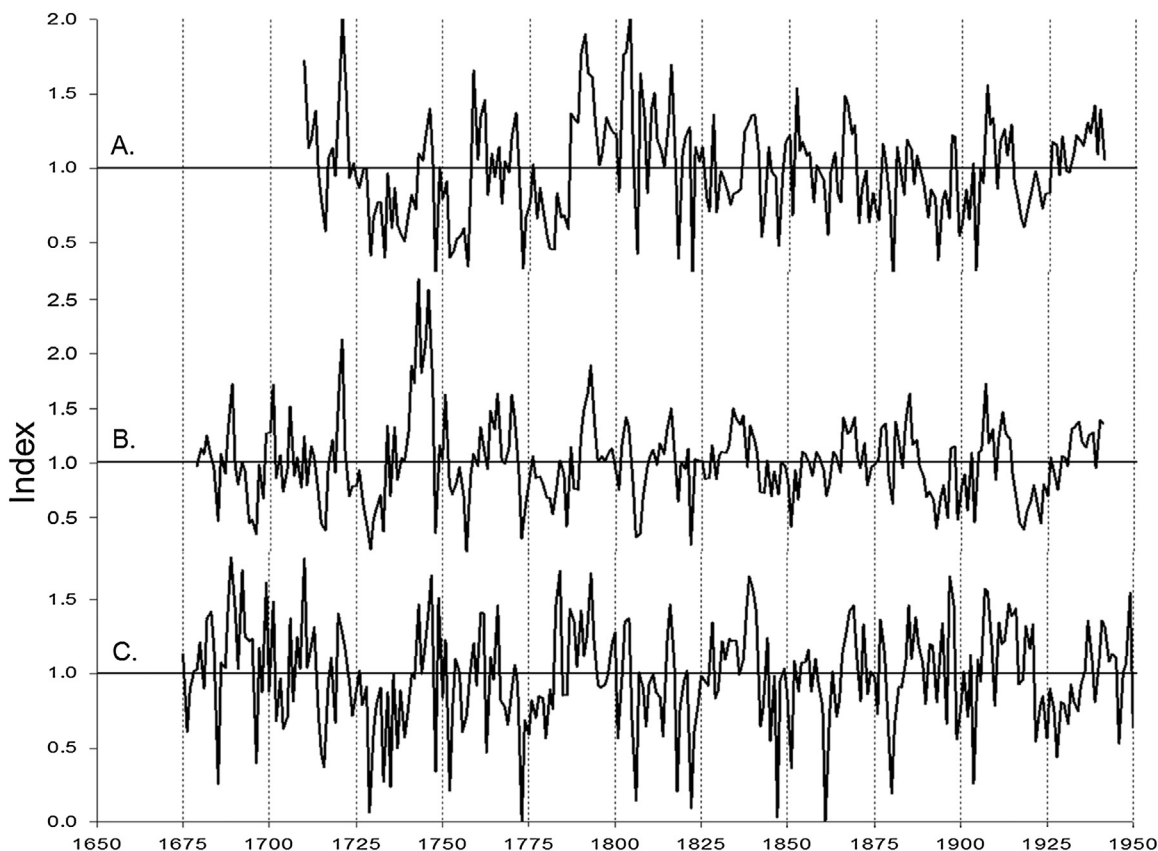


Fig. 5. Tree-ring chronologies for the (A) Salt Barn and (B) Commissary Cabin compared to the (C) Fenton Lake reference tree-ring chronology, showing a high degree of correspondence in their patterns.

Table 2

Dates and attributes for logs from the Commissary Cabin, Valles Caldera National Preserve.

Sample #	Species ^a	Provenience	Wall and log # ^b	Inside date ^c	Outside date	Outer ring type ^d
NMI-151	DF	Porch sill	East porch	1675 np	1940	G inc
NMI-152	WF	Porch sill	East porch	–	–	–
NMI-153	DF	Horiz log	E 5	–	–	–
NMI-154	WF	Horiz log	S 1	1853 p	1940	vv
NMI-155	DF	Horiz log	S 3	–	–	–
NMI-156	DF	Horiz log	E 10	1731 p	1940	GB comp
NMI-157	WF	Horiz log	S 5	–	–	–
NMI-158	WF	Horiz log	E 11	–	–	–
NMI-159	WF	Horiz log	S 5E	–	–	–
NMI-160	DF	Horiz log	E 5	1837 p	1940	LB comp
NMI-161	DF	Horiz log	S 8	1861 p	1941	GB comp
NMI-162	DF	Horiz log	E 1	1855 np	1941	B inc
NMI-163	DF	Horiz log	S 7	–	–	–
NMI-164	DF	Horiz log	N 1	1851	1941	r inc
NMI-165	WF	Horiz log	W 6	–	–	–
NMI-166	WF	Horiz log	N 3	1840 np	1939	B comp
NMI-167	DF	Horiz log	W 7	–	–	–
NMI-168	DF	Horiz log	N 20	1855 p	1940	GB inc
NMI-169	WF	Horiz log	W 9	–	–	–
NMI-170	DF	Roof primary	Beam 6	1856 p	1939	B comp
NMI-171	WF	Chinking	W	–	–	–
NMI-172	WF	Roof primary	Beam 3	–	–	–
NMI-173	DF	Horiz log	W 12	1856 np	1939	vv
NMI-174	WF	Horiz log	W 14	–	–	–
NMI-175	WF	Horiz log	W 5	–	–	–

^a WF: white fir; DF: Douglas-fir.

^b Cardinal direction of each wall. Log # counting from sill log at bottom = #1.

^c p: pith; np: near pith.

^d G: beetle galleries present; B: bark present; L: patina indicating outer ring present; comp: complete ring; inc: incomplete ring; r: continuous ring around circumference; vv: unknown number of rings could be missing.

Table 3

Dates and attributes for logs from the Salt Barn, Valles Caldera National Preserve.

Sample #	Species ^a	Provenience	Wall and log# ^b	Inside date ^c	Outside date	Outer ring type ^d
NMI-136	DF	Horiz Log	E 1	1709 p	1940	GB inc
NMI-137	WF?	Horiz Log	N 1	–	–	–
NMI-138	DF	Horiz Log	E 4	1820 p	1941	GB comp
NMI-139	WF?	Horiz Log	N 2	1854	1941	GB inc
NMI-140	DF	Horiz Log	E 2	1805 p	1941	GB inc
NMI-141	WF	Horiz Log	N 5	–	–	–
NMI-142	WF	Horiz Log	S 1	–	–	–
NMI-143	WF?	Horiz Log	N 8	–	–	–
NMI-144	DF	Horiz Log	E 5	1854 np	1940	B inc
NMI-145	WF	Horiz Log	N 10	1857 p	1941	B inc
NMI-146	DF	Horiz Log	M 4	1880 np	1941	r inc
NMI-147	WF?	Horiz Log	S 9	–	–	–
NMI-148	DF	Horiz Log	M 1	1764	1941	GB inc
NMI-149	WF	Horiz Log	Floor 3	–	–	–
NMI-150	WF	Horiz Log	Floor 4	–	–	–

^a WF: white fir; DF: Douglas-fir.^b Cardinal direction of each wall. Log # counting from sill log at bottom = #1. “M”: middle wall.^c p: pith; np: near pith.^d G: beetle galleries present; B: bark present; L: patina indicating outer ring present; comp: complete ring; inc: incomplete ring; r: continuous ring around circumference; vv: unknown number of rings could be missing.

the cutting date years and terminal ring attributes, we infer that both structures were built in the spring or early summer of 1941 using freshly cut logs and logs that had been cut the previous spring (1940) and stockpiled. Although freshly cut logs may be easier to modify, stockpiling conifer logs reduce weight by one-half to two-thirds after drying (Snygg and Windes, 1998). Therefore, timber weight versus ease of working is a trade-off in terms of labor investment. We assume that, because the samples crossdated with the local ring series, the timbers were procured locally and construction was accomplished using local labor—probably employees of the Bond Ranch.

Discussion

Based on historic references and oral histories, Dennison et al. (2007) reported a construction date of 1909 for the Commissary Cabin (based on Martin, 2003) and the 1910s for the Salt Barn (based on Martin, 2002). Those dates would link the structures with Federico J. Otero and would make them the oldest buildings on the VCNP. Dennison et al. (2007), however, also reported a possible year of construction of 1934 for the Commissary Cabin based on an oral account provided by ranch foreman Richard Boyd. This later date appears more likely in part because examination of aerial photography from 1935 shows a structure in the general vicinity of the Commissary Cabin but closer to the road than the structure we sampled. We assume the structure was dismantled sometime after the aerial photographs were taken as it was not standing as of 2012. Furthermore, graffiti documented on the inside of the Commissary Cabin door dates to no earlier than 1951.

The cutting dates of 1940 and 1941 indicate that this building was instead constructed during the Franklin Bond era. Anschuetz and Merlan (2007) indicate that Bond's *partido* contracts required *partidarios* to outfit themselves at Bond's store. Given assumptions about the purpose of the large window in the south wall of the structure, the Commissary Cabin may have functioned as a store from which *partidarios* purchased supplies and the cabin is therefore directly associated with the common day-to-day activities, tasks, and interactions between *partidarios* and Bond ranch employees. The fact that graffiti on the Commissary Cabin door dates to the terminal Bond era and later suggests that a change in the use of the building may have occurred around 1953. This date corresponds to the transition from the *partido* system to the

modern cattle ranching executed by outside lessees after Franklin Bond's death.

Based on the cutting dates of 1940 and 1941 and current interpretation of oral histories, the current Salt Barn also was not built during nor associated with the early sheep ranching period of F.J. Otero. Rather, the structure was built during the Franklin Bond era and was used by cowboys to house horses and attendant supplies and tools. The building is also likely associated with the period of transition from sheep ranching under the *partido* system to modern cattle grazing leases. One source of confusion derives from calling this building the “Salt” Barn. It is well known at the VCNP that this name was not the historic designator. Rather, oral interviews taken in recent years indicate that the most common mid-century name for this barn was simply “the corrals.” Interviews with Ruby Hoolihan and Richard Boyd (Dennison et al., 2007) indicate that the “Salt Barn” was constructed after 1934. Ruby Hoolihan described how the current Salt Barn was used to house the “night horse” used by the cowboy whose job it was to round up the other horses each morning.

Conclusions

The Valles Caldera Preservation Act of 2000 directs the Valles Caldera Trust to protect the Preserve's resources and provide interpretations to the public. The cutting dates of 1940 and 1941 represent a significant departure from the previously assumed ages of the Commissary Cabin (ca. 1909) and Salt Barn (ca. 1910s), which were likely related to earlier structures. This changes our knowledge of the historic context for these structures, reassigning them from the Otero era to the Bond era, which impacts how we understand the headquarters area as a whole. These dates will help inform future management decisions about the structures and their surroundings. From an interpretative standpoint, these two structures are popular stops on guided tours; absolute dating of these structures provides interpretative staff with more accurate information that can be given to the public. Furthermore; the holes left from the coring process (filled with labeled corks) also provide staff with an opportunity to discuss dendrochronology and dendroarchaeology as useful research disciplines. The new dates associated with the Salt Barn and Commissary Cabin provide a more distinctive understanding of the cultural resources at the Valles Caldera National Preserve. By combining dendroarchaeological methods with historical documents, oral histories/interviews,

and archaeological surveys, the Trust and the public's understanding and appreciation of the Preserve's history and social dynamics are significantly enhanced.

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