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ARCHEOLOGICAL INTERPRETATION OF THE FRONTIER BATTLE AT MUD SPRINGS, NEBRASKA

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ABSTRACT—Between February 4 and 7, 1865, Cheyenne, Sioux, and Arapaho warriors engaged a force of U.S. Army soldiers at Mud Springs, Nebraska. Historical records from both sides indicate that this fight marked an early phase of the Indian Wars. Based on systematic metal detections, firearms identification, and terrain analysis, this paper adds archeological insights into the arms and tactics used by the opposing sides. Well-armed Native fighters used terrain to approach U.S. troops, who maintained a defensive posture. U.S. soldiers appear to have dug a rifle pit to see approaching attackers.

Key Words: battlefield archeology, Civil War in the West, firearms identification, Indian Wars, viewshed analysis, weapons fan analysis

INTRODUCTION

Mud Springs is the modern name given to a perennial wetland in the uplands south of the North Platte River about 120 miles west of the fork of the South Platte. Native folks certainly used this area, but its modern designation was established by Oregon-California Trail emigrants who used the area as a watering and resting point (Fig. 1). In 1860 a Pony Express "home station" was built near the Mud Springs water hole (Corbett 2006), and the transcontinental telegraph line reached the station in July 1861. These occupations created archeological records that warrant study, but this paper discusses the results of archeological research into fighting that occurred at Mud Springs on February 4-7, 1865, when it was the center of an armed conflict between troops of the U.S. Army and a body of Cheyenne, Sioux, and Arapaho.

The Mud Springs fight offers an opportunity to demonstrate how the holistic approach of modern battlefield archeology can augment historical sources to offer new interpretations of specific conflicts. Mud Springs was not as large as some other western battles, but it was longer and sharper than others. Unlike many fights that occurred in the open, the Mud Springs conflict involved defense of a fixed facility. It occurred as the Civil War was ending and before many tactical trends that marked the post-war period of Indian warfare had begun (Griffith 1989; Jamieson 1994; Scott 2001). The U.S. Army had not yet developed a clear strategy for combating Native populations, so reports of events at Mud Springs (Collins 1865) contributed to development of the strategy that emerged in the next decade of the 19th century. Occupation of the West was still in an early phase. Military innovations of the Civil War, notably repeating firearms, were less common in the West than they would be in a relatively brief time. It also happens that Mud Springs has remarkably complete written accounts from both the army and Indian perspectives. These sources have been amply assembled and presented (Henderson 1951; Hyde 1983; Robrock 1983; McDermott 1996, 2003; Halaas and Masich 2005). Finally, the site is well preserved both as a Nebraska State Historical landmark and is listed on the National Register of Historic Places as 25MO72, representing the convergence of several significant historic events or themes.

This paper summarizes the results of investigations carried out at Mud Springs. A full account of the results of those investigations is available in an unpublished technical report (Bleed and Scott 2008).

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THE FIGHT AT MUD SPRINGS

The Mud Springs fight was one of number of clashes that followed the November 29, 1864, destruction of Black Kettle's village of Cheyenne (McDermott 2003; Greene and Scott 2004) by a regiment of Colorado Volunteers. In the wake of that assault, a large community of Cheyenne,

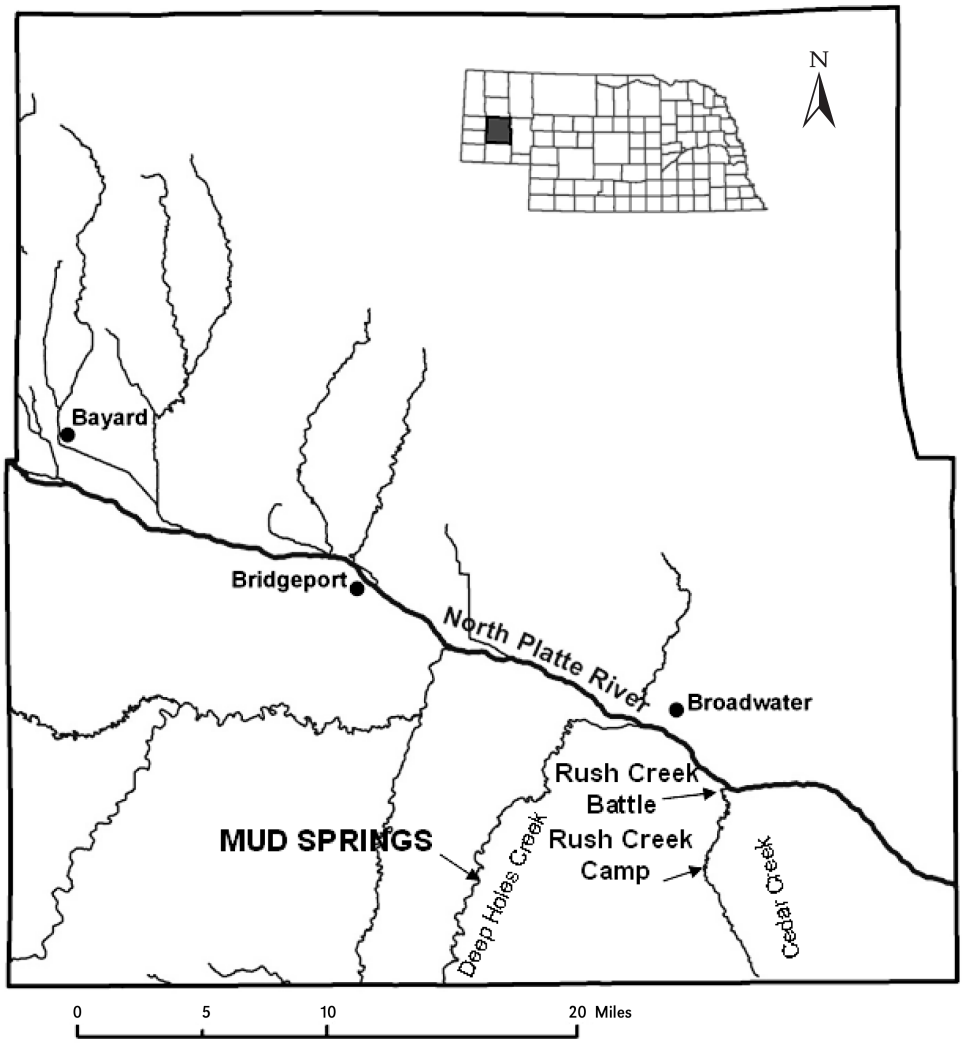


Figure 1. Aerial view of the Mud Springs Station site (25MO72).

Sioux, and Arapaho coalesced and moved toward the security of the isolated Sandhills and the Black Hills. With relatively little opposition, this group attacked Julesburg, Colorado, and ranches and other facilities to avenge the massacre and to gather resources. The mobile community numbered some 2,000 to 3,000. They reached the North Platte in early February 1865 with a substantial store of captured arms and resources. By no later than February 5, they established a camp at a place identified as "Rush Creek." This site has not been specifically located, but it was probably in an area of natural springs near the head of modern Cedar Creek eight miles east of Mud Springs. Fighting at the Mud Springs Station may have started as the Rush Creek camp was being established, and for a couple of days it appears to have been the operational base from which fighters attacked Mud Springs. The Rush Creek camp, having many families and their gear, was a substantial base that was maintained until February 8, when the Native community continued its northward journey. On the 8th and 9th, on the southern side of the North Platte, warriors covering their community's move north met U.S. troops who had moved on from Mud Springs. This engagement has come to be called the Battle of Rush Creek.

As shown in an 1864 ground plan, the Mud Springs Station consisted of two log buildings and a corral. One building measured 35 × 16 feet and served as a squad room and telegraph office. The other building was a stable that measured 40 × 20 feet. These buildings were not designed for defense; rather, they were built as a working unit on the overland trail system. The structures sat on the west side of dry wash that served as the path of the "Jules

Cutoff," a shortcut that provided Oregon Trail travelers a way around the steep hill at Ash Hollow. The station buildings were on a land surface some 10 feet above the wash and separated by a low bank. A wetland, possibly blocked to form a shallow pond, formed the northern margin of the station. A lightly built corral was located next to the stable, apparently to the west.

Sir Richard Burton, an English sportsman who on August 12, 1860, passed through the Pony Express station on his westward travels, described it:

> The station-house was not unlike an Egyptian Fellah's hut. The material was sod, half peat with vegetable matter; it is taken up in large flakes after being furrowed with the plough, and is cut to proper lengths with a short-handled spade. Cedar timber, brought from the neighbouring hills, formed the roof. The only accommodation was an open shed, with a sort of doorless dormitory by its side. We dined in the shed, . . . Dreading the dormitory . . . of fleas . . . I cast about for a quieter retreat. Fortune favoured me by pointing out the body of a dismantled wagon. (Burton 1963: 87-88)

By 1865 the adobe structures appear to have been dismantled and rebuilt with logs, as described by A. G. Shaw, a battle participant with the 11th Ohio Volunteer Cavalry:

> There were several buildings, and rooms connected or a part of the same building. The Indians got behind the hill in the rear of the buildings & would crawl to the top and shoot down into the log buildings. There were no windows on that side, but occasionally a bullet went through the chinking and penetrated to the inside, but nobody was hurt. (Jensen 2005:304)

The station complex is surrounded by a variety of topographic features (Fig. 1). Immediately east of the buildings there is a broad sandy draw. The level of the station is separated from the draw by a bank that is steep in some areas but less than 20 inches high. A series of hills is located to the south of the building site. The closest of these is less than 100 yards away and directly overlooks the buildings. The buildings have not survived, but their location is marked, based on oral traditions, by a stone monument erected in 1939. The site has not been systematically tested, but in 1995 it was assessed with ground penetration radar (Steinacher 1995). Specific anomalies were not identified.

The Mud Springs fight is presented by both army and Indian accounts, which have been assembled by John McDermott (1996, 2003). The primary army accounts are the after-action report of Col. William Collins of the 11th Ohio Volunteer Cavalry (Collins 1865; Hewett 1997:203-33). The Native perspective is represented in accounts of the fight left by George Bent, the son of noted trader William Bent and his Cheyenne wife, who rode with his Indian kinsmen (Haack n.d.; Grinnell 1956; Hyde 1983; Halaas and Masich 2005).

As recorded in these accounts, fighting at Mud Springs began in the morning of February 4. At that time, the site was occupied by a telegrapher, nine soldiers of the 11th Ohio Volunteer Cavalry, and four local cowboys who had a small herd of cattle as well as horses and mules in the station corral. Indians attacked, driving off the cattle and a number of horses. They did not immediately cut the telegraph wire, however, so word of the attack was quickly sent down the line. For the remainder of the 4th, the defenders stayed in the station buildings and traded shots with the attackers. Indians attacked both on horseback and on foot. They appear to have been able to approach the station building closely.

George Bent described the opening phase of the Mud Springs fight in a May 4, 1906, letter to George Hyde. This letter has been cited by several authors (Grinnell 1956; Hyde 1983:183-89; Halaas and Masich 2005), but the original text transcribed by Stephen Haack presents useful information:

> That night scouts were sent ahead reported ranch on Muddy Springs had soldiers, so early next morning everybody got on their best horses and started for the springs. The village turned north east from here. We went due north for the ranch. When we got near we could hear lots of firing. Lot of Indians had started for this place that night so as to run the stock, but soldiers had all their animals inside the corral. The soldiers were inside of buildings and had port holes to shoot through. We could not tell how many soldiers were in this party. Sand creek ran close to the ranch with high bank. The Indians got behind this bank and shot into the buildings. At noon they turned all their animals loose. The mules and horses ran in every direction. Indians were running after them. Among rules with Indians, who touched the

> animal with anything in his hand, the animal was his. I understood the soldiers were running out of ammunition. They turned their stock loose so the Indians would leave them and they did so. After this the big village camped about [he gives no number here] miles east of Muddy Springs where we had fight. No Indians were killed in this fight and as I say we could not tell how many whites were killed in this fight. Lots of shooting was done on both sides. All the guns we ever captured were Spencer carbines. They were the best guns at that time and were handy to carry on horses. (Haack n.d.:33-34)

Bent's recollections present a number of useful insights. First, he makes it clear that Indian fighters were well armed and that from the outset there was considerable shooting. He clearly states that the station defenders shot from loopholes made in the station wall. It is also significant that although Bent does not mention attacks from the hill south of the station, his account indicates that the bank of the sandy draw on the east side of the station let the attackers draw very close to the defenders' base and that the attackers heavily used the bank.

Colonel Collins and his cavalry were about 90 miles west of Mud Springs at Fort Laramie when word of the attack was received (Collins 1865; Jones 2005). On the evening of the February 4, he set out to relieve the station with some 120 men, including companies of the 11th Ohio Volunteer Cavalry and some men of the 7th Iowa Volunteer Cavalry. He also ordered a relief party of Lt. William Ellsworth and 36 men of Company H, 11th Ohio Volunteer Cavalry, stationed at Fort Mitchell, to Mud Springs. Ellsworth arrived early on February 5. Collins arrived early on the 6th, having ridden for two nights. An overnight ride in midwinter must have been a demanding effort, but the weather appears to have been quite mild. Temperature records at Fort Laramie record the afternoon high on February 5 at 48 degrees (Fahrenheit) (J. Preston, personal communication, Wyoming Water Resources, March 23, 2006). In a letter written in 1906, George Bent recollected, "There was no snow on the ground although it was February. Winter of 1865 was open winter" (Haack n.d.:34).

The newly arrived army troops established a corral of wagons and other materials adjacent to the station. They kept their stock in this confine and used it as a defensive line for most of February 5. Army troopers were armed with Spencer rifles or carbines. Indians were described as using repeating rifles, revolvers, and bows and arrows. In his report presented in the *Official Report of the War of the Rebellion*, Collins (1865) described the fighting on the 6th as a game of "bo-peep" in which both the army and Indian fighters searched out sheltered spots from which they could stand and surprise their adversaries. The warriors were attracted to horses in the expanded corral. They also harassed the station on horseback and on foot, using the terrain as effective cover to draw close to the station. The fighting spread over a wide area, with mounted Indians alternately charging the station and taking shelter from soldiers' rifle fire by galloping behind far hills.

On February 6, the fighting became quite intense. Collins estimated that between 500 and 1,000 Indian fighters were involved in the attack. Based on estimates by other observers, McDermott (2003:38) believes the higher number is the most accurate. In addition to continuing to try to drive off horses and mules penned in the corral, Indians also brought groups of up to 200 individuals to the top of the hill immediately south of the station. This brought them within 75 yards of the station buildings and allowed them to send in volleys of bullets and arrows. To deal with those attacks, on the afternoon of the 6th Collins organized an assault by mounted and unmounted troopers on the hill south of the station. After that assault, Indians abandoned the high ground, and troopers occupied it. They even dug a "rifle pit" on the hilltop (McDermott 2003:39).

With a secure perimeter and another detachment of 50 men of the 11th Ohio Volunteer Cavalry, who arrived from Fort Laramie with a cannon late on the 6th, the army was able to leave the station confines. On the 7th, Collins sent out scouting parties to locate the main Indian camp. Following well-worn trails, the scouts easily located it. On the morning of the 8th, Collins led a force of some 185 troopers out of Mud Springs to pursue the Cheyenne and their allies, who were by that time breaking their Rush Creek camp and heading across the North Platte. At that point, the battle of Mud Springs was over.

In sum, the Mud Springs battle involved more than 200 U.S. troops and upwards of 1,000 Indian fighters. The two sides fought for more than three days, using a variety of firearms and traditional weapons. Casualties are uncertain but seem light. No army soldiers were killed outright in the fighting, and no Indian bodies were observed, although army participants suggested that some 30 of their adversaries had been dispatched. George Bent says no Indians were killed in the fighting at Mud Springs (Hyde 1983:193). The fight did not mark a decisive point in frontier military history, but the formal report Collins prepared on the fight appears to have been read and

considered by military leaders (McDermott 2003:35-45). Combat of this period also contributed to formation of post-Civil War military policies in the American West (Hatch 2003).

Questions about the Mud Springs Fight

Since few historic battles have been investigated in the Central Plains, the site presents an opportunity to identify the archeological characteristics of set, multiday battles in this environment. There were also specific uncertainties about the Mud Springs fight that were clarified with archeological materials. The most obvious of these is the armaments used by the Indian fighters. Army soldiers carried Spencer repeating carbines or rifles and other regulation weapons. It was not known what kinds of arms Indian fighters carried, but they were identified by recovered bullets and cartridge cases.

The limits of the battlefield and the extent of the contested zone were not known. The tactics of the fight were also unclear. Descriptions of "bo-peep" exchanges and firing volleys at charging mounted warriors seem graphic, but it is not clear what they actually involved. Where did attackers and defenders position themselves? How was local terrain used to support these tactics? How was volley fire aimed? The role of the rifle pit also required investigation. The size and shape of the pit needed to be clarified to determine how it conformed to standard Civil War-era entrenchment practice. Excavation determined that the pit is truly an artificial feature and is associated with the fight. By assessing the location of the pit relative to other terrain features of the battle, one can suggest the strategic intentions behind its construction and its role in the fight.

FIELD AND ANALYTICAL METHODS

Since a primary research goal of the Mud Springs inventory was to locate and define the limits of the battlefield, it was necessary to determine where artifacts were found, but also where artifacts were not found. The first requirement, then, was to develop field procedures that were capable of examining the entire extent of the battlefield. The area to be inventoried was relatively small, totaling some 40 acres. It was assumed that most surviving artifacts of war are either metallic or associated with metal, and metal detectors were employed as an inventory tool because of the success of the technique at Little Bighorn Battlefield National Monument (Scott and Fox 1987; Scott et al. 1989) and its wide use since then.

Locational control was accomplished through the use of a Global Positioning System handheld unit and electronic data collector. As artifacts were found, each item or location was recorded on the data recorder. Each was identified by unique UTM coordinates and a previously established identification code. The recovery crew followed and carefully uncovered subsurface finds and identified the finds. Inventory operations were designed primarily to locate subsurface metallic items with the use of electronic metal detectors. The operators walked transects by topographic feature orientation. The area examined included the immediate area around the Mud Springs Station buildings, the purported corral area to the west, and up to the banks of the present pond on the north. The areas between the station site and the hill to the south and the steep creek bank were examined in detail, as was the rolling hills to the west for one-quarter mile. The first and second terraces of the creek on the east were also metal-detected, but no historic finds were made. The creek is an active fluvial channel, and only modern items were found on the sweeps below the stream bank. Either the area has been flushed by flooding events or the older surfaces are buried beyond modern metal-detector depth range.

The archeological integrity of the Mud Springs battle appears good. There are reports that cartridges have been collected around the station site. The area has also been visited by collectors with metal detectors. Previous searches of the site seems not to have been systematic or intensive, though, and there are no signs of serious earth moving.

Archeological Assemblage

Cartridges, cartridge cases, and bullets form the majority of the artifacts recovered at Mud Springs. A full discussion of these materials is presented in Bleed and Scott (2008). The Nebraska State Historical Society also has a small collection of items collected from or near the presumed site of the buildings at Mud Springs Station. Since precise recovery points were not known, these items were not analyzed as part of this project. Systematically recovered materials were analyzed using standard firearms identification procedures (Gunther and Gunther 1935; Hatcher 1943; Hatcher et al. 1977; Harris 1980; Heard 1997; Haag 2006) in order to determine the kind of arm, and where possible, the specific weapon that fired the materials. This then allowed determination of the number of different types of guns in use at the battle. Further, comparing the unique qualities of individual firearm types allows us to identify individual weapons. This

capability is very important because we can use identical individual characteristics, coupled with the precise artifact locations, to trace the movements of individual weapons across the field of battle. With this information, patterns of movement can be established and the battle sequence can be more precisely interpreted.

In total, 44 cartridges, cases, and bullets in the systematically recovered assemblage could be dated to the period of the battle. These were fired from the following weapons: .36-caliber Starr revolver, .44-caliber Henry rifle, .44-caliber Ballard carbine, .54-caliber Leman rifle, .56-56-caliber Spencer and Joslyn carbines, and .58-caliber rifled musket, which might be either a rebored M1841 rifle, or a M1855, a M1861, a M1863, or an Enfield P53 rifled musket. Additionally, a single "top hat" or "musket cap" was found during the test excavation of the rifle pit. The cap is unfired, as it bears no tool marks from being struck by a hammer (Weber and Scott 2006:131-43).

Beyond identifying the kinds of guns used at Mud Springs, firearm identification of the archeologically recovered materials indicates that there were at least 21 different firearms used during the 1865 Mud Springs battle. This number includes at least one .36-caliber Starr revolver, one .44-caliber Colt M1860 army revolver, two .44-caliber Henry rifles, five .44-caliber Ballard carbines, one .54-caliber Leman rifle, two .56-56-caliber Joslyn carbines, eight 56-56 Spencer carbines, and one .58-caliber rifled musket.

Firearms Artifact Distribution

Total artifact recovery was limited given the sampling technique employed. It was also no surprise that only a small number of artifacts were recovered given the landowner's statements that he has allowed relic hunters on the site on a routine basis, as long as they asked permission. He recalled that previous collectors found handfuls of Spencer and other cartridge cases.

Nevertheless, the archeologically recovered cartridge cases and bullets do not appear to be randomly distributed. Rather, the find pattern distribution is consistent with the historic battle accounts. The Spencer and Joslyn cartridge cases representing eight and two separate guns, respectively, were found scattered around the traditional location of the buildings at Mud Springs Station. Cartridge cases fired from those same guns were found on the north side of the hill and on top of the hill south of the station as well as in a low area between the south hill and a rise to the west. This distribution is consistent with the army accounts of the battle, which have the soldiers fortifying the station even after arrival of the relief columns. The Spencer and Joslyn cartridge cases found around the south hill and to the west are also consistent with Colonel Collins's report of making a mounted sortie to the south and driving the attacking warriors from the hill and the general area.

The .44-caliber Ballard cartridge cases, representing five guns, and the .44-caliber Henry cartridge cases, representing two guns, were recovered either on the rise or ridge to the southwest of the station buildings or behind a low rise on the lower west flank of the south hill. This distribution, along with that of the bullets, is consistent with positions the warriors utilized.

The 11th Ohio Volunteer Cavalry is known to have been armed in 1864 with Spencer, Smith, and Merrill carbines as well as M1847 Musketoons (McAulay 1996:54). In 1865 only Spencers are reported (McAulay 1996:64). The 7th Iowa Volunteer Cavalry is reported to be armed with the Gallager carbine in 1864 (McAulay 1996:52), but there is no information reported for 1865. The Smith, Merrill, and Gallager carbines were all percussion ignition types and not cartridge firearms (McAulay 1981:32-35, 40-44, 62-68). Neither unit was reported to have been armed with the Joslyn carbine. However, ordnance returns for Union Civil War units are notoriously incomplete, and uncritical reliance on them is inappropriate. Certainly given the archeological context, it appears the units were likely armed with Spencer and Joslyn carbines both firing the same type of metallic cartridge ammunition.

The Ballard rimfire carbine and the Henry rifle were likely in warrior hands. Neither weapon type was new or unknown in the western regions. Both also employed the same caliber metallic cartridge, the .44-caliber rimfire.

The only other recovered artifact that is likely to be part of the battle debris is the strap bar segment of a brass 1859-pattern cavalry spur found near the station site.

"RIFLE PIT" FEATURE EXCAVATION AND INTERPRETATION

Given the mention that Collins's troops dug a rifle pit after they arrived at Mud Springs, a depression observed on the top of the hill south of the Mud Springs Station (Fig. 2) deserved specific investigation and documentation. Expedient defenses have a long military history. They were used in Civil War engagements but are presumed to be less common in western fights. Surviving examples of Civil War-era rifle pits are quite rare.

There are a number of "blowouts" that interrupt the sod on the hilltop. These may be why Henderson (1951)

Figure 2. View south across the Mud Springs Station site to the hill occupied by warriors and the army during the battle.

mentions multiple "pits," but only one of the interruptions appears to be evidence of a consciously excavated feature. Some oral history associated with this feature appears to conflict with the assumption that it is the pit Collins reported to have excavated during the fighting at Mud Springs. Scott Cape, the current landowner, related that his father had been told that this feature was a pioneer woman's burial site until her remains were moved to another location.

The observed depression was roughly circular, approximately 2 m in diameter and about 20 cm lower than the surrounding ground level. The test unit opened to assess the depression was laid out across what appeared to be the western margin of the original pit. The profile of the south wall of the test unit, however, did not reveal a clear, excavated edge. Below the thin layer of matted vegetation, the pit fill consisted of mixed gray sand that contained charcoal flecks and artifacts, including the mid-portion of a bifacially flaked projectile point, four flake fragments, and an unused percussion cap. There was no apparent edge to this level that might reflect the excavated edge of a rifle pit, but it was thickest toward the center of the depression. Below the gray sand layer, the soil consisted of more solidly compacted sandy loam. The divide between this layer and the mixed sand was distinct enough to potentially reflect an artificial surface. No artifacts were found below this level. The top of the undisturbed sandy loam seems to form a gentle depression that at its deepest point is some 60 cm below the current soil surface.

Test excavation of the potential rifle pit indicates that it is a shallow artificial feature that was excavated to have sloping sides. Little more can be said about its original size and shape, but it seems very uncertain that it could have served as even a temporary burial site. The combination of stone artifacts and a percussion cap strongly suggests that the area of the pit had a complex history. Given the historical mention of a rifle pit, and pending further investigation, we believe that the hilltop feature can be interpreted as a simple excavation linked to the Mud Springs fight.

MARTIAL CONTEXTS OF MUD SPRINGS: ARMY AND INDIAN TACTICS IN THE MID-19TH CENTURY

The Napoleonic Wars and the U.S.-Mexican War (1846-48) heavily influenced army tactical doctrine during

the early years of the Civil War. Officers learned this approach to warfare during their education at the West Point military academy and in the field during the Civil War. The basic tactic taught at West Point prior to the Civil War was close-order infantry assaults with bayonets gleaming, cavalry charges with sabers flashing, and direct fire by smoothbore artillery placed toward the front of the line. These tactics, through hard-learned lessons of the Civil War, gave way by 1863 to a different approach (Griffith 1986, 1989). By the last years of the war, tactics had adapted to the effectiveness of modern rifled arms. Infantry tactics were modified to open-order skirmish lines using available cover whenever possible. Defensive positions were usually fortified with extensive entrenchments. Prepared rifle pits, picket posts, and videttes usually protected even short-term camps.

Of the three combat branches, cavalry made the greatest adaptation during the latter part of the Civil War, continuing these tactics during the Indian Wars (Russell 1987; Jamieson 1994). In battle it moved from the close-order charge meant to break or outflank a line to a mobile unit that could move quickly to the scene of action, then dismount and fight as light infantry. With the advent of breech-loading single-shot and repeating carbines, cavalry firepower increased dramatically. This increased firepower and mobility allowed the cavalry to regain the usefulness on the battlefield it had lost with the introduction of the rifled musket. Cavalry was also used extensively throughout the Civil War and Indian Wars as a fast and efficient scouting and intelligence-gathering arm. Mobility was its key asset; cavalry units could range far and wide around larger, marching columns to protect them and to scout the opponent's movements.

In general, the nature of conflict between soldiers and Indians was unique and afforded some major differences in the way each group of combatants conducted warfare. Within the Indians' cultural context, fighting was usually accomplished as individuals or in loosely affiliated war groups. Fighting usually employed surprise, ambush, and decoy (Grinnell 1910, 1956; Smith 1937; Secoy 1992; DeMallie and Parks 2003:66-76). Tactically, warriors employed the terrain to their benefit, striking quickly in small groups as opportunities presented themselves. The U.S. Army was constantly frustrated by the Indian hit-and-run tactic (White 1978). Also, frontier army officers and men had little understanding of the Plains Indian's war-honor concept of counting coup, which was so ingrained within their cultural construct to achieve hero status within the group (McGinnis 1990). Aside from touching an opponent, one could gain other levels of distinction by capturing a weapon from a live enemy, stealing a horse, or rescuing a fallen warrior from the enemy. Regardless, destruction of an enemy or protection of the family or band were paramount in combat, and inflicting casualties on the enemy by killing or wounding was a natural outcome of such tactics.

The tactics employed by both sides during the Mud Springs fight are evident in the patterned distribution of the archeological record. When that record is supplemented by the application of firearm identification procedures, the actual movement of both soldiers and warriors is clearly seen. Individual warriors availed themselves of the protective cover provided by the terrain within gunshot range of the Mud Springs Station buildings. The soldiers, employing those buildings as a fixed defense, utilized tactics current with late-Civil War fighting proscriptions. When Collins arrived, he took an aggressive posture and literally charged the warriors' positions with his men, forcing the tribesmen to vacate the area. Those events deposited physical evidence on the ground in patterns that remained to be recovered during the archeological investigations. That evidence was recovered, and the patterns of deposition reflect the fighting methods employed by both sides. Yet there were still questions to be answered that were not fully reflected in the recovered data set.

LOOKING AT THE MUD SPRINGS LANDSCAPE: TERRAIN ANALYSIS

The Mud Springs rifle pit presented a special challenge. Use of hasty entrenchments was certainly an established tactic by the mid-19th century, but it is not clear why the leader of a cavalry detachment decided to "dig in" shortly after breaking the siege at Mud Springs. Likewise, it is not clear why the pit was dug where it was. Those questions offered an opportunity to reassess the documentary and oral history resources from yet another angle. The approach chosen was viewshed analysis, which employs the power of Geographic Information System (GIS) computer-based programs. Viewshed analysis is a GIS technique that makes it possible to identify views and vistas available from a given point. It has become a refined archeological tool (Wheatley and Gillings 2002) that can expose settlement choices (Jones 2006) and visual landscapes (Llobera 2007). In military parlance this is known as terrain analysis or weapons fan analysis.

Viewshed analysis is a fairly straightforward technique that, when calculated on the computer, is facilitated by files known as digital elevation models (DEMs). A

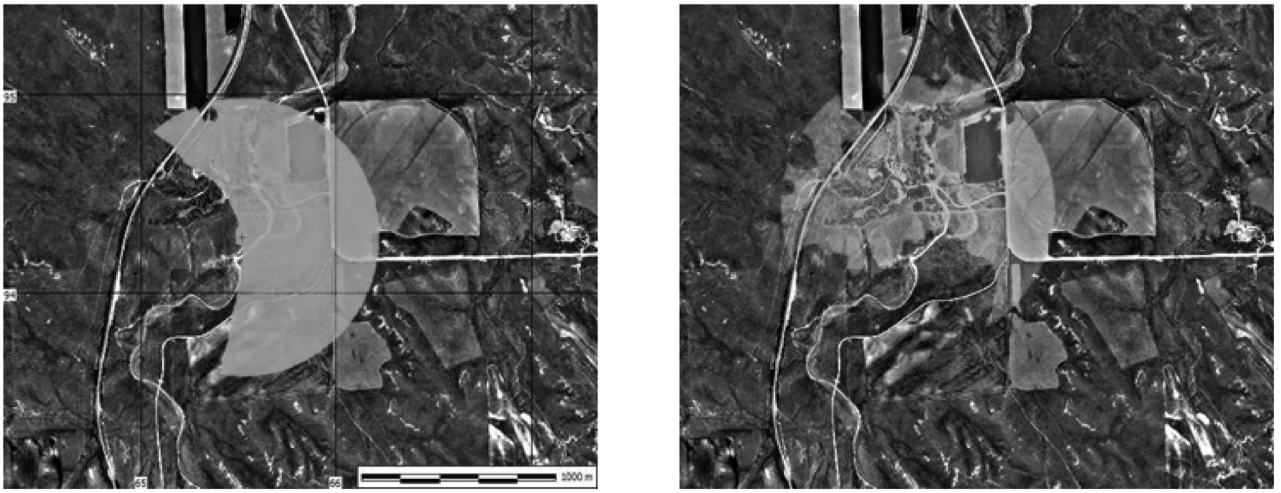


Figure 3. Comparison of the weapons fans available from the rifle pit (**A**) and from the station buildings (**B**). These fans suggest that shooting from the hill above the station had a slight advantage.

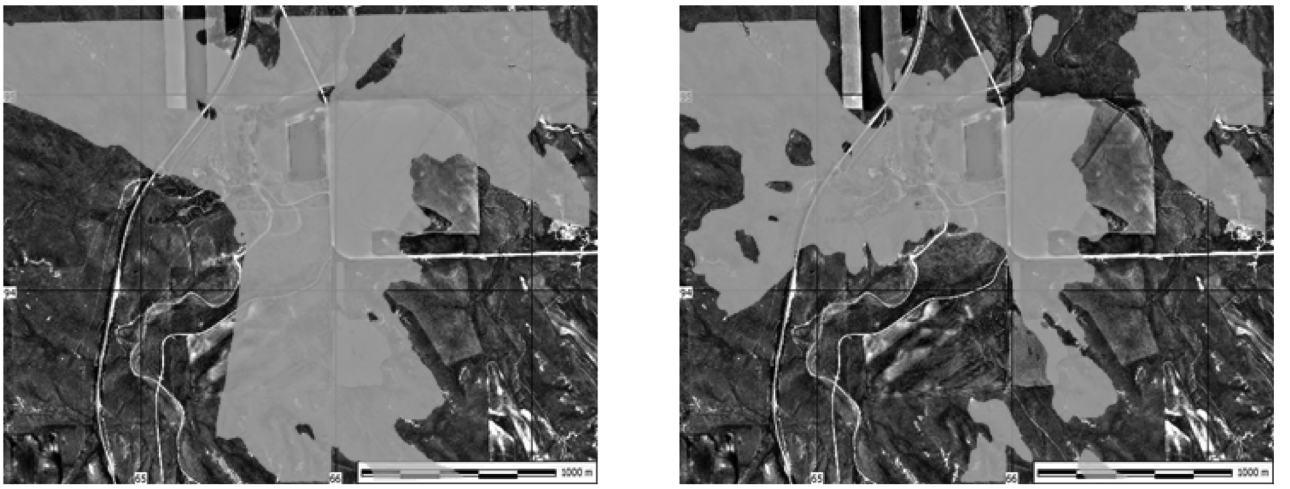
standard DEM is essentially the same as a digital image, a matrix of cells containing a given color value, with the important exception that in a DEM, instead of storing color information, the cells of a DEM store elevation data. This grid of cells is known as a raster dataset. For this analysis, each cell or pixel within the DEM represents the elevation of a square plot of land, in this case 10 m on a side. The elevation data may then be used by the computer to calculate viewsheds from any point or set of points on the landscape.

When calculating a viewshed from a given point, the computer simply tests each cell in the raster to see if a straight line can be interpolated from the cell to the designated point without being obscured by another cell. If a cell representing a higher elevation value lies between the point and the cell being tested, then that cell being tested is considered invisible from the selected point. However, if no such intervening value is present, then the cell being tested is within the viewshed of the selected point. Each of the viewsheds calculated for this exercise used the available DEMs. These data do not project undergrowth, trees, or other vegetation that may have been present, which are minimal at the Mud Springs site. The calculations simply show what can be seen from a certain spot at a certain point above the ground for a certain distance without taking into account vegetation patterns. These patterns can then be correlated with the archeological and historical record as an additional validation tool.

Weapons fan analysis is a military amplification of viewshed methodology. If a viewshed defines those areas of a landscape visible from a given point, weapons fan analysis combines the viewshed approach with technical information about the weaponry in actual use to determine potential targets to be had from a military emplacement. Weapons fan analysis builds easily on firearms analysis since it makes use of the same kinds of ballistic information. The Mud Springs rifle pit's calculated viewshed was based on the functional range of the firearms available at the time.

Figure 3 presents the weapons fans that would have been available to soldiers or stockmen in the Mud Springs Station or for a picket stationed at the rifle pit on the hill to the south. It assumes a 700 m rifle range, the approximate limit of effective use for a Spencer carbine. It also assumes that crouching shooters fired from window height, or 1 m. The calculated weapons fans show clearly that gunmen could see and cover most of the area around the station. There were two exceptions. The hill to the south of the station hid much of that area so that attackers could approach unseen to within 100 m of the station. The far horizons were both out of rifle range and not visible from the station. The archeological evidence shows that warriors used that landscape to fire on the occupants of the Mud Springs Station complex.

Two long-distance viewsheds (Fig. 4) document that most of the areas visible from the station, together with distant vistas, were also visible for a 1.5-m-tall individual standing at the tested rifle pit. The hilltop did not reveal much that could not be seen from the station, but distant plains to the south and west were visible from the hilltop.



A B

Figure 4. Comparison of the 2,500 m viewsheds from the rifle pit (**A**) and the station site (**B**). Clearly, a fuller view was available from the rifle pit.

An individual stationed in the rifle pit could easily see the areas to the north, south, and east, and warn of anyone approaching from those directions. The location especially afforded a good view of the territory to the east, which riders traveling back and forth between Mud Springs and the Rush Creek camp had to cross. Areas to the north, south, east, and immediately west of the station were visible enough to allow defenders to see anyone approaching from those directions.

Clearly, the pit would have been a good lookout post. But since soldiers could see farther than they could shoot, the weapons fan from the pit is very different from its distant viewshed. The hilltop weapons fan did reach a few areas that could not be hit from the station, but it was far less than perfect. It was certainly fragmented, so that warriors could approach from the west unseen to within 20 m of the pit. Beyond that, the hill to the southwest of the station covered an area big enough to serve as a staging area for mounted raids. The pit was thus not well placed for combative defense of the soldiers' position. If the rifle pit was occupied by soldiers after breaking the station siege, other pickets or guards must have covered the western approaches. If the pit was occupied in order to provide a view of attackers coming from the south, it was an effective location that allowed for ample time to warn those camped around or in the station. On the other hand, if the pit was constructed by the besieging warriors, then they had an excellent tactical position to pour fire into the station and corral while maintaining excellent protection for the pit occupants. Given that their warrior kinsmen were on their western flank, a view of that area may not have been necessary.

CONCLUSIONS

Archeological investigations of the Mud Springs battlefield present clear evidence that even the relatively small conflicts of the Great Plains frontier left physical evidence that can be archeologically recovered and interpreted to augment other records. Mud Springs also shows that even though western combat may have involved hundred of fighters and days of conflict, it is likely to be evidenced only by broad artifact distributions that require close analysis.

The artifact distribution across the landscape indicates that during the fight, warriors used the available terrain to their advantage. They fired at the station from behind the crest of the south hill, from behind a small rise on its lower flanks, and from behind a rise to the west. All locations were well within the range of the warriors' firearms and the range of return fire from soldiers and civilians in the station. The archeological assemblage suggests that the two sides that met at Mud Springs were in one way surprisingly well matched. Indian fighters appear to have had a wider array of arms than U.S. troops, but the armaments of the two sides seem fully comparable. The fighting left material signatures that suggest, however, that the two sides were tactically mismatched.

Recovered ammunition is consistent with intense fire from near the station. Volley fire at mounted fighters and

shots by mounted raiders, which are described in historical accounts of the fight, are not readily apparent even though hills and surfaces well removed from the station were surveyed. Archeologically, the margins of the Mud Springs battle were very hard to recognize. In part this may be due to indiscriminant relic collecting over the years, and to flooding and other fluvial events in the area where the creek has changed the landform. However, the rifle pit excavated to the south of the station can best be interpreted as a defensive lookout post. It suggests that most of the time, U.S. troops maintained an entirely defensive posture. A strong perimeter appears to have been augmented by a sentinel who could both see approaching enemy and possibly discourage furtive attacks. There is no evidence that troops were massed or arrayed in strength anywhere but at the station itself.

Indian warriors employed a very different approach to the Mud Springs fight. Artifact distribution together with viewshed and weapons fan analyses suggest that the terrain around Mud Springs supported hit-and-run tactics, stealthy attack, and mounted forays. At least some Indian shots were taken from open areas west of the station, and, according to historical accounts, the warriors appear to have used the available terrain, including the creek bank, to their advantage during the fight. The warriors fired at the station from behind the crest of the south hill, from behind a small rise on its lower flanks, from protection of the creek bank to the east, and from behind a rise to the west. The general situation appears to be a classic example of Native American fighting traditions of hit-and-run tactics, employing maximum cover to minimize exposure, and using superior numbers to pin down opponents in order to take the stock, supplies, or other war booty (Secoy 1992).

The U.S. Army was constantly frustrated by Indian hit-and-run tactics throughout most of the mid- to late 19th century. Organized effort, dependence on technological advantage, and defense of fixed facilities judged important marked U.S. military thinking of the day and is reflected in the archeological record of the defense of Mud Springs Station. Such tactical thinking was just beginning to undergo a marked change and to be carried to fruition over the next few years as warfare with the various Plains tribes reached its zenith. The warriors' use of the terrain to maneuver and to provide cover and maximum protection to the combatants is also amply reflected in the archeological record. A combination of analytical techniques, evaluation of historical and oral history sources, interpretation of the archeological record, and GIS-based terrain analysis provides a more complete view of the events at Mud Springs in February 1865. Aside from precisely locating battle events in space, the Mud Springs artifact distribution provides clear evidence of the different fighting styles of the two combatant groups, demonstrating the U.S. Army's versus the Plains Indians' manner of fighting and defense. Viewed in light of the expanding array of analytical techniques of modern battlefield research, Mud Springs offers an archeological reflection of those cultural differences in the practice of war and warfare.

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