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Uncapped Potential: Applying Firearms Identification Procedures in the Analysis of Percussion Caps

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ABSTRACT

Firearms identification procedures continue to play a role in the archaeological study of battles and warfare. Percussion caps, if well preserved, have the potential to yield unique individual tool marks that can be microscopically examined to determine a minimum number of weapons present at a specific site. This study analyzed 110 percussion caps from an 1854 U.S. Army and Apache battle site and determined that at least 34 firearms were used in the battle. A validation study using modern percussion caps from 11 known weapons was also undertaken to demonstrate the potential for percussion cap analysis in future studies.

Introduction

Physical manifestations of U.S. Army and Apache warfare are abundant in the American southwest and are being actively studied by archaeologists (Adams et al. 2000a, 2000b; Laumbach 2001). One such battle took place on 30 March 1854, the Battle of Cieneguilla, in the mountainous terrain near Taos, New Mexico (Johnson 2003). The battle site was located by Carson National Forest archaeologists and is undergoing inventory and analysis under the supervision of David Johnson. During the metal detector and visual inventory phase, the archaeological team recovered abundant evidence of the fight, including more than 100 percussion caps. The percussion cap (Figure 1) is an external priming device used on a muzzleloading firearm to ignite and fire the powder charge and bullet situated in the bore of a gun (Lucas 1985). Percussion caps were officially adopted as an ignition system in the U.S. Army in 1841 with the introduction of the U.S. percussion musket, Model of 1842, and the "Mississippi" rifled musket, Model of 1841 (Coggins 1990: 31), although the percussion system was used on select military firearms as early as 1833. The percussion cap, in essentially the same form as it was constructed in the 19th century, is still made today and used by blackpowder muzzleloading shooting enthusiasts for hunting and target shooting.

Percussion caps are an untapped analytical resource for archaeologists studying sites where firearms were utilized. These tiny artifacts have the potential to yield information regarding the minimum number of weapons present at a site, and the locations and use of those firearms. Coupled with precise provenience information, the actual movement of firearms across a battlefield or any site with firearms use can be reasonably determined using standard firearms- and tool-mark identification procedures. This study introduces archaeologists to the analytical potential and examination procedures of this underappreciated firearms artifact type.

Percussion Cap Development

Percussion caps were developed in the early-19th century and, like other percussion primers, served to improve upon the flintlock system of firearms ignition. The flintlock system was beleaguered by a high rate of ignition failure due to chronic powder dampness and lack of an adequate spark for ignition. Research conducted

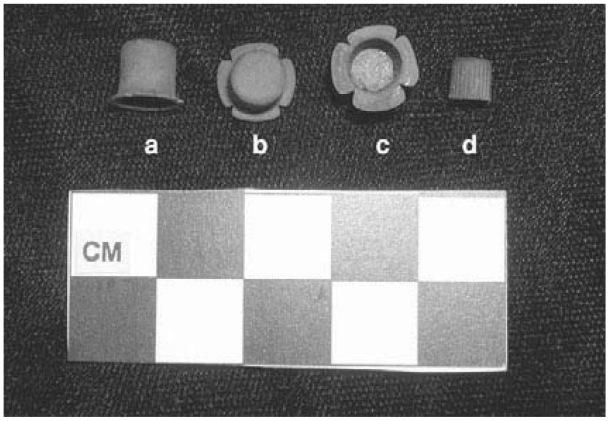

FIGURE 1. Two percussion cap types: "top hat" or musket caps from (*a*) top, (*b*) side, and (*c*) interior view, respectively; (*d*) common or pistol cap with ridged sides. (Photo by Douglas Scott.)

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on explosive materials around the beginning of the 19th century soon moved the flintlock system into retirement.

It is generally agreed that the method of using an explosive compound to ignite gun charges can be attributed to the Reverend Alexander Forsyth of Scotland. Forsyth's and other inventors' experiments and successes at using fulminates and chlorate of potash in the early 1800s gave rise to dozens of patents employing different methods of harnessing this new ignition material (Bailey 2003; Dickens 2003). This significant transition in the use and manufacture of firearms resulted in the creation of many varieties of percussion primers in the form of tubes, pellets, pills, and caps (Gooding 1966b).

A popular and widely accepted design of that era was the percussion cap, consisting of a small open-ended cup containing a slight quantity of igniting compound sealed in place with varnish or another waterproof sealer. The percussion cap was more reliable and easier to use than earlier attempts at percussion primers and began to solidify the movement towards a reliable ignition system. Percussion cap design is most often attributed to British painter Joshua Shaw for his claims of having invented reloadable iron caps about 1814 (*Scientific American* 1869; Gooding 1974, 2004). Shaw received a U.S. patent for his idea in 1822 (Coates and Thomas 1990), but claims of percussion cap conception by European inventors around the same period make it difficult to determine the person deserving true credit for this innovation.

There was no shortage of patents for variations on the percussion cap design. In terms of function, the variations were negligible, focusing mostly on differences in size and material. Caps with ribbed or corrugated sides (Figure 1*d*) became popular as a way of lessening the chance of cap fragmentation upon ignition. These primers became known as "common" caps but are also called pistol caps due to their smaller size and lighter ignition charge being more suitable for pistol or small rifle operation (Gooding 1975). Another well-accepted design was that of the "top hat" cap (Figure 1*a, b, c*), also called the military or musket cap. This cap was developed with wings or protruding sides for easier handling by soldiers wearing gloves. Top hat caps were not exclusively military issue, as sporting versions were also manufactured and are still in production today (Gooding 1966a). Both pistol caps and top hat caps were recovered during the U.S. Forest Service's archaeological inventory and were submitted for analysis in this study.

Manufacture of percussion caps varied slightly depending on individual design, but most required at a minimum nine basic steps: (1) rolling of copper sheets to a proper thickness and excluding those areas with imperfections, (2) an annealing process to ensure malleability, (3) cleaning to eliminate effects of fire or heat during the annealing process, (4) the cutting or punching of sheets of copper into the proper forms, (5) oiling of cutouts to promote ease of machining, (6) formation into the desired shape using a tool-and-die process, (7) removal of oil through the use of sawdust, (8) insertion of an ignition compound, and (9) varnishing to seal the ignition compound (Benton 1867: 350; Whittemore and Heath 1878:20–22; Gooding 1966b). By the mid- to late-19th century, steps one through eight were accomplished at a rate of 31,000 caps per day per machine or workstation, with the finishing touches of varnishing (step nine) accomplished at the rate of 7,000 caps per hour per laborer (Whittemore and Heath 1878:20–22). A manufacturer's stamp was sometimes included in the formation process, further documenting the company or even country or region of manufacture. U.S. Army arsenals that produced percussion caps for military use packaged 10,000 caps per bag and 10 bags per shipping crate to be sent to various arsenals where cartridges were manufactured (Gaede 2004:112–113).

From the 1830s until the late 1860s, when the percussion cap system faded from the U.S. military arsenals, military cartridges were made of combustible paper or linen and packed 10 to a bundle. Included with each 10-pack of cartridges were 12 percussion caps (Gibbon 1860: 368; Gaede 2004:112). Generally, a soldier would place his 10 rounds in a cartridge box, and his percussion caps were placed loose in a leather cap pouch lined with lamb's wool and worn on a waist belt. The ordnance department understood that percussion caps could be dropped during the heat of combat, mishandled when wearing gloves, dropped on cold days, or otherwise lost in service, thus the rationale for including two extra caps per 10 cartridges.

Once employed in the field, use of the percussion cap is a simple process. The cap is placed over the nipple or cone on the firearm and struck by the hammer (Figure 2), causing ignition of the compound, which is channeled by way of a small flash hole in the tip of the nipple to the powder charge residing in the barrel itself (Benton 1867: 296). After discharge of the firearm, the used cap is discarded (Figure 3), the barrel is reloaded with fresh powder and a projectile, and a new cap is placed over the nipple for the next fusillade.

FIGURE 2. A musket cap in firing position on a military musket. (Photo by Douglas Scott.)

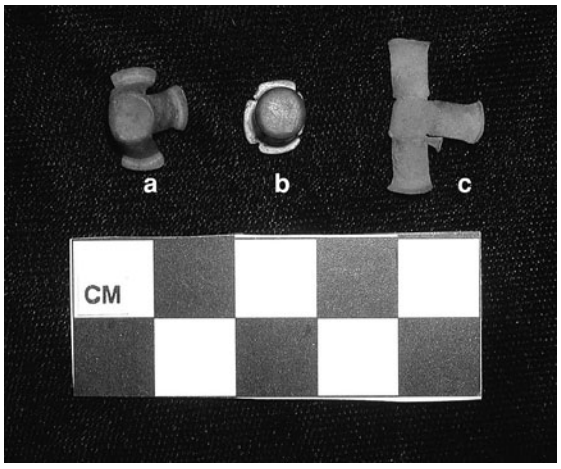

FIGURE 3. Fired musket size caps showing (*a*) splitting of sides during firing, (*b*) little or no firing distortion, (*c*) extreme firing distortion of the side wings. (Photo by Douglas Scott.)

An Overlooked Resource

Percussion caps are a well-known artifact type on Civil War battlefields and from pre-1870 sites where firearms were in use, although little archaeological study has been made of this artifact type. One exception is an analysis of percussion caps from Fort Union Trading Post National Historic Site, North Dakota (Hunt 1989).

William Hunt's (1989:338–350) analysis of more than 80 archeologically recovered percussion caps dating between 1830 and 1868 indicated two size clusters, essentially equating to the common or pistol and small rifle cap and a large size equating to the top hat or musket cap. Hunt identified variations in cap length and diameter in both size clusters. A search of historical sources (Pittman 1990, 1992) on percussion caps revealed a similar pattern. Comparable measurements of archeologically recovered caps from three Civil War era battles (Wilson's Creek, Missouri, Pea Ridge, Arkansas, and Monroe's Crossroads, North Carolina) obtained by author Scott; measurements of modern caps taken randomly from containers dating from the 1950s, 1980s, and 2002 in the possession of Scott; as well as measurements from manufactures' data from the 1980s (Barnes 1980) also demonstrate that percussion caps divide into the same two general size clusters as defined by Hunt (1989:338–350), regardless of period of manufacture. Measurements of the modern caps demonstrate that variation in length and diameter occurs within the same lot. Common caps range in diameter from 0.17 to 0.18 in. (0.43–0.46 cm) with lengths of 0.17 to 0.24 in. (0.43–0.61 cm), and musket or top hat caps range in diameter from 0.22 to 0.24 in. (0.56–0.61 cm) and in length from 0.22 to 0.25 in. (0.56–0.64 cm). It is abundantly clear that measurements can only be relied on for determining if the cap is the common type or top hat/musket type.

Until the early 1990s apparently no one had studied percussion caps to determine their value as evidence in law enforcement investigations. Lucien Haag (2003, pers. comm.) of Forensic Sciences Services conducted some experiments with percussion fired weapons and found that the hammer and cone marks imparted on the cap during the process of firing the weapon leave unique and reproducible marks that can

be studied using standard firearms and toolmark examination protocols. There are no other reported law enforcement investigations where firearms identification of percussion caps has been undertaken indicating the tool marks left on a fired percussion cap are unique to the weapon that fired it. Likewise, no one has undertaken a study of archaeological percussion caps to determine if they retain individual marks or characteristics from the process of firing unique to the weapon on which they were fired.

Firearms Identification and Archaeology

Law enforcement agencies have long used the investigative technique of firearms identification, commonly but erroneously called ballistics, as an aid in solving crimes. They usually compare bullets or cartridge cases (Gunther and Gunther 1935; Hatcher et al. 1977; Harris 1980) to identify weapon types from which they were fired. Firearms investigators are routinely successful in matching bullets or cartridge cases to a crime weapon simply by demonstrating that the set of impressions and striations, called class and individual characteristics, on cartridge cases and bullets could only have been made by that specific weapon. Modern firearms identification is based on the principle of pattern transfer theory. In the event that weapons used in a crime are not recovered, investigators can say with certainty, on the basis of the class and individual characteristics found on bullets and cartridge cases, that specific types and numbers of weapons were used in the event under study..

The archaeological study of warfare and battlefields has been enhanced in recent years by firearms identification and analysis (Scott 1989; Scott et al. 1989; Fox and Scott 1991). Cartridges, cartridge cases, and bullets usually comprise the majority of the artifacts recovered from the battlefield. Class and individual characteristics of these ammunition components have shown the potential to reveal the most information about the role firearms played in a battle, such as types of firearms used, minimum numbers of guns, and tracing of movement of firearms across the field of battle (Scott et al. 1989; Scott 1994; Adams et al. 2000b; Laumbach 2001). Firearm characteristics located on cartridge cases are breech face, firing pin, and extractor marks. Bullets display land and groove impressions and striations from the interior of the barrel (Hatcher et al. 1977; Heard 1997). These characteristics factor into the determination of the type of firearm (model or brand) in which a given case or bullet was fired. Differing class characteristics on ammunition components indicate the number of different types of guns in use at the battle. Further, these details make it possible to identify individual weapons by comparing the unique individual firearm characteristics. This capability carries great significance because, when coupled with the precise artifact locations, identical individual characteristics on multiple artifacts or firearms components can be used to trace the movements of specific weapons across the field of battle.

Percussion caps have the potential to retain unique tool marks associated with the hammer face striking the cap while it is seated on the nipple or cone of a firearm (Figure 4). Such a unique characteristic signature, coupled with precise artifact locational information, allows for patterns of weapon movement to be established and the battle sequence to be more precisely interpreted using what otherwise has been a neglected artifact type.

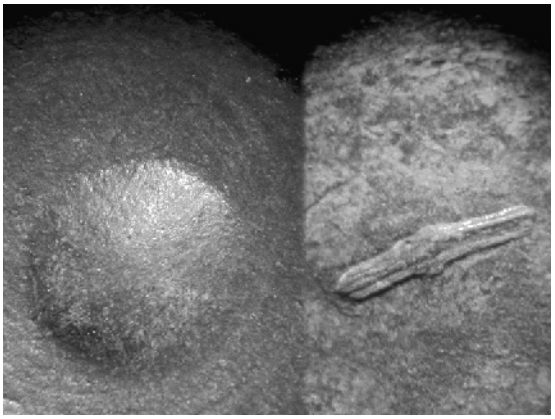

FIGURE 4. Side-by-side microscopic comparison of caps fired on different weapons. (Photo by Douglas Scott.)

Percussion Caps and Tool Marks

As with modern day cartridge cases, percussion caps come into contact with parts of

the firearm that have both class and individual characteristics due to imperfections and machining techniques used during the firearms manufacturing process. On muzzleloading firearms such as those used in the Battle of Cieneguilla, percussion caps come into contact with both the nipple or cone and the hammer (Figure 2). The force of the hammer striking the percussion cap, coupled with the explosive forces of the igniting compound, cause the imperfections and unique characteristics of the hammer, the nipple, or both to be imparted onto the cap itself (Figure 4). It is these markings that allow the firearms examiner to make determinations that multiple percussion caps were fired on the same firearm (Figure 5), even without the firearm being present. The more unique the markings present, the greater likelihood of being able to single out a specific firearm.

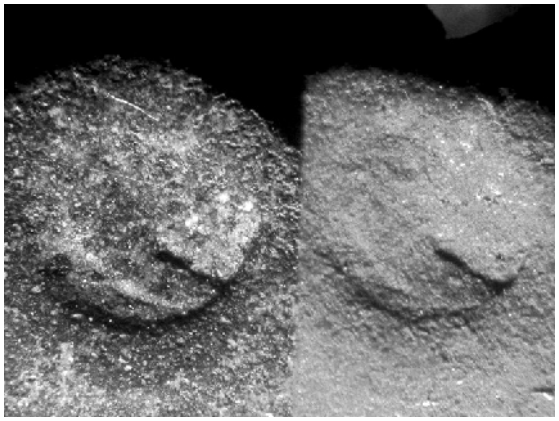

FIGURE 5. Side-by-side microscopic comparison of Artifacts 304 and 349 showing matching individual characteristics indicating firing on the same gun. (Photo by Kent Weber.)

Additional identifying characteristics may be attributed to the blackpowder shooting process itself. Blackpowder firearms are easily dirtied or "fouled" during the shooting process. Fouling can provide additional characteristics for making an identification on percussion caps. Incompletely burned powder and particles of metal from the projectile coat the barrel and associated components of the firearm in a sooty residue (Coggins 1990). The same powder and residue, as well as additional residue and metal particles from the percussion cap, can manifest itself on the nipple or cone and the hammer of the firearm. When this occurs, fouling can add to the unique set of impressions and striations created by the hammer and nipple that transfer to the percussion cap as well. This fouling may remain a part of the hammer and nipple impression for a lengthy period of time as a reproducing mark or may go away after the next firing.

Other factors to be considered in examining percussion caps for unique marks are the manufacturing process, manner of storage, and manner of transport. At any point during the manufacturing or storage process, it is possible for machined parts, storage receptacles, or even other caps to impart markings onto a percussion cap. These markings tend to be subtle but can be confusing if interpreted improperly. Order of placement may need to be determined to decide which markings are more critical for examination. One method of determining whether an impression or striation is more recent than another is to look for overlapping or even continuous patterns. If a striation or impression appears to cut off or otherwise obscure another marking, it is probable that the overlapping striation or impression occurred after the interrupted mark. Likewise, if a set of markings is apparent on either side of an impression and also can be seen throughout the contoured impression, those markings may be a pre-existing set of characteristics incurred during the manufacturing process or been caused by caps coming into contact with each other during the shipping process and, perhaps, even the packaging process itself.

Not all percussion caps retain markings with enough individualization to show that the cap came from a specific firearm. Due to overall consistency in the firearm manufacturing process, individual hammers or nipples installed on a firearm may transfer markings to caps that are similar to markings imparted by corresponding parts on other firearms. When the markings are not individualized to the extent necessary to make an identification, it is only possible to say that the cap displays class characteristics consistent with having been fired in a blackpowder firearm.

The Battle of Cieneguilla: A Case Study

In spring 1854 New Mexico was far from the quiet backwater territory most Americans believed it to have been. The territory, taken by force from the Mexicans only eight years earlier during the War with Mexico, continued to be a hotbed of military activity. The U.S. Army found its hands full, just as the Spanish and Mexican governments before them, in its attempts to halt raiding activities by various Apache bands scattered throughout the territory. The Apache had a long history of raiding and warfare with other tribes. Spanish and, later, Mexican military units as well as the U.S. Army fought repeated battles and skirmishes with various Apache bands that did not end until the mid-1880s (Thrapp 1967; Altshuler 1981; Reedstrom 1990).

One of the many small unit engagements that occurred prior to the Civil War between the Apache and the U.S. Army took place in the rugged mountainous terrain south of Taos, New Mexico, on 30 March 1854 (Johnson 2003). Lieutenant John W. Davidson and a company of First Dragoons were ambushed by a Jicarilla Apache band under the leadership of Chacon at what became known as the Battle of Cieneguilla (Figure 6). The dragoons were outnumbered by about four to one, and by all accounts they fought desperately for three hours before they could effect a retreat. There were about 60 soldiers involved in the fight. Twenty-two were left dead on the field of battle and only 2 of the remaining 38 returned unwounded to their base of operations at Fort Burgwin (Utley 1981: 144). The Dragoons were armed with muzzle-loading Model 1847 Musketoons or carbines, .54 caliber horse pistols, and a few Colt revolvers, each of which required percussion caps as an ignition system. The percussion caps and the few firearms parts that were deposited at the battle site (Johnson 2003) constitute a unique component of the archaeological assemblage of the battle. The Apache possessed firearms in addition to bows and arrows, although the historical record is generally silent on their armaments. The archaeological analysis of the other battle artifacts is ongoing and not yet available, but it will undoubtedly illuminate the types of weaponry in Apache hands during the battle.

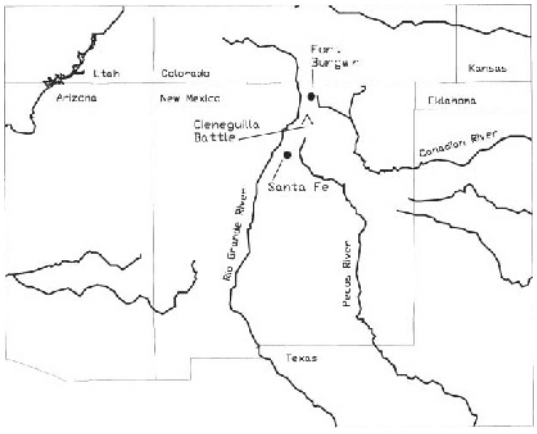

FIGURE 6. Location of the Battle of Cieneguilla, New Mexico. (Drawing by David Johnson, USFS.)

Cleaning and Preparation

From this historic battle site, a total of 110 percussion caps (Table 1) were collected by the U.S. Forest Service and provided to the authors for examination in this study. Of these, 105 caps were of the top hat, or musket, variety. The remaining five were pistol or common caps with the previously described ridged sidewalls. All of the examined caps were made of copper with no evidence of remaining ignition compound, even though many of the caps were unfired. The percussion caps were in superb condition despite having been in or on the ground for approximately 150 years.

Most of the caps required little cleaning and were readily examined after a cursory brushing to remove excess soil. There were a number of caps that exhibited a hardened oxidation or advanced form of patina and required more intensive cleaning. These caps were soaked in e-Z-est, a commercial coin and jewelry cleaner, to loosen adhering substances and oxidation, then scrubbed with a soft-bristled brush and water to remove the residue. The process was repeated if the first attempt was not completely successful until the entire head (or closed end) of the percussion cap could be viewed without obstruction, a necessary step in determining whether or not the cap had been fired. The copper was of sufficient thickness and rigidity to preclude harming or altering the cap with the cleaning methods used.

TABLE 1
LIST OF PERCUSSION CAPS ANALYZED FROM CIENEGUILLA

Artifact No.	Fired	Unfired	Match To	Head dia. (in.)	Comments
5		x		0.243	
6	x				
7		x			3 caps
8		x			2 caps
9	x				
10		x		0.241	
13	x				
14	x				
15		x		0.241	
16	x				
17		x			
18	x				
20	x				
21		x			
22		x		0.24	
25	x				
26	x				
27	x				
28	x				
29		x		0.244	
32		x			
37	x				
43		x			
44		x		0.244	
45		x			
46		x			
47		x		0.241	
54		x			
55	x		378		
57		x		0.203	pistol cap
58		x		0.244	
59		x		0.244	
60		x			
61		x		0.242	
65	x				
66		x		0.241	
71		x			5 caps
77		x		0.244	
79		x		0.241	
82		x			
83		x			
84		x		0.244	
85		x			
86		x			
87		x			
90	x				
91		x		0.24	
93		x			
94		x			
107		x		0.241	
110		x		0.247	
111		x			

TABLE 1 (CONTINUED)
LIST OF PERCUSSION CAPS ANALYZED FROM CIENEGUILLA

Artifact No.	Fired	Unfired	Match To	Head dia. (in.)	Comments
127		x		0.174	pistol cap
142		x			
206	x				
217	x				
218		x			
226	x				
227		x		0.174	pistol cap with GD mark
228		x		0.239	
235		x			
241		x		0.241	
249		x		0.188	pistol cap
250		x		0.185	pistol cap
269		x		0.241	
270		x		0.242	
277	x				
299	x				
304	x		349		
305		x			
306		x			
307	x				too distorted to compare
308		x			
309		x		0.242	
315	x				
319	x				
320		x		0.242	
327		x			
328		x			
329		x			
330		x			
331		x			
335	x				
344	x		354		
346		x		0.248	
347		x		0.245	
349	x		304		
350	x		352,382		
352	x		350, 382		
353	x				
354	x		344		
355	x				
356	x				
364	x				
372	x				too distorted to compare
378	x		55		
382	x		350, 352		
473	x				
902	x				
914	x				
935	x			0.244	
936		x			
965		x		0.241	

After cleaning, the caps were examined under magnification with a 10x hand lens for identification of markings indicating use in a firearm. Fired, or snapped, and unfired caps were separated but kept in their respective artifact packaging for later identification. Fired caps were then grouped according to similar characteristics and appearance as noted through low-power magnification. This grouping allowed comparison of both gross and individualized markings in the course of identifying matching patterns on the caps but also removed from comparison those caps that displayed distinctly different impressions. Musket and pistol caps were also examined separately due to differences in size that invariably dictates use on different types of firearms.

Once separated into gross groupings, the caps were examined under 10x to 60x magnification using a comparison microscope. The equipment used in this study was an American Optical universal comparison microscope. The comparison microscope is critical to the analysis of ammunition. Simply, the microscope is constructed so that two separate microscope tubes are joined by a bridge with prisms mounted over the tubes. Two separate images are transmitted to the center of the bridge, where another set of prisms transmits the images to central eyepieces. The eyepieces are divided so that each image appears on one half of the eyepieces. Movable stages allow the objects under scrutiny to be manipulated so that they can be directly compared for class and individual characteristics. This construction permits the examiner to simultaneously view two separate percussion caps or ammunition components at the same time, with the capability to overlay the images for confirmation of a matching pattern. Affixed to the microscope was a Nikon 995 digital camera, utilized in capturing both side-by-side and overlaying images for visual documentation.

Pistol Caps

The five small caps (Table 1) are consistent in style and measurement with the common or pistol cap identified by Hunt (1989:340). The pistol caps (Figure 1*d*) did not exhibit signs of having been discharged in a firearm. All five caps were intact with no distortions, striations, or impressions evident. One of the caps was

FIGURE 7. GD headstamp on Artifact 227. (Photo by Kent Weber.)

significant in that it displayed the manufacturer's raised stamped mark GD on the head of the cap (Figure 7). Gooding (1974) believes these letters are indicative of French manufacture, though an actual company name or its dates of operation were not identified. Hunt (1989:356) is of the opinion that the GD stamps may be an indication of size as well as manufacturer, citing historical accounts reviewed during his research of the Fort Union Trading Post percussion caps. He attributes the GD stamp to both French and American manufacturers, encompassing a small size range for the cap. Dean Thomas (2003: 210–234) attributes the GD headstamp to the Joseph Goldmark Company, which was in the percussion cap manufacturing business as early as 1853. There are surviving Goldmark pistol-sized percussion cap boxes labeled GD and containing GD headstamped caps. Additional research into this particular manufacturer's mark may give insight into both trade patterns and the consistency, or lack thereof, with which manufacturers in separate countries created caps utilizing the same headstamps.

Top Hat Caps

The larger caps are consistent in size and style with the top hat musket cap (Table 1) as identified by Hunt (1989:340). Examination

of the musket caps resulted in the grouping of 41 fired caps (Figure *2a, b, c*) and 64 unfired caps. This division was determined through the presence of striations or impressions that, in the experience of the authors, could only have come from use on a firearm.

As described above, the 41 fired caps were further grouped according to general patterns present on the head of the cap. Once grouped into these subdivisions, the caps were examined against one another within their individual groupings for the presence of identical impressions and/or striations. In many cases, the level of detail typically seen in modern-day firearms examination was not present on these percussion caps due to age and the weathering process. It was possible to recognize distinctive patterns under magnification, resulting in the positive matching of four separate groupings of caps, encompassing a total of nine percussion caps (Table 2). Matching percussion caps were compared through the microscope both as side-by-side (Figure 5) and as overlapping (Figure 8) images to ensure the matching impressions or striations reproduced in a carbon-copy manner. A range of magnifications was used to ensure both gross and minute detail was accounted for in the comparisons. The entire set of fired caps as well as the distinctive subgroupings was examined repeatedly to ensure reliability in the final results. Percussion caps from different subgroupings were also cross-checked as a confirmation of the difference in patterns.

TABLE 2
FIREARMS REPRESENTED BY MULTIPLE MATCHING PERCUSSION CAPS

Set No.	No. of Caps	Cap Type	Artifact No.
1	2	Top Hat/Musket	344, 354
2	3	Top Hat/Musket	350, 352, 382
3	2	Top Hat/Musket	304, 349
4	2	Top Hat/Musket	55, 378

The 41 fired caps examined showed that unique and reproducible marks were present, representing a minimum of 34 firearms. Four of those firearms are represented by more than one percussion cap (Tables 1, 2). These four distinct matching sets are: Set 1 consisting of two caps (Artifacts 344 and 354), Set 2 consisting of three caps (Artifacts 350, 352, and 382), Set 3 consisting of two caps (Artifacts 304 and 349), and Set 4 consisting of two caps (Artifacts 55 and 378). Two of the fired caps (Artifacts 307 and 372) could not be compared to the rest of caps due to extreme distortion and were excluded from further analysis. Although these crushed and distorted caps may represent additional guns or matches, individual characteristics could not be distinguished beyond the class level due to the extensive crushing and associated distortion of the individual features.

Validation

In order to validate further the examination methods employed, a blind comparison of modern percussion caps was conducted. Larry Ludwig, site manager for Fort Bowie National Historic Site in Arizona, collected 15 fired musket caps from 3 different black powder firearms, reproduction Model 1863 rifled muskets, and mixed all of the caps in a container to ship to the authors. Both authors were able to accurately determine which percussion caps came from specific firearms without prior knowledge of the number of guns represented and without having the firearms present.

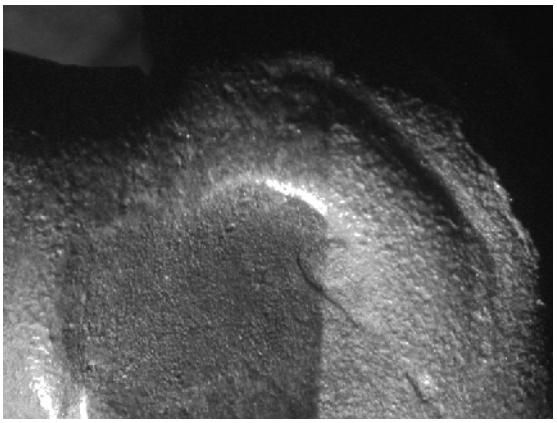

FIGURE 8. Overlapping microscopic comparison of matching individual characteristics on Artifacts 378 and 55 indicating they were fired on the same gun. (Photo by Kent Weber.)

As another component of the validation process, the authors looked at yet another pool of eight sets of known matching caps to study the variety of markings reproduced by different blackpowder firearms provided by Lawrence Babits of East Carolina University. The firearms represented included a reproduction .36 caliber Whitney revolver, a reproduction .44 caliber Remington Army revolver, a reproduction .44 caliber Colt Army revolver, a reproduction Model 1841 "Mississippi" rifle, a reproduction Model 1842 Springfield rifled musket, a reproduction Model 1853 Enfield rifled musket, and an original Model 1863 Springfield rifled musket. All of the caps exhibited some form of reproducing marks from use on the firearms that the authors could readily separate and identify. This test further strengthened the results of the analysis conducted and conclusions reached after examining the historic caps from the Battle of Cieneguilla.

Results of Study

Forensic firearms examination provides a framework for interpreting the firearms artifacts in this study. Applying the techniques of firearms identification and employing the equipment used in modern day forensic investigations, it is possible to draw accurate interpretations of the number of firearms represented in this skirmish, as evidenced through examination of the fired percussion caps.

The nine caps in four matching sets represent four different firearms. The 30 remaining nonmatching percussion caps all represent individual firearms, making it possible to say that a minimum of 34 different firearms are represented by the firearms data presented in this study. With this information the project archaeologist will be able to analyze the individual firearms distribution and movement at the battle site. Given that 60 dragoons were ambushed at this site and 22 of them left dead on the field, the identification of 34 musket-caliber firearms is quite remarkable. Sorting out which caps may represent soldier or Apache warrior weapons is an on-going phase of the analysis along with a focus on movements of the protagonists in the battle.

This study has shown that well-preserved percussion caps dating back 150 years are capable of yielding hammer face and nipple marks that are unique and reproducible, which expands the ability to identify minimum numbers of firearms in use at a site. Analysis of modern fired percussion caps from 11 different antique and reproduction firearms used as a validation study confirms the ability to identify those individual characteristics that define a specific firearm used in battle. The Cieneguilla percussion cap analysis demonstrates that these seemingly inconsequential artifacts are a data set that can be measured, sorted, and studied microscopically and will yield information that can expand knowledge about a site and the role that firearms contributed to the event under study.

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