The Pecos Trade Fair Area: Archeological Investigations of Apache, Comanche, and Spanish Related Sites at Pecos National Historical Park, New Mexico

Prepared by
Douglas D. Scott,
Department of Anthropology
University of Nebraska-Lincoln,
Peter Bleed,
Department of Anthropology
University of Nebraska-Lincoln,
and
Charles Haecker
Heritage Partnership Programs
National Park Service
Santa Fe, New Mexico

In fulfillment of Great Plains Cooperative Ecosystem Studies Unit
Task Agreement P12AC100344 and Cooperative Agreement Number: H6000110100
And a grant from the Intermountain Region Conservation Program Office, National Park Service

Lincoln, Nebraska
April 1, 2014
Final Report

List of Tables

List of Figures

Acknowledgements

The Pecos National Historical Park metal detecting project could not have been accomplished without the help of a great many people. Regional Archeologist James Bradford was helpful as always in getting the project underway. Former Park Archeologist Susan Eininger and former Park Curator Heather Young provided guidance, support, and direction during the course of the project for which we are extremely grateful. We are also grateful to current park archeologist Jeremy Moss for his invaluable comments and suggestions on earlier drafts of this report. The Pecos National Historical Park staff was helpful throughout our work in the park and we gratefully acknowledge their support.

Dr. Lee Drake of the Bruker Corporation was kind enough to conduct the non-intrusive XRF analysis of many of the artifacts collected during the field work. Dr. Drake's assessment of the data set suggests that Colonial Spanish iron may have a distinct trace element assemblage. His analysis is a first step in defining a pattern for the possible identification of Spanish Colonial iron using non-destructive techniques. We are most grateful to him for his support, time, effort on the XRF analysis.

Artist Nancy Lamm did an excellent job rendering several of the artifact details that are difficult to see in a photograph. We are grateful for her fine work.

We wish to extend our gratitude to Breana Garreston of the University of Nebraska for her patience and assistance with administrative details. Gary Wilson (NPS retired) and Dawn Bringelson of the Midwest Archeological Center, NPS were extremely helpful in getting the Cooperative Ecosystems Study Unit grant in place and operational. Many thanks to them.

We also wish to express our sincere thanks to Christopher Adams (USFS) and the members of the University of Nebraska-Lincoln 2012 summer archeological field school for their hard work in the field gathering and documenting the finds. Chris Adams demonstrated the true worth of metal detecting with his unparalleled skills in the archeological use of metal detectors.

Abstract

The 2011 and 2012 metal detecting investigations demonstrate the value of metal detecting as a complement to the earlier park-wide pedestrian survey by confirming certain site distribution patterns, identifying a wider variety of historic sites by the presence of datable metal artifacts, and identifying historic areas disturbed by modern activities that have no surface manifestations. Metal detecting has minimal impact to archeological deposits or archeological integrity especially in areas that have been exposed to years of collecting and other forms of surface disturbance. The metal detecting survey recorded 1438 metal targets. About 20% (304) of the metal targets were excavated and about 20% (65) of the excavated targets were collected for additional analysis. The metal distribution is patterned as far as the pre-twentieth century materials are concerned. The investigations may have found a Coronado era campsite. The project found the presence of metal objects in and around the 1617 Ortiz church with possible evidence of some burning supporting recent historical analysis the church was finished before being recycled in 1621. Recycled metal and trade item distribution patterns indicated both the Pueblo occupants and their trading partners used the boulder strewn slopes to the north and east of the Pueblo as temporary camp and metal working sites. The inventory also established there are good data present to identify mid-nineteenth century Santa Fe Trail routes and uses of the current park lands, and there is some evidence of Civil War era activity near the Pueblo, which has yet to be fully interpreted.

Introduction

Over a two week period in the early summer of 2012, with support, leadership, and participation of National Park Service (NPS) archeologists, a field party from the University of Nebraska-Lincoln under the auspices of a Cooperative Ecosystems Studies Unit Task Agreement P12AC100344 and Cooperative Agreement Number: H6000110100 conducted a systematic metal detector survey of several areas of the Pecos National Historical Park (Pecos NHP) focusing on the area traditionally known as the Trade Fair. Approximately 104 acres (42.9 hectares) were inventoried using metal detectors. As a cooperative undertaking at a property with a deep human history, a long research tradition, and responsibilities of diverse communities, the 2012 archeological fieldwork was undertaken after careful planning and coordination with NPS researchers, planners, and curators. It followed detailed assessment of the known and potential cultural resources of the Pecos NHP and the Upper Pecos Valley. It was designed to enhance understanding of the Park's history since 1541. And it was carried out to insure minimal impact to sites, objects, and areas that were visited.

The primary goal of this report is to present the information that was assembled in ways that reveal broad trends of human occupation of the Pecos River valley. Achieving that goal requires presentation of the understanding of the Upper Pecos Valley culture history that researchers brought to the field work. The link between the project objectives and the field activities is also explicitly laid out to maximize the utility of the results. This requires presentation of the sections and areal subdivisions that field workers visited. Finally, assessment of the methods that were applied in 2012 is another goal of this report since they involve some innovative approaches.

Culture History of Pecos NHP

Pecos Pueblo was the principal sedentary community in the Upper Pecos River Valley of New Mexico from circa A.D. 1450 until the 1790s, when Hispanic settlers entered the valley. The pueblo was a dominant force in the Pueblo-Plains-Hispanic interactions throughout most of the Spanish Colonial period (Haecker 2012; Baugh 1984; Capone 2010; Lintz 1991; Schroeder 1979; Spielman 2010).

Pecos Pueblo also was the site of A.V. Kidder's pioneering excavations from 1915 to 1929, which introduced more rigorous methods to American archeology (Beck 2006; Eininger 2002; Morgan 2010). Twelve years later, at a regional conference held at Pecos Pueblo, Southwestern archeologists devised the cultural-temporal classification scheme still used today to refer to a variety of archeological phenomena throughout the American Southwest (Woodbury 1993:90-95). Pecos Pueblo continues to offer a wide range of archeological research opportunities, particularly for understanding multi-cultural interactions and trade dynamics in the Southwest's Early Historic Period.

The first encounter between Pecos Pueblo and Europeans began in the fall of A.D. 1540, when elements of the Vázquez de Coronado expedition arrived at the site (Flint 2008:127-138; Flint and Flint 2005:401). In May 1541, the entire expedition, during its trek eastward to find the fabled city of Quivira, encamped for several days near Pecos Pueblo (Flint and Flint 1997:263-264). No overt acts of hostility took place at that time. However, when an advance company of the expedition returned to Pecos Pueblo in September, open conflict erupted. For four days, warriors launched periodic attacks against the company's encampment; the company in turn placed the pueblo under siege. Hostilities ceased only with the arrival of the main body of the expedition led by Vázquez de Coronado (Flint and Flint 2005:413). With the expedition's westward departure, Pecos Pueblo experienced a nearly 40-year respite from Spanish visits (Kessell 2002:67).

During this hiatus, the Faraon Apaches of the Texas western plains traded at Pecos Pueblo. Some Apache families even spent their winters there, both inside and just outside the pueblo (Forbes 1960:255). There is also archeological evidence suggesting that, by around 1600, Jicarilla Apache bands from north-central New Mexico were also trading and staying at Pecos Pueblo on an occasional basis (Gunnerson 1969:37). Archeological work conducted by James and Dolores Gunnerson within Pecos NHP revealed at least nine areas having concentrations of Apache ceramics (Eininger 2002:30-31). One of the largest of these concentrations is within the Trade Fair Area. Testing within this area produced pieces of stick-impressed adobe chunks intermixed with Jicarilla Apache ceramics (Gunnerson and Gunnerson 1970:3-4).

The thirty-one member Sánchez Chamuscado-Rodríguez expedition (1581), and the twenty-one individuals of the Espejo expedition (1583) renewed Native-Spanish encounters at Pecos Pueblo in the later sixteenth century through brief visits. After a sharp battle, a force under the command of expedition leader Gaspar Castaño de Sosa took control of the pueblo on New Years' Day, 1591, and then abandoned it days later when this force returned to the expedition's main camp, located hundreds of miles downstream on the Pecos River (Schroeder and Matson 1965:84-164). The entire Sosa expedition, numbering around 170 individuals (Schroeder and Matson 1965:11), arrived at Pecos Pueblo two months later and established their camp near the pueblo (Kessell 1979:59). In July 1598, Governor Juan de Oñate y Salazar, leading a 60-man company, visited Pecos Pueblo to receive its homage and then left the following day (Kessell 1979:77). With this latter encounter, Pecos Pueblo entered the sphere of sustained Spanish Colonial influence.

Artifact collections resulting from Kidder's excavations reflect a centuries-old Spanish contributions to the pueblo's material culture. Most of these historic artifacts derive from excavations of pueblo room blocks and the mission church complex and date primarily from the seventeenth and eighteenth centuries. Within the collection, however, is a sixteenth century copper crossbow bolt head (Kidder 1932:307, fig. 251i), recovered from an area that appears to lie outside the pueblo. The bolt head is diagnostic of the Vázquez de Coronado expedition, and may have been deposited as a result of the four-day siege of the pueblo in September 1541. An inspection of the Kidder Collection on loan from the R.S. Peabody Museum of Archaeology to Pecos NHP by Clay Mathers and Charles Haecker in 2009 identified at least one piece of plate armor that is either a brigandine plate or modified jack plate (Haecker 2012). This type of armor is typical of the Late Medieval-Early Modern Periods, and is likely to be associated with some of the major sixteenth century Entradas that visited Pecos Pueblo, such as those of Vázquez de Coronado or Castaño de Sosa.

Between 1697 and 1829, Pecos Pueblo was subject to 36 Indian attacks with the Apaches responsible for most raids throughout the period between 1697-1728 (Levine and La Bauve 1997:96). Yet Apaches continued to trade at Pecos Pueblo during this same period, reportedly setting up their tipis in the open valley to the east and southeast of the Mission Complex (Kessell 1979:134). In 1761, a priest described a typical Pecos trade fair as "…some two hundred or at least fifty, tents of barbarous heathen Indians…here the governor, alcaldes, and lieutenants gather together as many horses as they can; here is collected all the ironware possible such as axes, hoes, wedges, picks, bridles, machetes and knives…Here in short, is gathered everything possible for trade and barter with these barbarians in exchange for deer and buffalo hides, and what is saddest, in exchange for Indian slaves…" (Hackett 1937:486-487).

Pecos also functioned as an assembly point for Spanish Colonial militia companies and their Indian auxiliaries when the colony conducted punitive campaigns against their nomadic enemies (Jones 1966:72). Comanche raids occurred at Pecos Pueblo beginning in 1739 and continued until 1786, the year when Governor Juan Bautista de Anza successfully concluded a peace agreement with the major Comanche bands (Simmons 1970). Peace agreement festivities lasting several days were then held, with hundreds of Comanche tipis erected to the southeast of the Pecos Mission Complex. From then on, the Comanche participated in the annual Pecos trade fair, with all Apache bands then being treated as enemies by Comanche, Spaniards and Puebloan people alike (Kenner 1969:51-52; Kessell 1979:403-406). Pecos Pueblo began to lose its preeminent role as a trade center with the nearby establishment of the Spanish village of Vado in 1793. By 1800 Comanchero traders made their base of operations at Vado; instead of waiting for the Comanche to come to them, they took themselves and their goods to the Comanche. Nonetheless, the occasional trade fair took place at Pecos Pueblo well into the nineteenth century (Kessell 1979:410).

Previous Archeological Investigations of the Pecos Vicinity

Sue Eininger (2002:21-38) has ably summarized the seminal works of Adolph Bandelier, Edgar Hewitt, and A.V. Kidder at and around Pecos NHP. The following focuses on the archeological investigations of these and other researchers as they relate to the specific project goals of locating evidence of Spanish Colonial and later Euro-American presence at Pecos NHP. Bandelier is credited with placing Pecos Pueblo on the "archeological map" (Eininger 2002:21-22). His documentation efforts created a baseline for the later development of broad regional chronologies.

It was the advent of A. V. Kidder use of stratigraphic excavation techniques in the deep midden trash deposits of Pecos that led to the development of a local ceramic typology and site chronology of the Rio Grande Valley Puebloan culture sequence. Between 1915 and 1929, Kidder, funded by the Phillips Academy of Andover, Massachusetts, conducted ten seasons of field excavation within what is now Pecos National Historical Park. About 12-15 percent of the Pecos Pueblo site area was excavated. The results of his work and that of ceramist Anna Shepard literally changed the landscape of Southwestern Archeology and the larger field of North American Archeology.

Kidder's investigations touched on the extent of Plains influence, interaction, and trade at the Pueblo. Kidder uncovered some evidence in the form of artifacts that had “eastern derivations.” He dated these potentially Plains artifacts to the Glaze V (A.D. 1500-1700) and later periods based on their association with Pueblo artifacts and ceramics of those eras (Kidder 1958:313). In addition to the native Plains artifacts, Kidder also found unequivocal evidence of Euro-American presence in the form of wood and metal artifacts (Kidder 1932). Among the organic items he recovered at Pecos were four wood Christian crosses found in probable graves below Mission floor (Kidder 1932:295-296). Other definitive Spanish and other Euro-American goods consisted of metal artifacts (Kidder 1932:305-308).

In total, Kidder notes that there were 108 metal items found in the excavations of the upper levels of late rooms, presumably the material was largely from the South Pueblo, but the report is not specific (Figure 1). He mentions that some were found with bones of domesticated animals and fragments of china. He lists 108 iron items but does not describe them (Table 1) In addition he recorded 229 items made of copper or brass or bronze, 6 lead objects, and one small silver cross. In total there were 344 metal artifacts collected during Kidder’s excavations. Kidder (1932:308) mentions that he found and collected a few sherds of glazed olive jars and several hundred pieces of china. He noted the china was largely from blue and white dishes, but that some yellow, orange, red, black, and one purple colored decorated fragments were recovered. In addition he notes that glass and what he terms china beads were recovered from burial contexts in the Mission. He deferred describing the items, but states they were placed on deposit with the New Mexico State Museum in hopes an expert in sixteenth to eighteen centuries European ceramics and beads would eventually examine them.

The skeletal remains resulting from Kidder's excavations were another focus of study. Nearly 2000 burials were discovered during the work (Kidder 1958:279). Of these almost 1,000 individuals were examined, documenting age, sex, bone, cranial, and pathological observations by Hooton (1930). Kidder (1958:300-305) observed that 59 burials were found buried “at length”, now termed supine. He determined all but four dated to the Spanish Colonial and later periods. The majority, about 31, were recovered in the nave of the Mission church and the others in middens and rooms. None of the remains found in 1925 in the nave were examined by Hooton. Of the total supine burials only four contained European-type grave goods. One male burial had a wooden cross and 67 glass beads as inclusions. An adolescent male was found with three copper buttons and a stone arrowhead embedded in his torso. He was apparently wrapped in a woolen blanket. On his chest was a bronze religious medallion, a copper cross, some glass beads, and scraps of green brocade and silk fabric. Kidder (1958:304) noted that a 1915 excavation by Jesse Nusbaum in the same area recovered beads, buttons, wooden and copper crosses, medals, and a framed religious picture.

Table 1
European-made artifacts reported by Kidder (1933:305-306)

Iron total		108
Awls	48	
Nails	12	
Knife blades	8	
Harness rings	5	
Spoons	2	
Hoe frags.	2	
Keys	2	
Gun lock frags.	2	
Armor frags.	2	
Arrowpoints	2	
Rings, ½-3/4 inch	2	
Ring, 2 ½ inch	1	
Buckle	1	
Spur rowel	1	
Chisel blade	1	
Plane blade	1	
Pot handle	1	
Religious picture frame	1	
Unidentified frags.	14	
Copper, brass, and bronze total		229
Sheet scraps	132	
Rolls of sheet metal	15	
Crosses	15	
Rings	9	
Church bell frags.	8	
Candlestick frags.	8	
Awls	7	
Gun ornaments	6	
Small bells	5	
Buttons	5	
Religious medals	5	
Flat ornaments	4	
Arrowpoints	2	
Thimble	1	
Bodkin	1	
Knife	1	
Spatulate implement	1	
Unidentified	6	
Lead objects total		6
Small ornaments	2	
Sheet lead	1	
Bullet splash	1	
Unidentified	2	
Silver objects	1	
Small cross	1	
Total metal objects		344

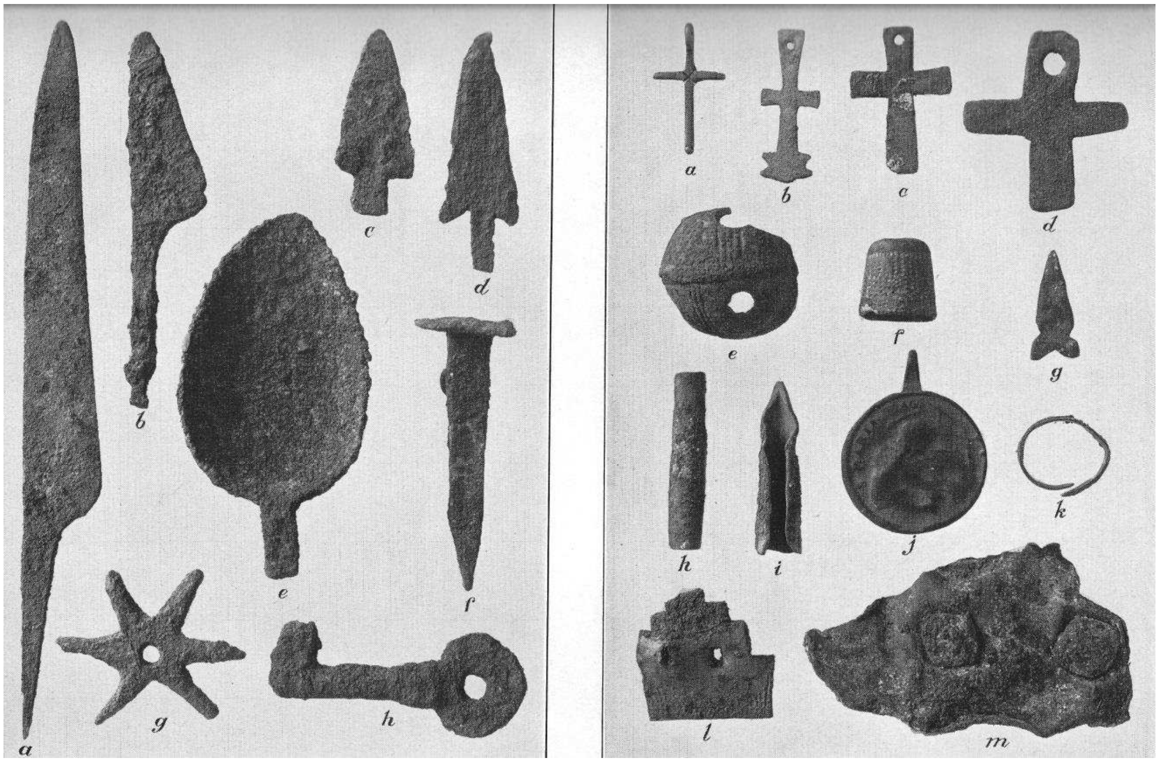


Figure 1. Metal artifacts illustrated by Kidder (1932) in his excavation report on Pecos Pueblo.

Lost Church Investigations

In 1956, Stanley Stubbs and Bruce Ellis, supported by the Laboratory of Anthropology, excavated portions of the so-called Lost Church. The Lost Church (Figure 2) is first of the "four churches of Pecos" (Hayes 1974:19). The Lost Church, also known as the Ortiz Church (Ivey 1996; 2005), was described and mapped by Bandelier in 1880 and re-mapped and tested by Kidder in 1925 (Ivey 1996:3-1). Stubbs and Ellis' work was designed to determine the age of construction and use (Stubbs et al. 1957:68).

Based on their historical research and excavation findings, Stubbs et al. (1957:85) suggest a construction date during "the first two decades of the 1600s". They concluded that the church was never completed, its materials salvaged for later construction elsewhere. Ivey's reanalysis of the various datasets concluded (1996:3-13; 2005:23-38), based on additional historical research and field investigations, that the church was complete or nearly complete when it was dismantled in 1621. Distinctive yellow adobe bricks originally associated with the Lost Church were found in walls of the South Pueblo that was constructed when the second church was begun in 1621. The second church ruins are under the standing ruins that are so visible today.

Figure 2. The Lost Church viewed from the east in 2012.

James Gunnerson's Search for Apache Sites at Pecos

During the summers of 1969 and 1970, James and Dolores Gunnerson, then of Northern Illinois University, conducted survey and excavation of several areas of Pecos National Historical Park in an attempt to locate evidence of Apache presence at the site. The Gunnersons were pioneers in trying to identify artifact and feature patterns that defined the Apache presence in northeastern New Mexico and the western Great Plains.

The 1969 (Gunnerson 1970) and the 1970 (Gunnerson 1970; Gunnerson and Gunnerson 1970) work at Pecos and nearby areas was done with support of a National Science Foundation grant and under authority of an Antiquities Act permit. The 1969 survey work located nine areas that yielded Apache pottery, Ocate Micaceous, and thin grayware sherds, that they believed were also of Apache origin. The same areas also yielded lithic material they assigned to the Texas Alibates quarries. Eight of the nine areas identified by the Gunnersons were within the metal detector areas investigated by this project. Only the area designated M, southwest of the church and pueblo, was outside our investigation area.

The Gunnersons' findings for each of their investigation areas will be discussed in relationship to the metal detecting survey results later in this report.

Square Ruin Investigations

A variety of test excavations conducted in the park during the early 1970s and early 1980s included testing at Square Ruin (LA 14081), a large, pentagonal-shaped masonry structure west of the South Pueblo. A variety of ceramics and some metal artifacts were found during the excavations (Nordby and Cruetz 1993). The 1982-1983 Square Ruin excavation was exploratory, and research questions concerning cultural affiliation and site function were largely unanswered. The discovery of an early pit structure—either a Developmental pithouse or a Coalition kiva--added further complication to the already murky findings from the excavations.

Pecos NHP Inventory Survey

In the 1990s, NPS conducted an intense, well-designed and well-executed inventory of the nearly 2,396 hectares (5,920 acres) of the main unit of Pecos National Historical Park recording 678 archeological components represented by 629 sites (Head et al. 2002). The work has provided an outstanding systematic analysis of the prehistoric and historic archeology of the area surrounding Pecos Pueblo. The stated project goals were to describe the discovered archeological materials, and examine two aspects of prehistoric Puebloan society in the Upper Pecos Valley: (1) the development of the Pecos community and (2) exchange of material goods between Pecos Pueblo and other Rio Grande Pueblos, and between Pecos Pueblo and a variety of nomadic Plains groups.

The survey effort employed mean ceramic dating techniques to identify occupation periods as well as potential ebb and flow of the resident population. The mean ceramic dates span a total of 510 years with the majority of the dates clustering in the fourteenth and fifteenth centuries. The mean ceramic date plots suggest a relative lack of sites dating to the 1500s, with a resurgence of dates by A.D. 1600. Another potential population decline occurs between A.D. 1718 and 1744.

The 1990's survey recorded only three sites that could be affiliated with Plains or Apache culture groups. The Plains cultural affiliation was assigned with low confidence because at least an equal amount of Puebloan material was present on the sites, probably indicating reuse of locations over time by different groups of people. Two of the sites with Ocate Micaceous ceramics, which are assumed to be diagnostic of Apache presence, also had other diagnostic Plains/Apache traits. PECO 200, dating to ca. A.D. 1475-1600 had a high proportion of obsidian and a metal projectile point. Another site (PECO 366), a large artifact scatter, was dated to A.D. 1450-1838, based on the finding of an end scraper and a basal notched projectile point, often considered to be diagnostic Plains attributes.

Of the 629 archeological sites and 678 components recorded during the Pecos survey, 53 sites with 54 components were dated to the historic Euro-American periods. Euro-American artifacts were found on 50 of these sites. These historic sites reflect the significant presence and impact of Euro-American residents, short-term occupants, and users of what is now the park. Included are Santa Fe Trail campsites and trail components, a previously recorded Civil War Union army camp, a trading post, and ranches and their components of corrals, outbuildings, fences, and line camps. It should be noted that all sites were located based on their surface manifestations. No metal detecting or other geophysical instrumentation was employed on the park-wide survey.

Previous Metal Detector Sampling Survey

In the summer of 2011, Haecker (2012) implemented a metal detecting sampling survey of the Trade Fair Area and adjacent areas where pre-modern trading visitors to the pueblo are likely to have camped and assembled. The metal detecting effort was designed to determine the presence of metal artifacts within the survey area. The project sampling universe comprised 33 contiguous survey units, each measuring 100 by 100 meters, totaling 330,000 square meters (33 hectares/81.50 acres). Eighteen of the survey units included portions of *exclusion areas*, that is, areas that were avoided during the investigations as they fell within known culturally sensitive areas. Park maps and sites files were checked prior to initiating fieldwork, to identify previously recorded surface remains indicating sites and isolated occurrences within the project area. Other exclusion areas incorporated zones where the presence of modern roads, parking lots, buildings, and the disturbances associated with them, would make surveying difficult or impossible. Together, the exclusion zone areas comprised approximately 51,000 square meters (5.1 hectares/12.6 acres), and represented 15.5 percent of the potential area of interest. Thus, the non-excluded portions comprised 206,280 square meters (20.6 hectares/51 acres), or 84.5 percent of the sampling area. Approximately five acres (two hectares), or ten percent of the non-excluded portion of the area, was surveyed. Survey work entailed placement of a series of parallel and evenly spaced transects, each transect measuring three meters wide and aligned to conform to the Universal Transverse Mercator (UTM) grid system, North American Datum (NAD) 1983, throughout the sampling area. Primary transects extended along a north-south axis.

2012 Project Objectives and their Link to Field Investigations

The Trade Fair Area played a crucial role in making Pecos Pueblo a primary center for exchange and communication within the Plains, Pueblo, and Hispanic culture regions for more than three centuries. This area is often defined as a neutral space, permitting various ethnic groups to conduct their trading activities with a modicum of safety; a place where Puebloan, Nomadic, and Hispanic emissaries and their respective retinues could interact in good faith. The Trade Fair Area also may have functioned as a sometime haven for the pueblo’s erstwhile Apache allies and a place of assembly for punitive expeditions. Unfortunately for Pecos Pueblo, the Trade Fair Area and its surrounding environs also may have functioned as a locale for its enemies to camp and launch attacks against the pueblo.

All of these activities may have deposited cultural remains that reflect specific ethnic groups and the activities that brought them to Pecos. Those activities may have been peaceful or warlike. The material culture remains help date the activities and time of deposition. The 2012 project, a cooperative effort between the NPS and the Department of Anthropology, University of Nebraska was designed to address these issues. In addition to identifying discrete activity clusters, and their ethnic-chronological associations, the project was designed to address other major thematic issues concerning Historic Period developments at Pecos Pueblo. These supplementary issues include:

- Differences in camp organization/layout/composition through time, by ethnic group, and by function – such as military vs. residential;
- Possible differences in trade items brought to, and exchanged with, Pecos Pueblo, such as changes in object classes and artifact morphology through time and by ethnic group;
- Post-manufacture modification of metal objects, including reuse and recycling of European objects by Pueblo and other Native communities;
- Identification of the type and location of camp, military and exchange activities relating to the earliest Spanish-led entradas.

Although there is a rich and well-documented historical record of sixteenth century Spanish expeditions to Pecos Pueblo, archeological traces of these salient events remain disproportionately meager. Southwestern archeologists, historians and anthropologists have repeatedly emphasized the importance of Pecos Pueblo from circa A.D. 1450 onwards (Kidder 1932:3; Head and Orcutt 2002:8; Spielmann 2010:21-22). Much of the Historic Period at Pecos Pueblo, however, remains poorly understood and elusive. The intent of this project was to address a major void in our understanding of this major Southwestern landmark. The archeological focus on the Trade Fair Area was intended to result in the identification of materials associated with the seventeenth century Spanish-led expeditions of Vázquez de Coronado, Sánchez Chamuscado-Rodríguez, Espejo, Castaño de Sosa, Leyva de Bonilla and Humaña, and Oñate y Salazar. It was hoped that evidence of Puebloan, Spanish, Apache and Comanche traders during the sixteenth, seventeenth, and eighteenth centuries, as well as of Anglo-American traders during the nineteenth century would be discovered. Discovery of artifacts relating to these activities, as well as possible traces of associated features visible on the surface may hold both national and international significance.

Metal Detection as a Technique for Extensive Archeological Survey at Pecos

Metal detection has become a well-established archeological tool (Connor and Scott 1998), but most research applications of metal detection have focused on specific questions, events, or places such as work at battlefields and farmsteads. By contrast, by surveying large blocks of terrain, the 2012 Pecos survey targeted general patterns and long-terms trends of landscape utilization. To be sure, most of the survey blocks included recognized archeological features. The events and trends of Pecos history are well-established so the survey blocks were hardly arbitrarily placed. The goal of the 2012 survey was to assess the kinds and amount of material around, between, and away from the Park's Pueblo-Mission Complex. It included several areas that were without obvious constructions, but that may have been used by travelers and visitors or ephemerally by transient communities. In any case, the goal was to locate activity areas rather than collect objects.

Because the 2012 investigations depended on metal detectors, essentially all of the artifacts located during the survey dated from the post-contact period. Still, this project and systematic metal detection can be viewed as an expansion of historical archeology. European-manufactured metal objects have been available in the Pecos area for some 500 years. During this deep block of time, the area was occupied and visited by several culturally diverse populations. These communities used the landscape in many ways and engaged in social patterns ranging from conflict to trade, from settlement to migration, and from professional archeological investigations to visitation. The depth of the post-contact period at Pecos is somewhat greater than it was in some other parts of North America. The population and material culture of Pecos are also distinctive, but post-contact developments and processes across North America are comparable to the situation in Pecos. This suggests that regional metal detection survey might have applications in other geographic areas and to a variety of anthropologically interesting issues.

Applied field methods centered on the complementary use of metal detectors and two Trimble® global positioning system (GPS) handheld units. The latter tools provided the UTM coordinate locations of targets (subsurface and surface metallic artifacts) with sub-meter accuracy. The survey team metal detected across each survey transect, spaced approximately 5 meters apart. Selection of these survey units was based on their being located within the three primary areas of interest: the Trade Fair Area; adjacent wooded uplands that demarcated the Trade Fair Area; and a portion of flat to rolling juniper-grassland southeast of the Mission Complex. Another consideration for selecting a particular grid unit for survey was its relative sparseness of vegetative ground cover, which would enable more effective use of metal detectors than the more heavily vegetated areas.

2012 Project Methods

The 2012 survey was built upon the methods and results of a 2011 survey. The 2011 area and transect size are described in a preceding section. The 2011 survey involved the use of metal detectors operated by professional archeologists who met the Secretary of Interior's 1983 *Standards and Guidelines for Archeology and Historic Preservation* [as amended and annotated]. Upon receiving a positive signal, operators placed a numbered red pin flag at each location and continued the survey. A sequential field specimen (FS or target) number was assigned to each metal detector hit. Visual inspection of the ground surface also identified some nonmetallic artifacts which were not recorded per park direction. Concurrently, another team member recorded each flagged location using a decimeter accurate GPS unit. In 2012 one variance from the 2011 plan included the need to survey forested areas covering broken landscape by following landscape contours, as opposed to surveying formally delineated transect bearings.

Another variance from the 2011 scope of work involved occasional excavation of targets that metal detector operators suspected held temporal significance, for example, copper readings typical of early- to mid-nineteenth century military buttons. However, most of the excavated targets were selected via random sampling, as described in the scope of work. To complete its tasks, the survey team employed forms that tracked in-field analysis of re-buried targets, a field specimen log for collected artifacts, and a photo log. The field data collection was done digitally using an Ipad 3®. The Ipad used the Documents to Go® application to record each target on a spreadsheet. Another application, Theodolite HD® was used to photograph each excavated artifact. The application recorded position in UTM coordinates, approximate elevation, horizontal angle of the image, and the azimuth of the camera. The application allows for a comment field to be inserted. A 20% percent sample of objects was excavated along each transect using preselected tables of random numbers, derived from the Arc4Rand® application on the Ipad.

An artifact was collected only if it provided information that was 1) diagnostic of a particular chronological period or ethnic group, or 2) was sufficiently unusual to merit additional research. In all cases, artifact collection adhered to procedures stipulated by the park. An aluminum tag, stamped with the field specimen number, was deposited in the excavated hole at the depth where the collected artifact originated, thereby marking the exact location of discovery if the park should later decide to return the artifact to its place of discovery.

The NPS and University of Nebraska-Lincoln built the summer 2012 project on the fall 2011 NPS survey results. Field methods were revised to reflect the need to more intensely investigate and cover more land surface. Field methods generally followed the 2011 concepts, but were adapted to obtain greater ground coverage and a larger sample of metal targets. No more than 20% of the identified targets were exposed and the great majority of those pieces were reburied in place after they had been documented.

Both *very low frequency* (VLF) and *pulse induction* (PI)-type metal detectors were used during the 2012 field investigations. VLF metal detectors are more versatile than PI machines since the former can identify different types of metals as well as pinpoint the exact location of a buried target. VLF detectors can identify targets down to a depth of approximately one foot (30 cm) below surface. VLF detectors were the primary metal detector employed during the block area surveys. Students and professional archeologists used a variety of VLF detectors including Minelab ETrac®, Minelab Explorer II®, White's V3i®, Fisher F75®, Tesoro Lobo Super Trac®, Troy®, and a FoersterMine-X® military grade mine detector.

PI detectors can identify targets to a depth of at least three feet (approximately1.0 meter) below surface, and can screen out conductive salts and mineralization. A PI detector, however, cannot distinguish between different types of metals nor can it pinpoint the approximate depth below surface of a target. PI detectors require that they are not used in proximity to VLF machines due to electronic interference potential. USFS Archeologist Christopher Adams employed a Minelab 3500® pulse induction metal detector to re-sweep three blocks to assure as complete coverage as possible. The PI result was also compared to the VLF transect sweep result to determine how effective the PI is at identifying additional small and deeply buried targets.

The survey was conducted in three steps. First, a line of five or six students spaced at 5 m. intervals walked across a selected area sweeping their path with a metal detector. In open country these transects were very regular, but even in areas of Piñon-Juniper forest where transects were meandering, detection aimed at systematically covering the block. We estimate that 20 to 25% of each of the survey blocks was intensely swept with a detector given the individual spacing within each block, which is consistent with previous tests of metal detector efficiency (Heckman 2005, Scott et al. 1989; Scott 2010).

When a metal target was encountered, a surveyor marked it with a non-metallic pin flag and continued the transect sweep. Following the detector line, flagged targets locations were recorded with a Trimble GeoHT® GPS unit. Finally, targets were selected for excavation using a random number generator, although a few targets were judgmentally exposed. In heavily vegetated areas where visibility hindered the recording team's ability to find target flags every fifth flag encountered was excavated instead of employing the random number generator. The excavated targets were identified and catalogued on an Excel® spread sheet and photographed using Theodolite Pro®, which captured a variety of information including a UTM location and allowed for the FS number and a comment to be embedded in the image. The last two steps were done with an iPad so the system was essentially paperless. Only a very few objects were collected because they reflected unusual qualities that supported the Park's research or interpretive priorities. Each collected target had a numbered metal tag buried at the excavation locale for future reference.

This recording system worked quite well. Key elements were all electronic or digital so that daily results could be downloaded and presented at the end of the day on ArcMap 9.3® GIS program. This made it easy to assure that records were complete and that coverage was comprehensive. The system also fit well with the training goal of a field school. Learning to use metal detectors and interpret their signals seems quite comparable to learning how to use any of the other tools of field archeology. The work was no more arduous than other field tasks, but it succeeded educationally since it introduced students to grids, record keeping and documentation, excavation, and identification of a range of artifact types.

Six Survey Areas (SAs) were investigated under this scope of work totaling about 104.5 acres (ca. 42.9 hectares) (Table 2, Figure 3). These areas were selected based on archival research and the 2011 metal detecting results. Each survey unit was identified by NPS personnel. The rationale for selecting these areas is described as follows, and is listed in order of priority:

SA 1: As noted above, the Trade Fair Area is defined as the estimated 20-acre open expanse located to the immediate east of the Pecos Pueblo convento. The metal detection sample survey in August 2011 (Haecker 2012), as well as limited excavations conducted in 1969 by James and Dolores Gunnerson, suggests SA 1 contains physical evidence of semi-permanent habitation features, in addition to associated artifact scatters. For example, Gunnerson and Gunnerson (1970:3-4) note subsurface remnants of stick-and-grass impressed burned adobe in association with eighteenth century Apache ceramics.

Table 2
Metal detected artifact quantity by Survey Area

Survey Area	**Acres**	**Total targets**	**Excavated targets**	**Collected targets**
1	20	599	69	11
2	2.5	33	5	1
2 addition	2	34	9	2
3	1	16	3	1
4	20	221	68	22
4 addition	5	194	5	0
5	10	125	20	4
5 addition1	6	15	2	0
5 addition2	3	74	36	2
6	10	80	16	1
6 addition	10	20	6	3
Oct. recon.	15	75	57	18
Total	104.5	1486	306	65

These archeological remains are located approximately 100 meters east of the Pecos Pueblo-Mission Convento complex.

SA 2: This is a 2.5-acre area located approximately 200 meters east of the Pecos NHP administration building complex (Table 2). This area comprises Survey Unit G-4, as defined in the August 2011 survey (Haecker 2012) and was resurveyed in 2012. According to park archeologist Sue Eininger (pers. comm. 2012), this general area of the park was subjected to mechanical ground disturbance associated with vegetation clearing.

Nonetheless, analysis of 2009-dated aerial images of Unit G-4 suggests that, within this unit, there is at least one circular anomaly that is approximately eight meters in diameter (Haecker 2012). This anomaly(ies) could be indicative of Plains Indian tipi ring(s). Significantly, in 1761, priests at Pecos Pueblo reported over 100 tipis were located to the southeast of the mission church; SA 2 is to the southeast of the church. Metal detection of SA 2 during the 2011 survey did not result in recovery of either Spanish Colonial or Territorial Periods artifacts. The area was expanded about 2 additional acres to the west and south

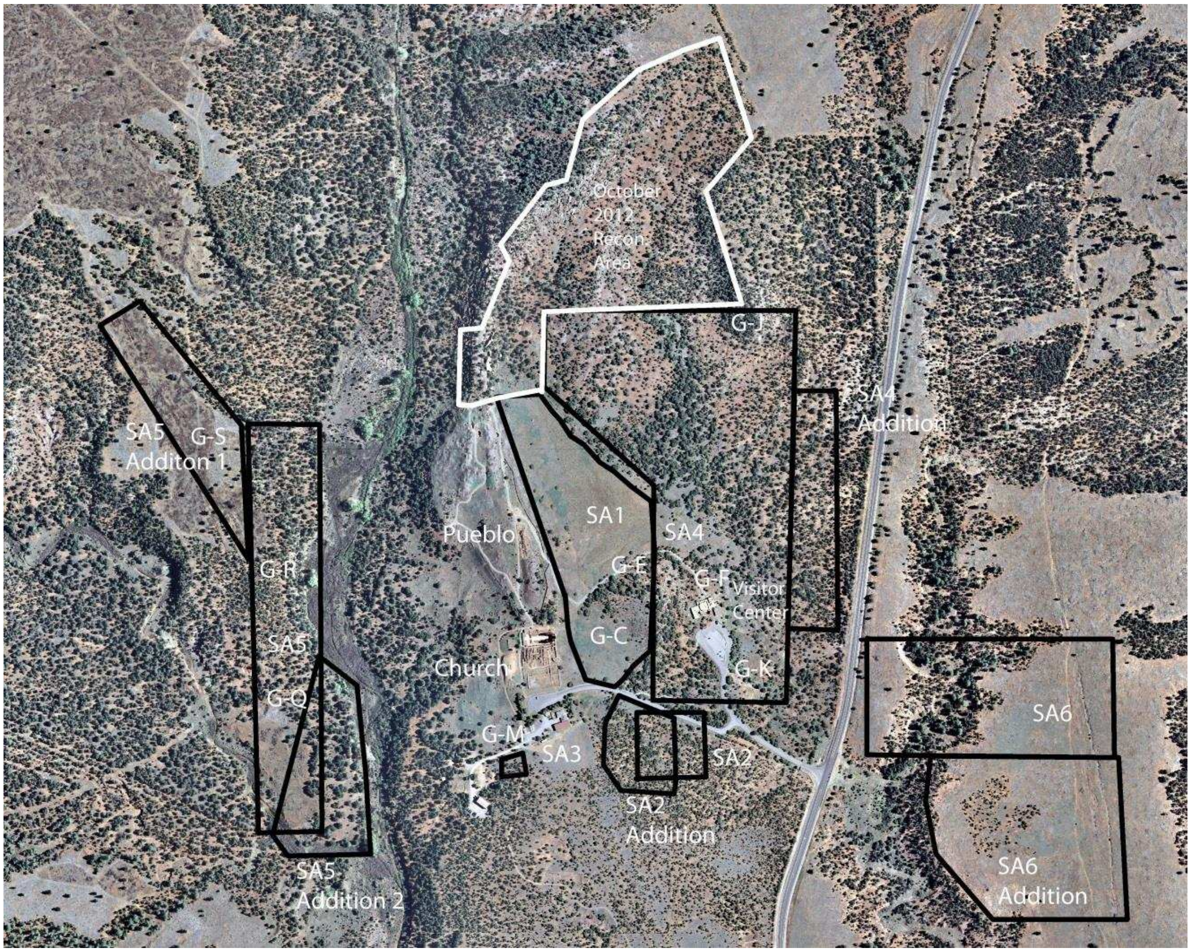


Figure 3. Metal detecting project survey areas note as SA 1-6 and additions. G denotes the approximate locations of James Gunnerson's survey and testing areas, C, E, F, J, K, Q, R, and S, in 1969 and 1970 (after Gunnerson and Gunnerson 1970:2).

during the 2012 metal detection investigation. In addition a suite of appropriate remote sensing techniques (described below) were applied within this search area, in order to determine probable chronology and cultural affiliation(s) of these soil anomalies.

<u>SA 3</u>: This survey area, of less than one acre, centers on PECO 65/LA 14148, which had been previously identified by Jicarilla Apache informants as a tipi ring. It is comprised of a linear array of rocks in associated with a less defined rock concentration. The site is located approximately 200 meters southwest of park headquarters. Geophysical remote sensing of this site provided comparative data with subsurface soil anomalies similar to those identified within other Survey Areas, e.g., SA 2.

<u>SA 4</u>: this is an estimated 20-acre area that forms the northern, eastern and southern boundaries of SA 1. Results of the August 2011 (Hacker 2012) reconnaissance survey suggest limited utilization of these wooded upland areas by non-puebloan peoples during the Spanish Colonial and Territorial periods.

SA 5: This is an estimated 10-acre area that borders the western side of Glorieta Creek, and approximately 300 meters west of Pecos Pueblo. In September 1541 approximately 400 members of the Vázquez de Coronado expedition placed Pecos Pueblo under siege. Such warlike action likely included prevention of the pueblo's inhabitants from acquiring water, and the nearest water source, aside from a now dry spring, for the pueblo would have been Glorieta Creek. SA 5 is comprised of a flat to rolling landform that makes it suitable for encampment. It is within viewing distance of the pueblo and adjacent to the creek.

SA 6: This is an estimated 10-acre area east of State Road 63 and approximately 450 meters east of the Pecos Pueblo-Mission Complex. The area is closer to the river and may have been chosen for campsites due to its broad flat expanse and association with water sources, similar to SAs 2 and 5.

Upon completion of the initial analysis of the summer data set as well as field observations it was decided to return to Pecos in October 2012 to conduct additional reconnaissance in two areas. The field work was performed by USFS Archeologist Christopher Adams, NPS Archeologists Charles Haecker, Pecos Park Archeologist Sue Eininger, and University of Nebraska Archeologist Douglas Scott using Troy®, Minelab Etrac®, Tesoro Lobo Supertrac®, and Minelab Explorer II® metal detectors. The areas of investigation were west of and north of SA1 and SA4. Much of this expanded area was not available for survey during the summer 2012 field investigations, but based on the summer finds the team recommended investigating these areas. Permission was obtained and the reconnaissance effort used five to ten meter spacing to metal detect the additional areas. Sixty-two additional targets were found and nearly every target was excavated and recorded, but only diagnostic materials were collected. The fall 2012 field work included areas in the vicinity of the Lost Church and select areas immediately north of Pecos Pueblo's North Defensive Wall and the west and east side of the narrow ridge that runs northeasterly from the Defensive Wall. Culturally sensitive areas were identified by the park archeologist and avoided by the metal detector team. The reconnaissance areas encompassed approximately 15 additional survey acres.

Geoarcheology Soils Analysis

An original intent of the project was to supplement the metal detecting and remote sensing with a geoarcheology soils analysis. It was anticipated that, if found, intact subsurface physical evidence of tipi rings, Euro-American tent pad clearings, hearths and other manmade soil anomalies could be represented by deposits of fine-grained soils mixed with ash, charcoal and other organic materials. The project originally included a geoarcheological soil scientist, Steven Hall, of Red Rock Geological Enterprises of Santa Fe. His assessment of the surface soils in which the vast majority of metal targets were found indicated that they were not conducive to soils analysis using the preferred coring (limited disturbance) method. Instead, he recommended if test pits could be dug, soil samples could be taken for complete and appropriate analysis. Digging test pits was beyond the scope of the approved project, however, and therefore was not included, but could be considered in future efforts.

Artifacts Identified by Block and Non-collected Artifact Identification

The 2012 field investigations found and recorded 1486 metal targets adding to the 304 targets recorded during the 2011 sampling effort (Figure 4). Forty-eight target locations were either Pecos Survey site stakes, old pin flag wires, mineralized or “hot” rocks, or mineralized soil pockets that gave a false reading on the detectors. Eliminating the 48 pin flag wires and false targets leaves 1438 metal targets. Of that number, 1132 were recorded but not dug and 306 were excavated and recorded. The excavated and recorded group comprises an approximately 21% sample of all metal targets (Figure 5). Within that group, 65 artifacts judged to be diagnostic or requiring further identification and analysis were collected (0.045% of all metal targets or a 21% sample of the excavated artifacts). Most of the excavated targets were modern in origin, which is twentieth century. The majority of the excavated but not collected materials were baling and fence wire and other non-diagnostic and nondescript artifacts such as wire nails, hole-in-cap tin can fragments, sanitary tin can fragments, tobacco cans, a baby’s spoon or small tea service spoon, various modern bullets and cartridge cases, and miscellaneous pieces of iron straps and sheet iron (see Appendix 1 for a complete listing and identification of materials excavated). The collected materials and the more diagnostic non-collected artifacts are described in the following section.

As part of the project study the question of how accurate was the UTM location derived from the Ipad® Theodolite HD® application was compared to the Trimble GeoHT, as a control, derived UTM location for the same target. A random sample of 10% of the Theodolite application artifacts were selected and compared to the location derived from the Trimble unit. The Theodolite locations varied from 0.6 meters to 1 meter from the Trimble locations. On average the Theodolite locations were about 0.8 meters less accurate than the Trimble locations. The Theodolite application was consistent in its data recording and depending on the necessity of precision and accuracy for spatial location in a given project it could prove to be a valuable tool in many archeological recording situations.

Metal detecting technologies were also tested over the course of the project fieldwork. Metal detecting in two small sections of Survey Areas, 1 and 2, employed comparisons of the PI and VLF systems. A portion of SA1, east of the church and in the highest metal density area was metal detected a second time using PI technology after sweeping the area with VLF machines. Fifteen additional targets were identified in the selected area by the pulse induction metal detector. In this case, the PI machine found about 25% more targets than the VLF machine in the same area. A portion of SA2 was also metal detected using both technologies. Twenty-four targets were identified in the selected area by the pulse induction metal detector. That area was detected again using a VLF machine. The VLF machine identified 17 targets. In this case the PI machine found 29% more targets than the VLF machine.

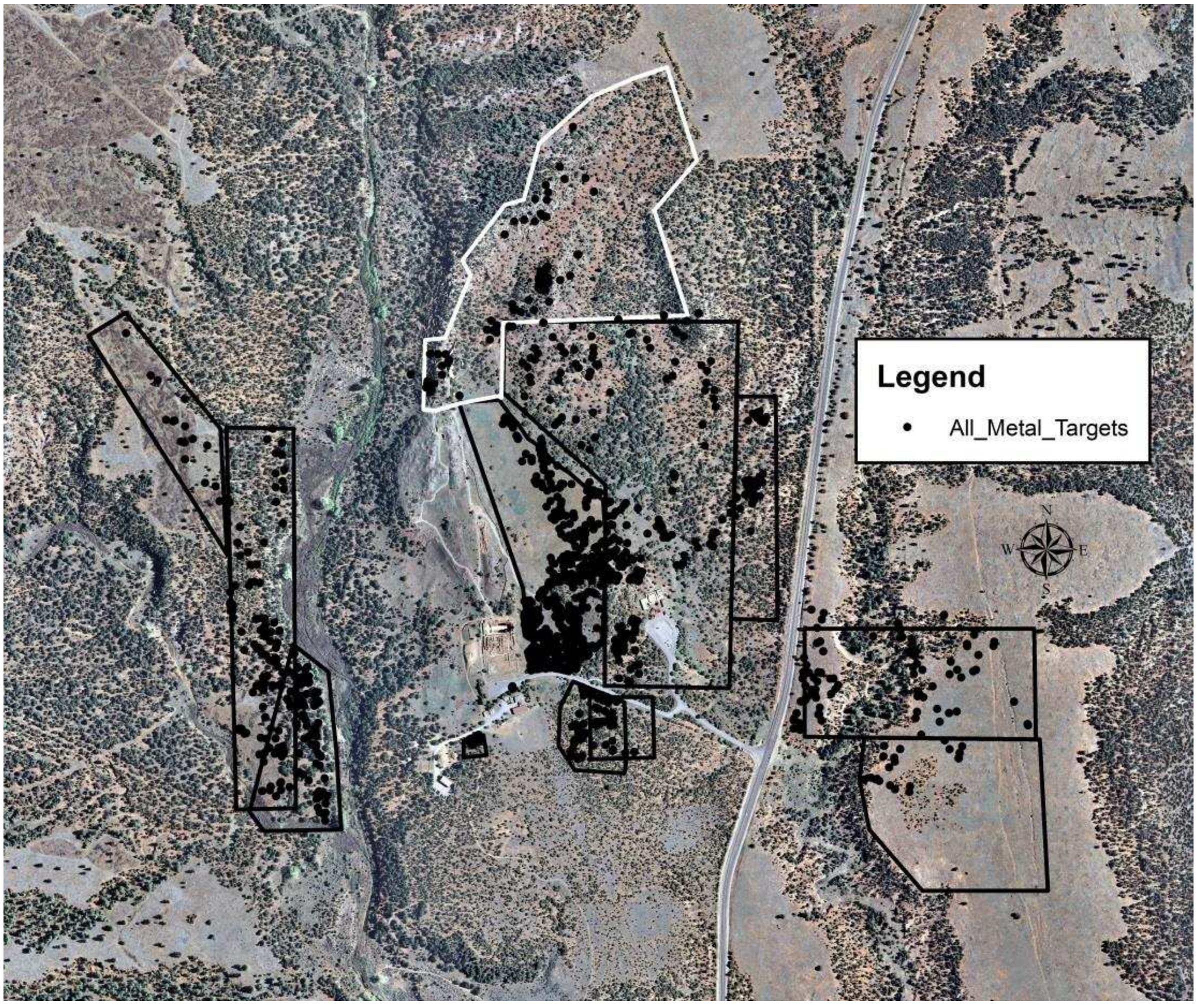


Figure 4. All metal detected targets recorded during the survey.

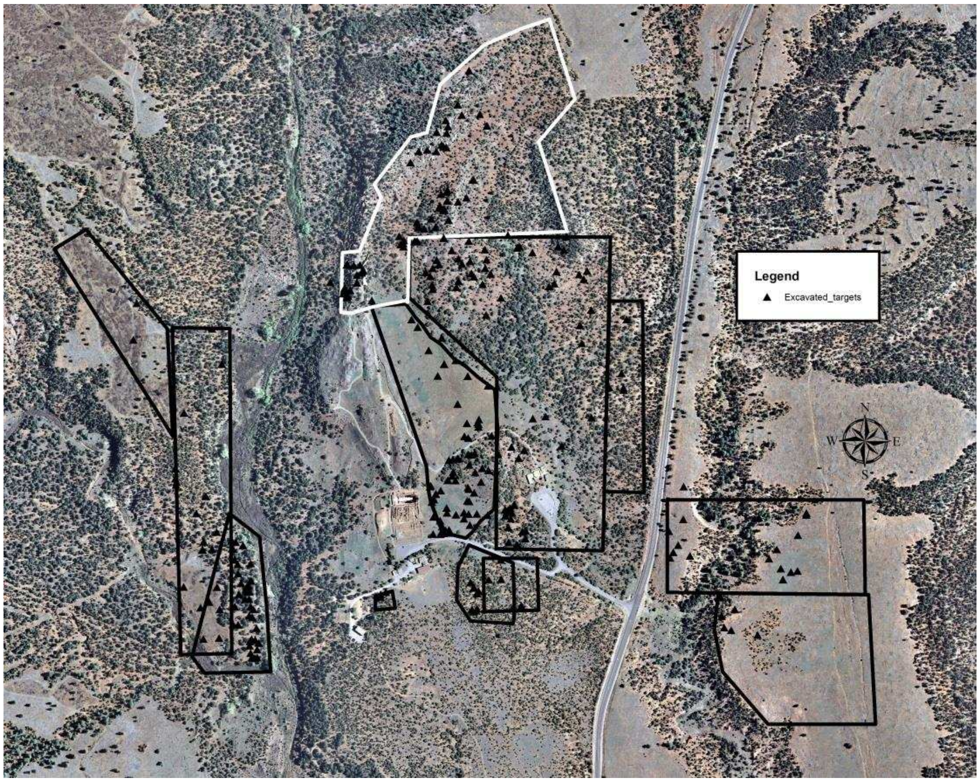


Figure 5. Metal detected targets excavated using random sampling methods.


Figure 6: Recording a metal detector find using an Ipad®.

A similar comparative test of PI and VLF metal detectors was carried out in 2010 at Little Bighorn Battlefield National Monument (Scott 2010). In the Little Bighorn test the PI found about 15% more targets than the VLF machines. The Pecos PI-VLF test resulted in a larger percentage of targets found with the PI compared to the Little Bighorn test. One reason for the discrepancy may be that the Little Bighorn test was carried out by professional archeologists with extensive metal detecting experience as opposed to the Pecos test which had an experienced professional archeologist use the PI and field school students use the VLF technology. Additional field testing of the PI machine compared to VLF machines with better controls is warranted, but the initial tests suggest that a pulse induction metal detector can find smaller and more deeply buried targets than the VLF machines. The PI technology, however, cannot discriminate different metal types from one another as can the VLF technology.

Artifact Descriptions and Analysis

The artifacts are described by type and function. A general description is provided as well as measurements when pertinent. Artifact measurements are given in the English system which is commonly used in historic archeology in the United States. The artifacts are also identified to function and dated where possible. Date ranges for known use or manufacturing period are provided when known. In addition to the descriptive component many of the artifacts were analyzed for their elemental content using a non-destructive and non-intrusive technique of X-Ray Fluorescence or XRF. The XRF analysis was done by Dr. Lee Drake of the Bruker Corporation. Dr. Drake employed a Bruker Tracer Series IV XRF to identify the elements present in a specific artifact. X-ray fluorescence is a process whereby electrons are displaced from their atomic orbital positions, releasing a burst of energy that is characteristic of a specific element. This release of energy is then registered by the detector in then XRF instrument, which in turn categorizes the energies by element. The XRF results for tested artifacts are presented in the descriptive section by artifact type.

Ceramics

Identification of historic ceramics was not a systematic part of the recovery program, but in the course of exposing targets and surface inspection, some sherds were noted and recorded. Target 710 is an uncollected fragment of salt glazed earthen ware, most likely from a crock. It dates to the late nineteenth century or early twentieth century.

A ceramic jar handle or lug, Target 1018, was found on the surface during the survey Figures 7, 8). It is an unglazed coarse and unrefined utilitarian ware that is light gray to white in color. The paste has a coarse sand temper and was fired at a low temperature. It is consistent with Spanish Colonial production. The style is consistent with a storage vessel handle possibly from a Cántaro-style vessel. This vessel style has a long history, dating from pre-conquest to the eighteenth century (Fox and Ulrich 2008: 20-28; Deagan and Cruxent 2002:205-211). XRF analysis indicated the elemental make-up of the handle is not consistent with local soil types, suggesting the ceramic item was manufactured and imported to Pecos. The XRF analysis is consistent with the identification of the ceramic as Spanish Colonial.

Religious items
Target 1016 is a flat, octagonal-shaped cast copper alloyed medallion about ½ inch long and 7/16 inch wide (Figure 9) and was found on the open ground below the Lost Church. XRF indicated the artifact is composed of 80% copper, with the remaining 20% being trace elements which are in descending order zinc, lead, tin and arsenic probably indicating it is brass and likely of European origin for the piece. One face bears the symbol for the doorway to heaven flanked by two saints and the other face bears the image of the stairway or holy stairs Christ walked up on the way of the cross, and these flanked by the words **SCALA SANCTA**. At the bottom are **A IV** with the A separated from the IV by an embossed dot and with another embossed dot following the IV. The A has no crossbar. The suspension ring is broken and missing. The medallion is known as a Roman Catholic Scala Sancta and has been used for hundreds of years by religious devotees. The "A IV" may refer to the Latin phrase *absit iniuria verbis* (Let injury be absent from the word) or *absit invidia* (Let ill will be absent). The method of manufacture suggests a seventeenth century to as late as the mid-eighteenth century date.

An uncollected piece of iron, Target 1247, may be the distal fragment of a small iron crucifix arm. The artifact is flat and is about ¼ inch long and 3/8 inch wide. The piece is very thin and oxidized, perhaps burned, with a suggestion of trilobed end. The identification as a fragment of crucifix is tentative.

Copper ear cuffs or earrings
Two copper rings are likely ear cuffs or earrings (Figure 7). Target 1703 is a plain copper strip that was about 1 inch long and 3/8 inch wide. It is now partially flattened but appears to have been circular in shape originally. It is cut from heavy sheet copper and has unfinished edges. The second ear cuff (Target 768) is circular and about ¾ inch in diameter and approximately 3/8 inch wide (Figure 10). It appears to have been cast in a mold. The edges are finished and the two ends are neatly finished and are separated from each other by about 3/16 inch. The exterior is emblazoned with zooomorphic designs that appear to be alternating canines and possibly turtles or tortoises.

XRF analysis of the ear cuffs or earrings indicates one is copper (Target 1703) and the other brass (Target 768) with other minor trace elements present. The general copper to other element percentages in Target 1703 is consistent with tested elemental composition of sixteenth century copper kettles found at Basque whaling stations in Canada (Fitzgerald et al. 1993).

Possible aglets and chainmail
Targets 1230 and 1655 are copper pieces that are likely aglets or lace ends used on clothing in the sixteenth and early seventeenth centuries (Figure 7). Target 1230 is a roughly circular flat copper piece about 3/8 inch in diameter (Figure 11). It was folded over on itself to create a rough half circle, which suggests it was pressed into service as

an ersatz aglet. The piece is heavily hammered which obscures much of its surface, but under high magnification of a digital microscope and employing oblique lighting two letters and part of two decorative motifs can be seen. The letters appear to be **VM** (possibly a part of the words "**Hispaniarvm** or **Alarvm Tvarvm**") and the motifs to be a set of lines and a rampant lion-like figure. It is possibly part of the Spanish royal seal of the type used on coins during the reigns of Ferdinand and Isabella (1474-1506) or Phillip II (1556-1598). If the interpretation of these badly damaged motifs is correct, this may be a repurposed sixteenth century one reale copper coin known as maravedis.

Target 1655 is a piece of rolled copper about ¾ inch long and 1/8 inch in diameter (Figure 12). It conforms exactly to aglets found at La Isabella by Deagan and Cruxent (2002:188-190), likely confirming a sixteenth or early seventeenth century date for the item. Very similar aglets were found on a 1540-41 Coronado expedition campsite by Donald Blakeslee (Smith 2009:40; Rhodes 1992:38).

XRF analysis of the aglets indicates they are copper and not brass or bronze and are consistent with elemental composition of known sixteenth century copper kettles (Fitzgerald et al. 1993).

Target 1232 is a roughly ½ inch diameter handmade iron ring (Figure 13a). It is open at one end with the ends suggesting they overlapped at one point and were hot hammered together. A second uncollected artifact, Target 1246, is a piece of similar iron ring that has been pulled open and is nearly straight. It is about 1 inch long. Both may be pieces of light chain for a bridle or some other light use item. However, they are the same size, style, and construction techniques exhibited by chainmail links found during the excavations of the Columbus settlements at La Isabella (Deagan and Cruxent 2002:243-245; cf Hoyt 1992:10-11). XRF analysis indicates the elemental composition is consistent with bloom or wrought iron that contains a very small amount of copper, which is low carbon iron that can be heated and manipulated in charcoal fired forges (Rostoker and Bronson 1990:12-20). Steels, particularly industrial era steels and cast iron, generally have trace elements of manganese, chromium, nickel, and molybdenum at varying levels.

Awls, gimlet, and needle

Six awls representing five different iron awl types, a possible burin, a worn gimlet, and a single bag/sacking needle were recovered in various surface contexts during the field investigations (Figures 14, 15). The bag/sacking needle (Target 1637) is a 6 inch- long shaft with a large eye at one end and a curving point at the other end. Bag/sacking needles were designed for sewing closed burlap and other types of coarse weave bags and containers. Stylistically the needle is consistent with those manufactured in the nineteenth century using automatic eye and pointing machines (Rollins 2008).

The gimlet (Target 1667) is made of square iron bar stock that is about 2 ¼ inches long. The square stock is tapered for mounting in a wood handle. The lower 1 inch tapers to a point and is twisted to form a drill like twist. Gimlets were used to bore holes in wood and have been made for centuries. XRF analysis shows this hand-made small gimlet has the same basic trace elements present as observed in the other awls, caret head or bi-facet head nails, and several of the coscojos. It is pre-1870 iron and most likely seventeenth or eighteenth century in origin.

The possible burin (Target 1686) is a thin piece of sheet iron about ½ inch long and 3/8 inch wide. The flat portion is about ¼ inch long and has a ¼ inch long point that angles from the flat sheet at about a 45 degree angle. This may be an expedient burin or simply a piece of oddly shaped cut sheet iron.

The seven different awls are all hand forged iron from bloom or wrought iron as identified by XRF analysis. For convenience they are simply identified as Types 1 through 5. Type 1 is represented by one specimen, Target 1495 (Figure 15c). Target 1495 is a complete specimen that is pointed on one end and flattened on the other. It has an overall length of 2 ¼ inches. Type 1 awls may have been repurposed bridle slack chain links or conversely awls may have been repurposed to make a slack chain (see description of Target 1020 in the ring bit discussion in the next section), as suggested by strongly similarities in forging.

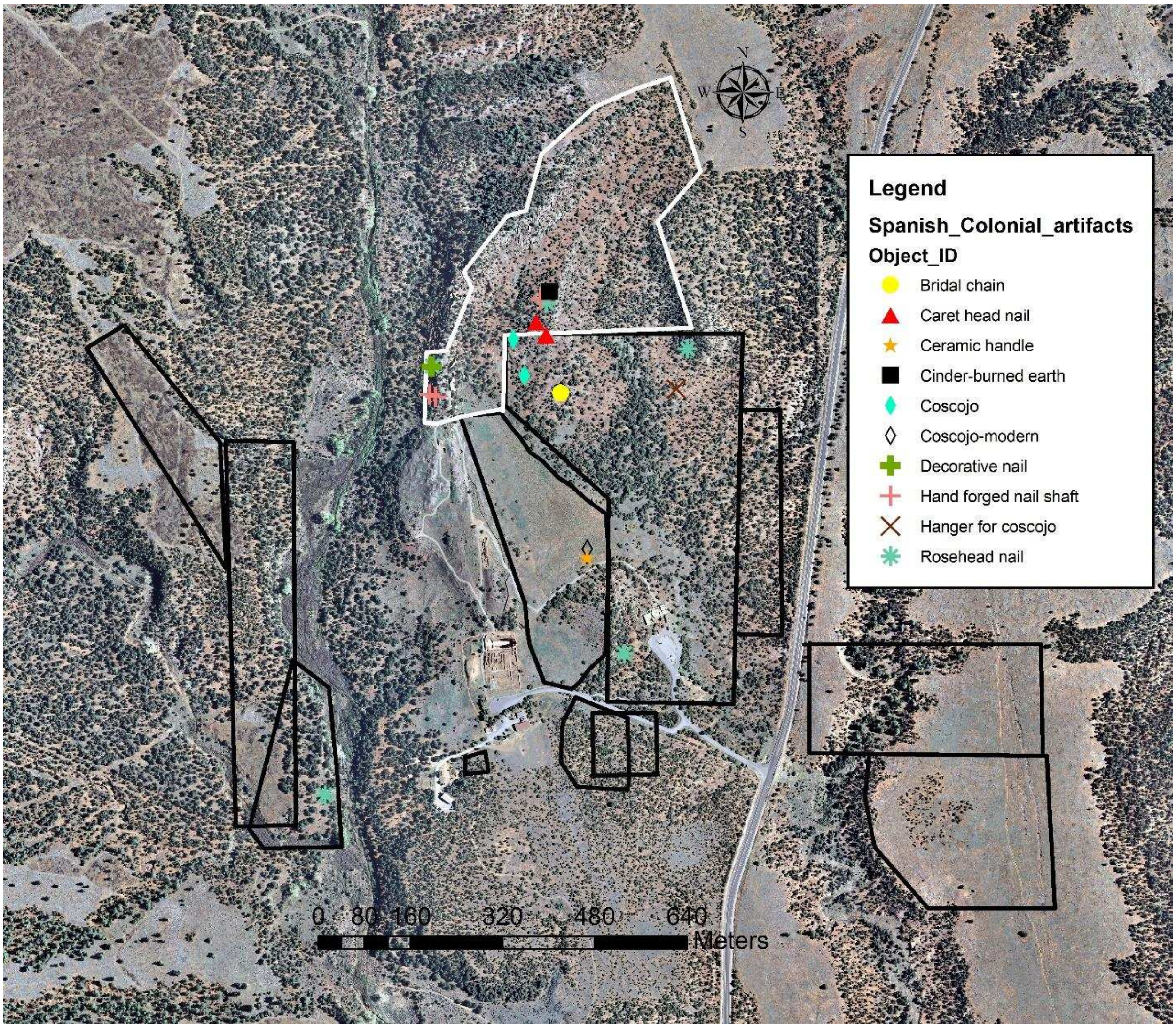


Figure 7. Distribution of Colonial period metal detected finds.

Figure 8. Spanish Colonial ceramic handle possibly from a Cántaro-style vessel (Target 1018).

Figure 9. Rendering of the Scala Sancta religious medal (Target 1016).

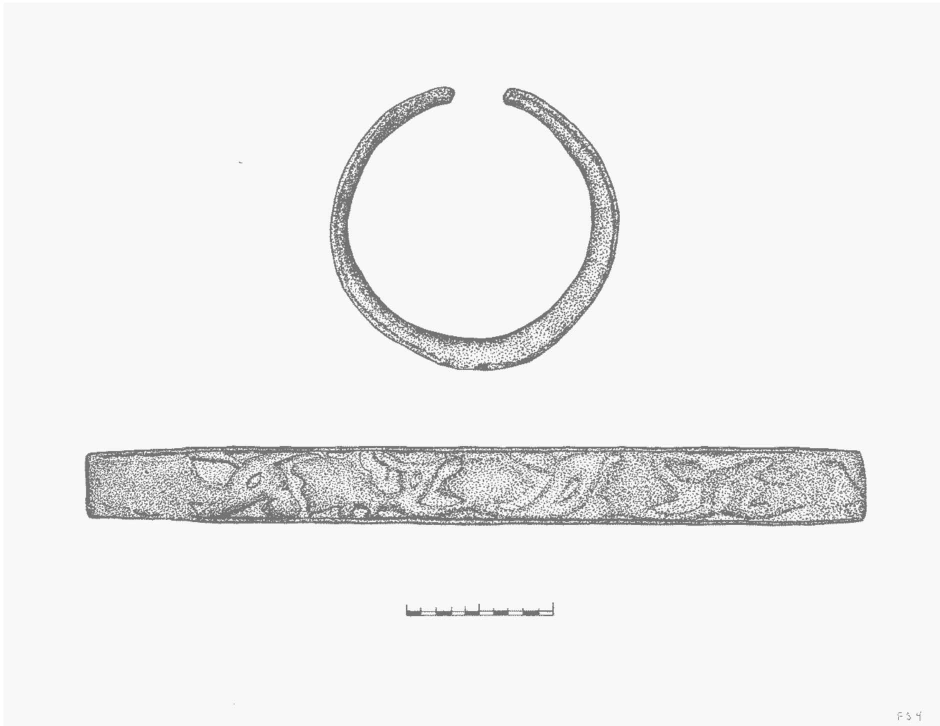


Figure 10. Rendering of a possible brass earring or cuff with zooomorphic embossing (Target 768).

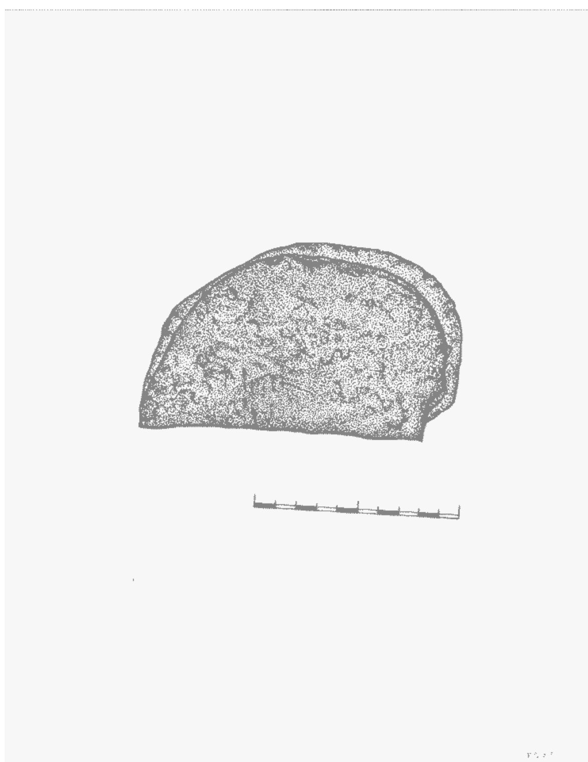


Figure 11. Folded copper item that may be a maravedis coin made into an ersatz aglet (Target 1230).

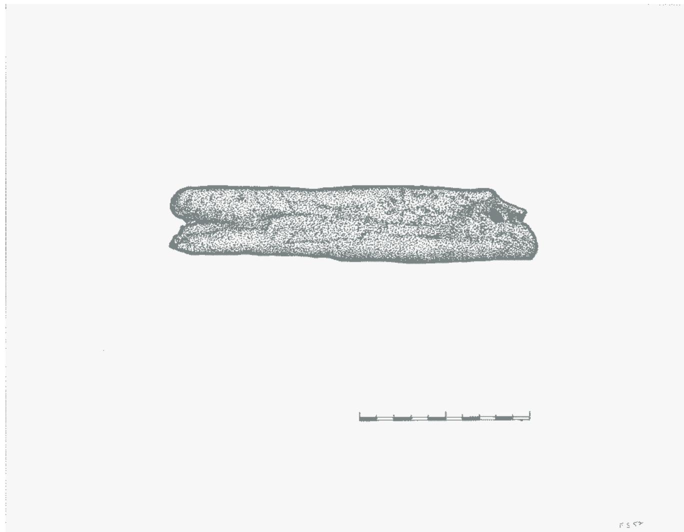


Figure 12. Rendering of a copper aglet (Target 1655).

Figure 13. Iron items, a. possible chainmail link (Target 1232), b. coscojo dangle (Target 1231), c. complete coscojo (Target 1019) that is nineteenth century in origin based on XRF analysis showing it was hardened with molybdenum, d. coscojo hanger (Target 1280), e. bridle slack chain (Target 1020).

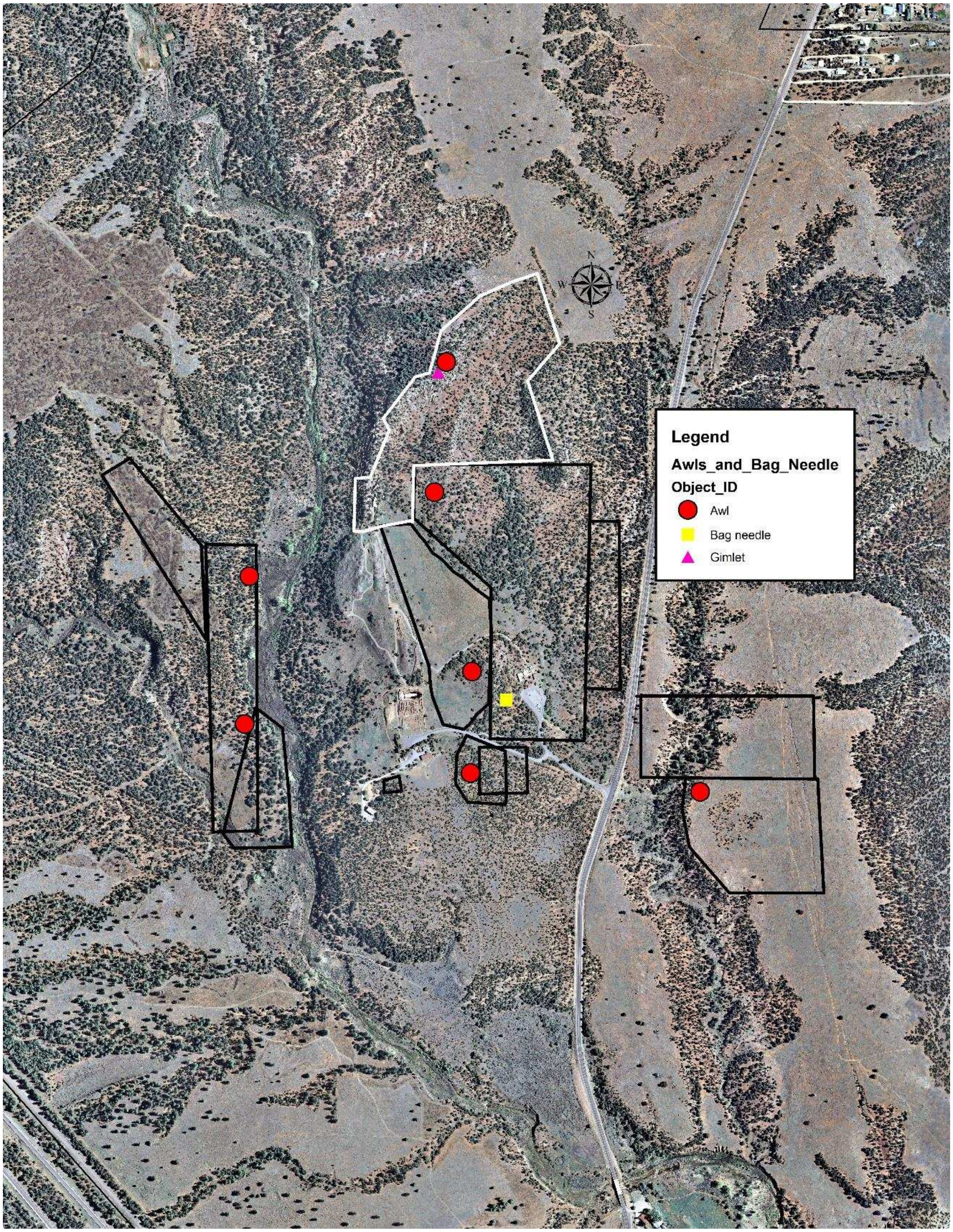


Figure 14. Find locations of awls and the bag needle.

Figure 15. Iron awls collected during the sampling element of the survey, a. possible burin (Target 1686), b. Type 5 awl (Target 1682), c. Type 1 awl or repurposed slack chain link (Target 1495), d. Type 2 awl (Target 899), e. Type 5 awl (Target 1430), f. Type 3 awl (Target 1024), g. a worn gimlet (Target 1667), h. Type 4 awl (Target 1332).

Type 2 is represented by a single specimen, Target 899 (Figure 15d). It is made of square bar stock and is 3 ½ inches long. It is pointed on both ends, although one end is less pointed than the other. The less pointed end may have been intended for mounting in a wood or bone handle.

Type 3 is likewise represented by a single specimen. Target 1024 (Figure 15c) is made of square stock that has a heavy blunt end that tapers to a point and is 2 1/8 inches long.

Type 4, also a single specimen, Target 1332 (Figure 15h), is 3 ½ inches long, made of square stock. It is pointed at both ends in a fairly symmetrical manner.

Type 5 is represented by two specimens, Targets 1430 and 1682. Each is made of rounded square stock with one slightly flattened and blunted end and a thick pointed end. Targets 1430 (Figure 15e) is complete specimen and is about 2 1/8 inches long. Target

1682 (Figure 15b) is a broken specimen of the same type. The remaining length is 1 3/8 inches with the pointed end missing.

Spanish ring bit parts
Four, and a possible fifth item, represent parts of Spanish-style ring bits (Figures 7, 13). This bit type was in use from early colonial to the late historic American/Federal period (Simmons and Turley 1980:100-102), although the styles recovered stylistically suggest they date to the sixteenth and seventeenth centuries. Possibly three artifacts are coscojos or jingles, one is a coscojo hanger, and the final item is a slack chain segment.

Target 1019 is decorated iron coscojo and hanger (Figures 13c, 16). The hanger is hand forged and about 1 inch long. The upper hanging loop is rectangular in cross-section and is flattened. Three roughly parallel lines are incised by either a chisel or a file at where the shank begins to flatten out. The coscojo is iron and hand wrought. It too is about 1 inch long and tapers from a roughly rounded loop end to a decorated and flattened end that flares to ¼ inch wide. The decoration consists of chiseled lines, three parallel at the upper end, two either side, but not connecting, of the center, a long incised line 1/8 inch above the flat end, and four shallow scallops on the terminal end. The overall design of the coscojo is that of a stylized figa, which is a clenched fist-thumb good luck charm of the Mediterranean region and is of ancient Roman origin. XRF analysis indicated this artifact had molybdenum added as a hardener to the iron. Molybdenum was not used in iron and steel forging before the late nineteenth century and was not common before the early twentieth century (http://en.wikipedia.org/wiki/molydenum, accessed Dec. 6, 1013). Spanish style bits with coscojos were made well into the nineteenth century and maintained a popularity with Comanche and Apache peoples throughout the nineteenth century.

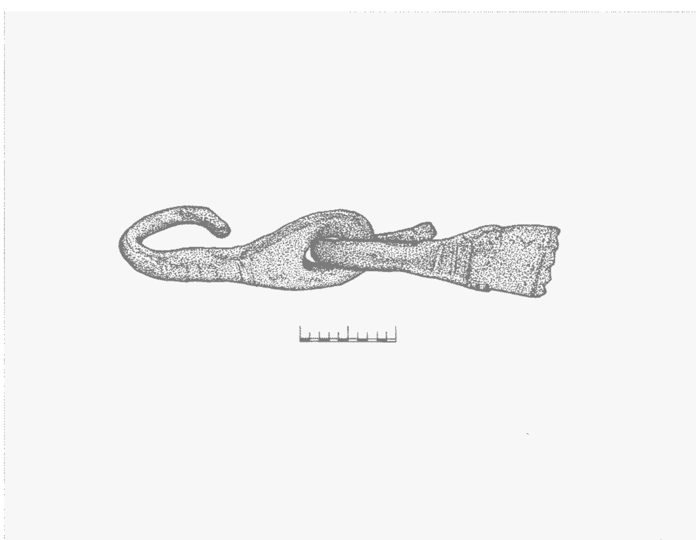


Figure 16. Detailed rendering of the complete coscojo dangle and hanger that dates to the nineteenth century (Target 1019).

Target 1231 is a coscojo dangle (Figures 13b, 17). It is iron and about 1 inch long with a hand forged attachment loop flaring out to a decorated flattened end that is about ¼ inch wide at the end. Three incised or chiseled lines are the decorative elements, one at the top of the tapered flattened area, one near the middle and one about 1/8 inch above the terminal end. XRF analysis indicates the trace elements in the iron are consistent with those found in the caret head nails suggesting an early type iron forging, probably sixteenth or seventeenth century. The iron type is known as bloom, bloomery, or wrought iron. Wrought and bloom iron are slightly different from a production point of view, but indistinguishable in working and metallurgically (Rostoker and Bronson 1990:11-12).

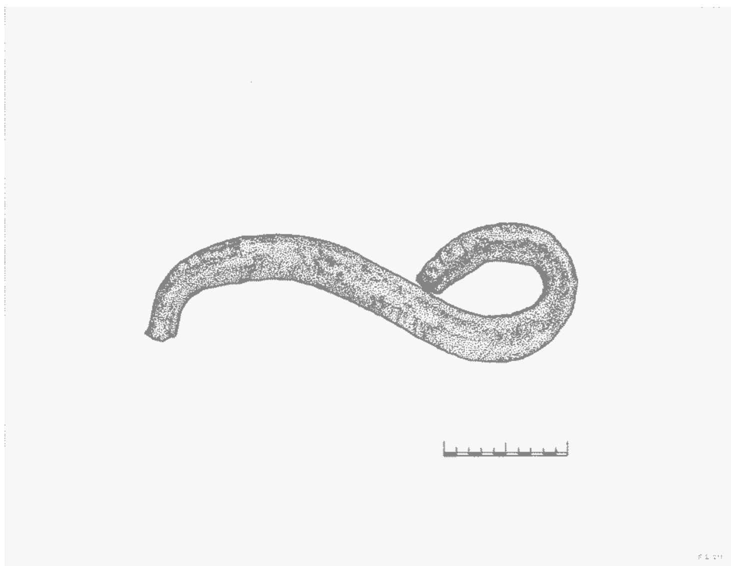


Figure 17. Rendering of coscojo hanger (Target 1280).

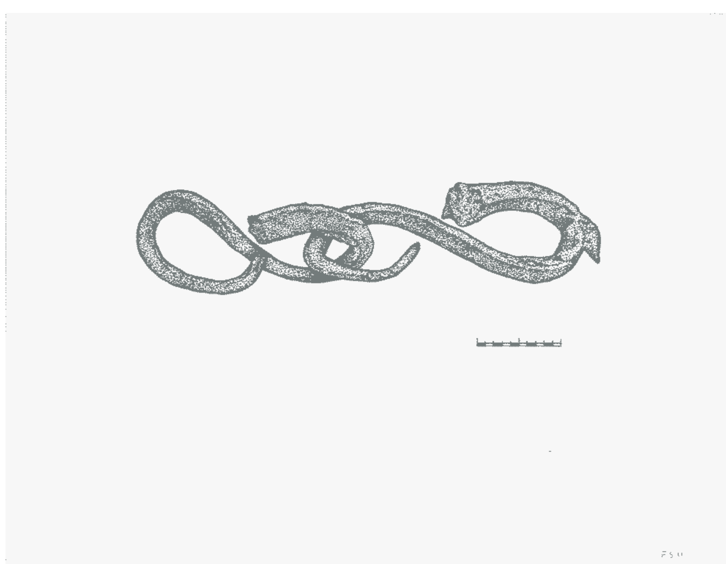


Figure 18. Iron bridle slack chain (Target 1020). Note the chain links similarity to awl Type 1.

Target 1261 is a 1 inch long brass or copper fragment that is cut and tapers from 3/8 inch at the narrow end to ¼ inch wide at the wide end. The artifact may be a fragment of a coscojo or just a discarded piece of cut sheet brass. The manner of cutting and the presence of a slight curve at the narrow end suggest this may be a coscojo fragment.

Target 1280 is an iron coscojo hanger (Figures 13d, 17). It is about 1 ½ inches long with a hand forged loop of about ½ inch at one end. It curves at the other end, but is broken where the other loop would have been. XRF analysis indicates the trace elements present are similar in type and percent to that found in the caret head nails suggesting a sixteenth or seventeenth century date.

Target 1020 is two segments of iron slack chain from a ring bit (Figures 13e, 18). The iron segments are rather crudely hand forged from square stock about 3/32 inch square. Each link is a double loop or closed S style. Neither end of the closed S is welded to the main shank. One link is about 1 ¼ inch long and the other is about 1 inch long. XRF analysis indicates this is a wrought iron that is consistent in trace elements with those observed in the caret head nails.

Hand wrought nails, square cut nails, and horseshoe nails
Thirteen hand wrought nails or horseshoe nails were discovered during the investigations (Figures 7, 19, 20). Nine were collected and four were not. Construction and light duty nails totaled nine. Uncollected targets (464, 1244, 1356, and 1701) are 1 inch long, 1 ½ inches long, 3 ½ inches long, and 1 inch long respectively. Collected nails represent similar types. Target 1276 is the head of a 1/8 square nail shank (Figure 20d). It is about ½ inch long.

Target 1356 is a complete early style square cut nail with a hand-forged head, circa 1840. It is about 3 inches long with a shank of about 3/16 inch square (Figure 20f). This is likely a heavy construction or timber nail. Target 1670 is the head and shank of a wrought nail that is broken (Figure 20e). The remaining length is 1 1/8 inches and the shank is about 1/8 inch square. The nail appears to be equivalent to a light framing nail. Target 1694 was a piece of sheet brass found in proximity to two 1/8 inch square shanks of hand wrought nails. The nail shanks are 1 7/8 inch and 1 1/8 long respectively. The hand wrought nails follow the typical pattern of handmade nails as seen on sites like La Isabella (Deagan and Cruxent 2002) through the early nineteenth century.

The XRF analysis indicated the early square cut nail had an entirely different trace element composition than seen in the hand wrought nails.

An unusual hand wrought nail or tack is Target 1702 (Figure 21). It is an oddly shaped nail, perhaps meant for a decorative purpose. It has a long thin square shank about 1 inch long but only 3/32 inch square. The head is deformed but appears to have been thin and roughly round like that found in modern brass furniture tacks. It appears to have been about 1 inch in diameter. Although lighter in fabrication than examples from other sites, this may be an estoperole tack which are known to have been used in the sixteenth century for holding organic matting to ships' holds to cushion cargo. These nails were often repurposed as they have been found on Columbus-related sites, a 1559 campsite of Tristan de Luna's expedition (Deagan and Cruxtent 2002:252; Caleb Curren, A Campsite of Tristan de Luna on Mobile Bay? http://www.archeologyink.com/Luna%20Campsite.htm), at Santa Elena, 1566-1587, the first capital of Spanish Florida (South et al. 1988), and at a mid-seventeenth century Spanish mission site in Georgia (Jefferies and Moore 2013:367). Target 1702 (the estroperole tack) has similar elemental composition to the trace elements found in the caret head nails.

As noted earlier, the caret head nails, and estoperole nails were identified by XRF analysis as consistent with bloomer or wrought iron that contains a very small amount and copper, which is low carbon iron that can be heated and manipulated in charcoal fired forges (Rostoker and Bronson 1990:12-20).

Three caret or bi-faceted head horseshoe nails were found near one another (Figures 20a, b, c, 22). Caret head nails are diagnostic of the Vázquez de Coronado expedition since this nail type drops out of the archeological record in the Americas after circa 1550 (Mathers and Haecker 2009:36-40). Each of the three wrought iron caret heads represents the worn head and partial shank of a nail. These are clearly worn out nails and given their general proximity to one another may represent a single re-shoeing episode. The horseshoe nails are Target 1022 (about ½ inch long head and ½ inch long shank fragment that is about 3/16 inch square), Target 1712 that is about the same dimensions and Target 1713 that is also nearly the same dimensions. A strike-a-light flint was found between 1712 and 1713, but nearer to Target 1713 and was recorded as part of Target 1713. A second one (FS1691) was found on the surface in the same general area.

The flint is a reddish gray chert and quartzite veined material. It is crudely flaked in truncated pyramid shape. The flint form is rectangular and roughly 1 inch long and ¾ inch wide. What is interpreted as the front edge shows use wear with micro flakes removed from both surfaces. The sides and rear edge do not exhibit use, but there is a hinge fracture present indicating a section is missing. The second flint (Target 1691) is a gray chert that is approximately 1 inch on a side. The shape is similar to Target 1713. Two edges, the front and back, show heavy to moderate use wear with both micro and large flakes being removed. One side has no edge wear evident and the other side is broken with a clear hinge fracture present. This suggests the flint was larger at one point.

While both flints (Figure 23) resemble a gunflint in general configuration they are larger than known Spanish gunflints (http://www.texasbeyondhistorynet/stlouis/images/traces-gunflints.html#). Manufacturing techniques are quite similar, but the truncated pyramid on the top of each would have prohibited the effective fastening of the flint in a hammer or cock jaw. The flints are most consistent with strike-a-light flint used with a steel to start a fire.

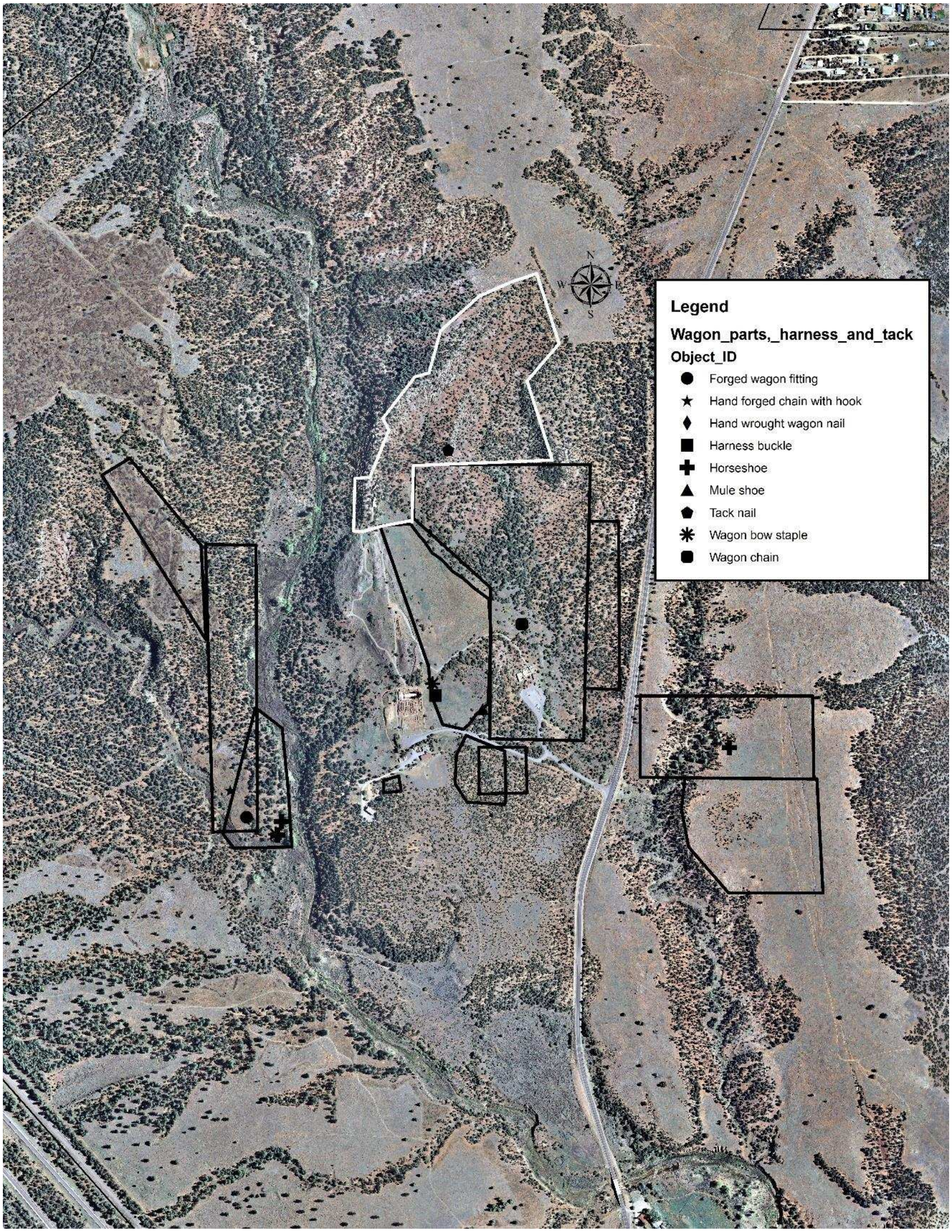


Figure 19. Distribution of wagon parts, harness, horseshoes, and mule shoes.

Figure 20. Caret or bi-faceted head and hand wrought nails, a. caret head nail (Target 1713), b. caret head nail (Target 1712), c. caret head nail (Target 1022), d. head of hand wrought nail (Target 1276), e. head and shank of hand wrought nail (Target 1670). f. large early square cut nail (Target 1356).

Figure 21. A possible estoperole tack (Target 1702).

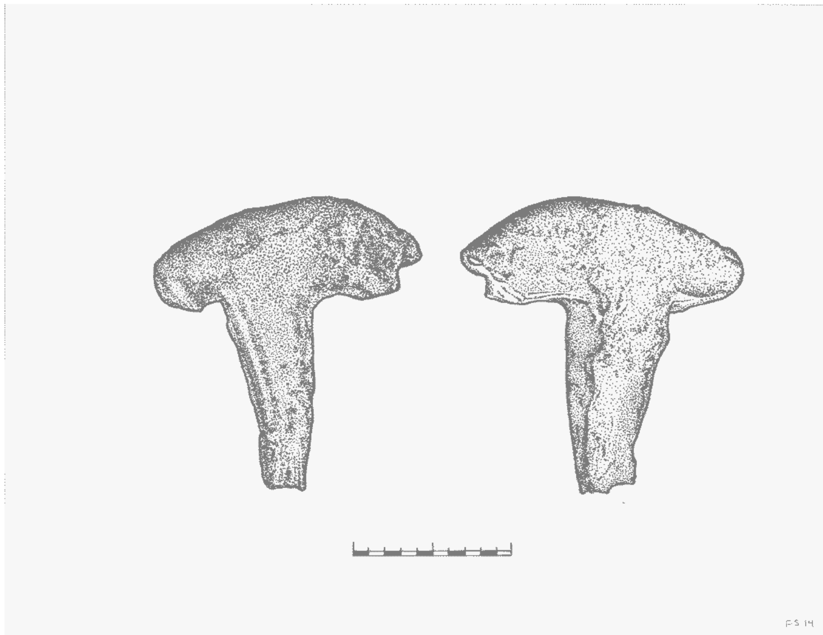


Figure 22. Detailed rendering of the front and back of a caret or bi-faceted head nail (Target 1022).

Figure 23. Strike-a-light flints recovered near the caret head nails and other Colonial era artifacts.

Wagon hardware and harness
Eight artifacts associated with horses and horse drawn conveyances were found during the metal detecting survey, but were not collected (Figure 19). A single mule shoe (Target 690) was found. Its method of construction suggests it is a late-nineteenth century item. A single ½ inch wide harness strap buckle was also found (Target 403). Two wagon bow staples or canvas wagon cover bow cleats (Targets 462 and 1560) were recovered. Both are mid-nineteenth century in style. Target 462 was also associated with a fragment of brown ale or beer bottle base. The bottle style represented by the base is also mid-nineteenth century manufacturing technology. Target 1348 is a large U-shaped iron staple, similar in shape but much larger, measuring 2 ½ inches long, to a fence staple. This large style was used on wagons and horse drawn equipment in the nineteenth century to fix rings to wooden elements.

Two chain segments comprise the final wagon hardware category. Target 1286 is an 8 inch long segment of iron chain links with a 2 inch diameter iron ring fixed to one end with three or four wraps of baling wire. The chain appears to be manufactured by drop forging and may date to the late nineteenth or early twentieth centuries. The wire wrapping suggests a "field repair" of a broken chain. Target 1545 is also about 8 inches long with a 5 inch long hand forged hook on one end. The chain links appear to be hand forged as well. This artifact is likely mid-nineteenth century in origin.

Arrowheads
Three iron arrowheads, a brass arrowhead tip, and a stone projectile point were collected during the investigations (Figures 24, 25). Target 1253 is a small iron projectile point that is 1 ½ inches long and ½ inch wide at the shoulders (Figure 25b). The tang is about ¼ inch long and expands from the shoulders to the base where it is ¼ inch wide. The arrowhead appears to have been hand cut from sheet iron. Target 1269 is similar in construction and also appears to be hand cut, but is longer and wider than the first point (Figure 25d). Target 1269 measures 2 inches long and 5/8 inch wide at the shoulders, with a straight tang that is 3/16 inch wide and 3/8 inch long. The shoulders are sloped upward toward the point and slightly rounded. Likewise Target 1677 is a handmade iron point with a bulbous shaped tang (Figure 25c). Overall the point is 1 ½ inches long and has asymmetrical rounded should that are 9/16 inch wide. The tang is narrow at the shoulder, 3/16 inch wide, becoming bulbous in its center (1/4 inch wide), and narrowing back to a 3/16 inch width.

Target 1685 is the tip of a brass projectile point (Figure 25a). The remaining portion is 7/8 inch long and wide. It has been sharpened by filing along each edge, but on opposite sides.

XRF analysis indicated the trace elements present in the iron arrowheads are consistent with the caret nails. This suggests the iron arrowheads are likely sixteenth to seventeenth century in origin. The brass projectile point (Target 1685) exhibits a trace element profile also consistent with sixteenth or seventeenth century production.

The stone projectile point (Target 1568) was a surface find near Square Ruin in SA 5. As it resembles an early metal projectile point style recovered by Kidder (Figure 1) it was collected for further analysis. The stone projectile point is made of white variegated chert. It is a late prehistoric to protohistoric style. It is side and basally notched. The point is 7/8 inch long, ½ inch wide just below the side notches that form the shoulder, and the base is ¼ inch long. A similar stone projectile point was also noted on the surface near the Visitors Center where it was in general association with the gimlet (Target 1667), bag needle (Target 1637), and a copper aglet (Target 1655).

Knives

Two wrought iron tang knives and two iron blade tips were collected (Figures 26, 27). The tang knives are Targets 1250 and 1699. Target 1250 is 3 5/8 inches long with the blade being 1 ½ inches long and tapers from a sharp point back to the bolster which is 3/8 inch wide, and sharped on one edge (Figure 28). The tang is rectangular, tapering from a point to 3/16 inch wide at the bolster. Target 1699 is a larger and heavier example of the same form. It is 3 ¼ inches long overall with the blade being about 2 ¼ inches long and ¾ inch wide at the bolster. The tang is 1 inch long is about ¼ inch wide at the bolster. Tang knives were meant to be mounted in a wood or bone handle. A similar knife was recovered by Kidder (1932:302). The knife type is considered a classic Spanish colonial trade knife and is found in various sizes. The site of Juan Pardo's 1566 Fort San Juan (31BK122) in South Carolina yielded one of this knife style (http://www.warren-wilson.edu/-arch/berryhistory).

The two knife tips (Targets 1251, 1370A) appear to be from side knives or belt knives. Typically these would be a butcher or camp knife. However, it is possible they are the tips of large pocket or folding knife blades. Target 1251 is a round pointed knife that is 1 ½ inches long and 5/8 inch wide. It is sharpened on one edge. Target 1370A is a clip point blade that is 1 inch long and 5/8 inch wide. It, too, is sharpened on one edge. Both appearto be late seventeenth or eighteenth century in style.

The XRF analysis suggests the elemental composition between the tang knife (Target 1250) and the iron knife tips (Targest 1251 and 1370A) are different. The tang knife trace elements are consistent with the caret nails, while the knife tips have higher amounts of manganese suggesting a later era for manufacture. The XRF analysis is consistent with the chronological assessment derived from the artifact typology.

Possible gun frizzen spring

Target 1692 is an iron fragment that is consistent is shape and construction with a frizzen spring from a firearm (Figure 29). The iron fragment consists of a partial mounting hole and a segment of the flat spring that held the frizzen in battery. The flat spring appears to have been cut forward of the mounting hole. Stylistically the fragment is consistent with frizzen springs found on firearms of the late sixteenth or early seventeenth centuries (Lindsay 1967; Hanson and Harmon 2011; Saidel 2000:195-198). The spring conforms to those found on gun locks of the wheel lock, snaphaunce, and early flintlock firearms. The earliest flintlocks date to about 1619 and are thought to be a French or Dutch innovation, although the concept spread rapidly throughout Western Europe by the mid-seventeenth century.

XRF analysis shows trace elements of manganese as well as the absence of copper that places the artifact chronologically later in manufacturing techniques than the caret nails. This is consistent with the identification of the frizzen spring as seventeenth century or later.

Lead and iron projectiles

Twelve lead projectiles, one lead ingot, and an iron canister ball were collected during the field investigations (Figures 30, 31, 32). Target 972 is an iron canister ball that is 1.077 inch in diameter (Figure 31h). This is consistent with canister fired in either 12-pounder or 6-pounder cannon like those used at the Battle of Glorieta (Scott 2011).

A lead ingot or bar lead is Target 1489 (Figure 32 middle). The ingot is roughly loaf shaped and is 0.67 inch long. It has a clean cut or slice on one end with the other being rough and likely the end of the casting. The remaining portion is 0.65 inch wide. XRF analysis indicated the ingot is nearly pure lead. It was found in SA 5 in the general vicinity of Gunnersons' Areas J and K. Gunnerson (1969; Gunnerson and Gunnerson 1970) identified these areas as Apache sites. The find location is also in the general area of the Santa Fe Trail. The ingot is likely a piece of bar lead dating to the eighteenth or nineteenth century.

The projectiles, with two exceptions, are spherical balls. Target 1322 is a cast ball with a shear trimmed sprue. It is deformed by impact and is approximately a .50-caliber, weighing 13.85 grams or 213 grains. Target 1017 (Figure 31d) is an impact damaged ball that is approximately .45-caliber, weighing 7.2 grams or 111 grains. XRF analysis of the ball indicated its elemental make-up is lead and iron. Iron is found in sixteenth century bullets and in some early seventeenth century bullets as part of the manufacturing process (Deagan and Cruxent 2002:231-234; Biddle et al. 2001:200; Harding 2012). Target 1021 (Figure 31f) is another impact damaged ball this is about .54-caliber. It was fired in a rifled weapon that had wide lands and narrow grooves with a right hand twist. The bullet weighs 13.9 grams or 214.4 grains. Target 1135 (Figure 31a) is a lead shot of approximately .33-caliber, equivalent to 00 buckshot. It weighs 2.9 grams or 45 grains.

Target 1194 (figure 31i) is a fully impact flattened or mushroomed ball that weighs 11.4 grams or 175.9 grains. XRF analysis shows significant amounts of tin mixed with the lead. The large amount of tin was likely used as a hardener. Tin and antimony were not normally added to lead as hardeners until around 1784 when it was used as a hardener in shrapnel balls found in explosive artillery shells. It was not commonly used as a hardener in small arms bullets until the advent of smokeless gun powders and higher velocities required harder bullets to keep from leading up gun barrels (Butterman and Carling 2004; Anderson 2012). The bullet likely dates to the late nineteenth century.

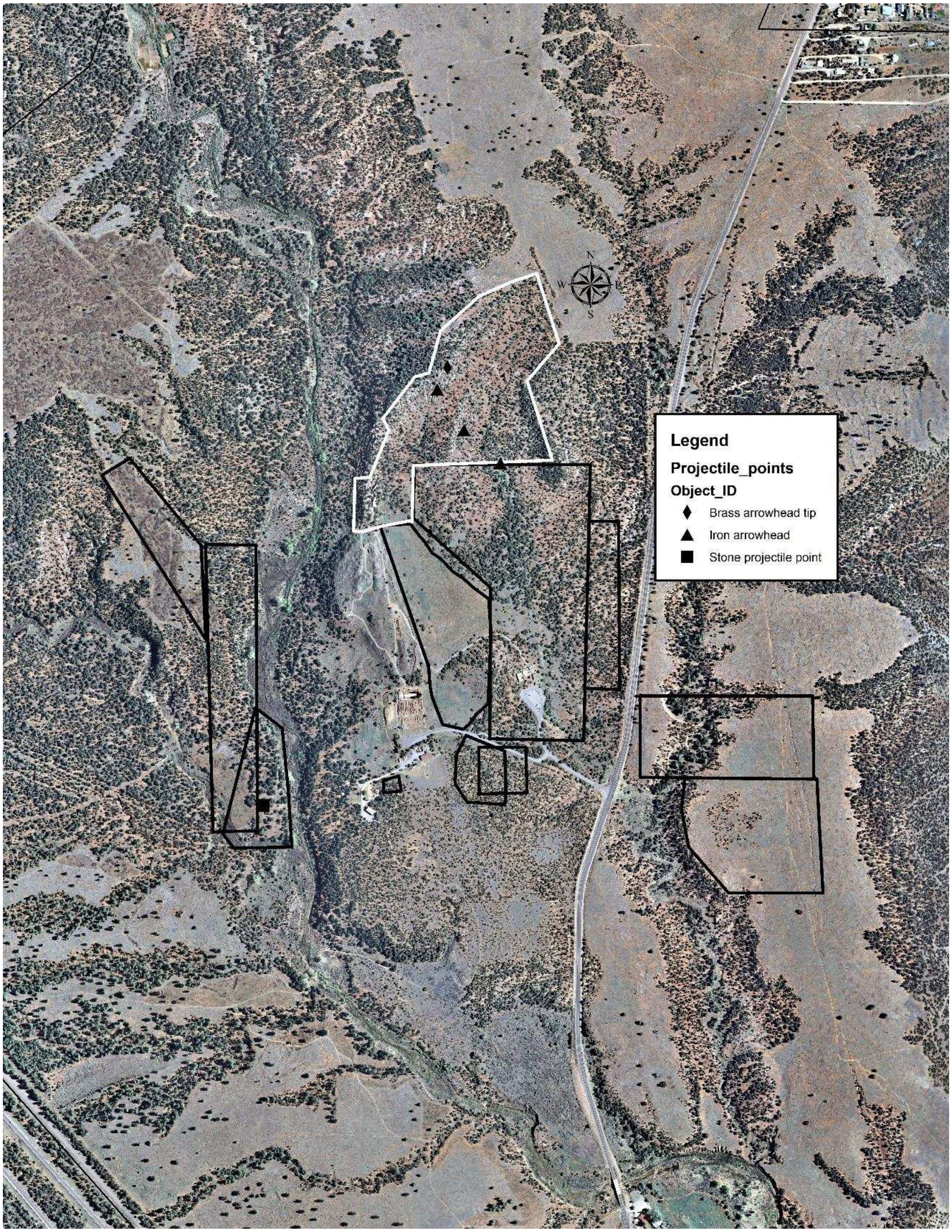


Figure 24. Metal arrowheads or projectile point distribution.

Figure 25. Brass and iron projectile points, a. tip of brass projectile (Target 1685), b. small straight tanged point (Target 1253), c. bulbous tanged point (Target1677), d. straight tanged point (Target 1269).

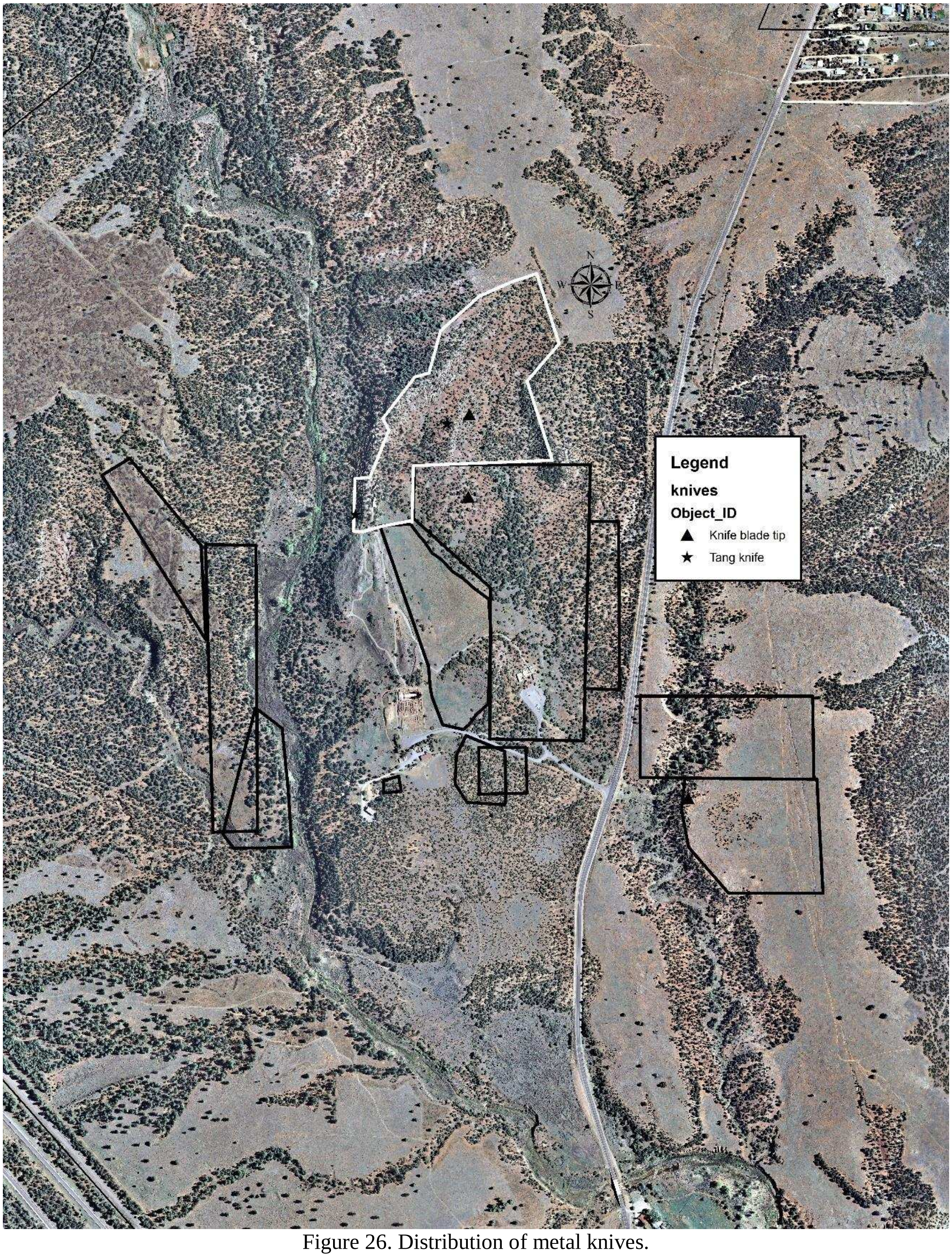


Figure 26. Distribution of metal knives.

Figure 27. Iron knives, a. clip point side knife tip (Target 1370a), b. round point side knife tip (Target 1251), c. small tanged knife (Target 1250), d. larger tanged knife (Target 1699).

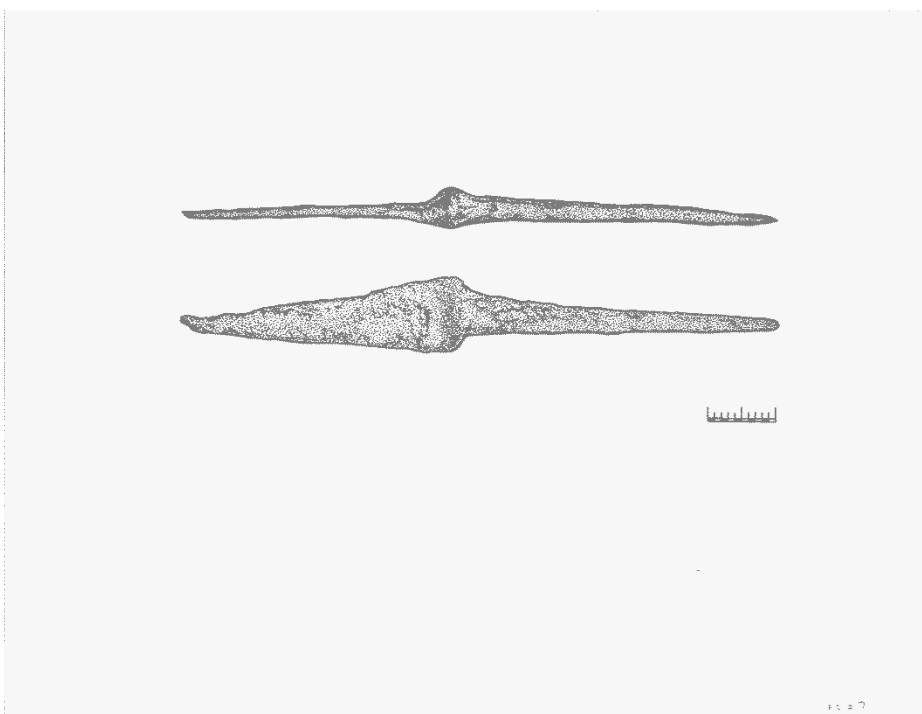


Figure 28. Rendering of the small iron tang knife (Target 1250).

Figure 29. Possible gun frizzen spring from an early seventeenth century style firearm (Target 1692).

Target 1281 (Figure 31k) are the lower rings of .58-caliber Civil War era Minié ball or conical hollow-base bullet. Target 1305 (Figure 31c) is an impact damaged ball of about .40-caliber. It was fired in a rifled weapon with wide lands and narrow grooves with a right hand twist. It weighs 5.25 grams or 81.1 grains. Target 1374A (Figure 31b) is also an impact damaged ball that could not be measured for caliber, but it weighs 3.6 grams or 55.2 grains. Target 1470 (Figure 31j) is also flattened impact damaged ball that weighs 14.5 grams or 224.2 grains. Target 1640 is a partially flattened impact damaged approximately .40-caliber ball. It has two heavily impress parallel lines on one flattened side (Figure 32 left). It was fired from a rifled firearm but the nature of the land and grooves was indeterminate with the exception that it had a right hand twist to the rifling. The bullet weighs 4.95 grams or 76.5 grains. Target 1647 (Figure 31e) is an approximately .45-caliber ball that retains impression of a coarse weave cloth, possibly patching. It was fired from a rifled weapon with a right hand twist. It weighs 9 grams or 139 grains.

Another twelve lead and iron projectiles were recorded but not collected. These artifacts include Targets 837 and 1674, which are pieces of deformed lead that may have been parts of spherical balls. Target 850 is an impact deformed .50-405 grain bullet that was fired in a .50-70-caliber firearm. This caliber was not developed until 1866. Targets

1675.1, 1688, 1710, 1714, 1715, 1716, 1720, and 1724 are all lead balls that range from about .44-caliber to about .50-caliber. They were all fired in non-rifled guns based on the field examination. Target 1684 is a possible iron ball or a lead shot with an iron core. It is very deformed by impact. Lead shot with iron cores are associated with fifteenth and sixteenth century and very early seventeenth century firearm use (Deagan and Cruxent 2002:231-234; Biddle et al. 2001:200; Harding 2012).

The XRF analysis include four artifacts, lead bullets, from the 1862 Battle of Moore's Mill, Missouri as a control for Pecos lead artifacts. The XRF analysis demonstrated the Civil War items clearly have a different composition from most of the Pecos lead artifacts. A few items can be separated as noted in the descriptions, but most lead could not be clearly sorted into meaningful groups. The lead XRF analysis suggests there is potential further research.

Cartridge cases
Three cartridge cases, or portions thereof, were excavated during the metal detecting survey. Two are nineteenth century in origin and one dates to the twentieth century. Target 1192 is the brass base of a 410 shot shell. The head is stamped **Western/ 410 Field 12m/m** indicating it was made by Western Cartridge Company for the 410 or 12mm shotgun. Western was founded by John Olin in 1898 about the time the 410 gauge shot shell was introduced (Barnes 2006:500-503).

Target 1325 is a lead bullet with a portion of Bloomfeld Guilding Metal cartridge case still attached. The case was cut off immediately below the bullet base. The bullet is .50-caliber and is identical to .50-70 caliber bullets pressed at the Frankford Arsenal for the U.S. Army. The bullet nose has been modified by carving a portion of it to a smaller size and reducing the bullet length.

Target 1564 is a Bloomfield Gilding Metal .44-caliber rimfire cartridge case. The case has a raised **H** headstamp indicating it was manufactured by Winchester prior to 1880. The round was fired and retains two sets of firing pin marks, one very faint and one deep and clear. The presence of two sets of firing pin marks indicated the round did not fire on the first try. Misfires were common with this pattern of firearm often due to a dirty or poorly maintained firearm. The .44-caliber Henry rifle and .44-caliber Model 1866 Winchester rifle and carbine are the only guns to have two firing pins configured in the manner present on the collected specimen. The guns Model 1866 is a later variation of the Henry design and the two models kept the double firing pin configuration throughout their production cycle. The Model 1866 was produced into the 1890s.

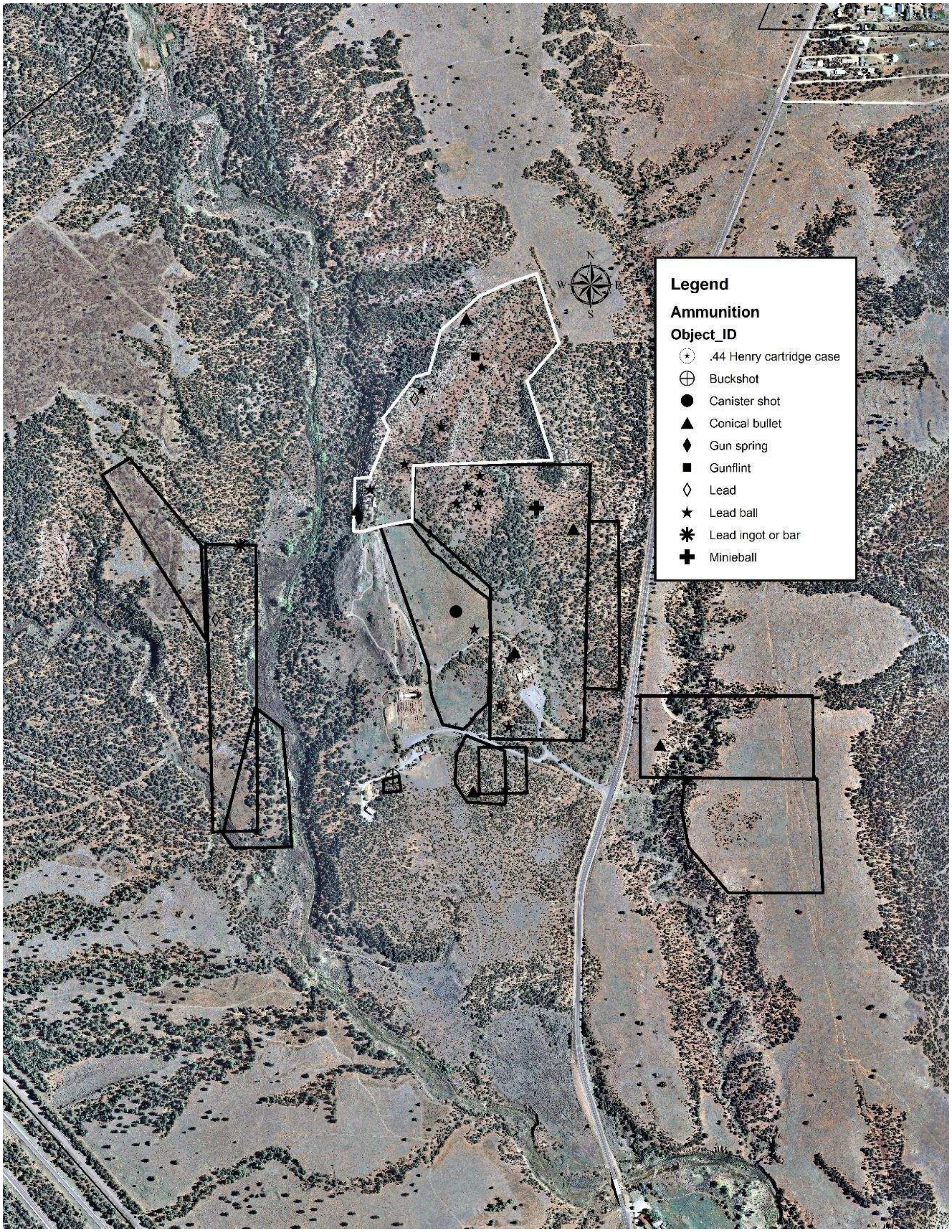


Figure 30. Distribution of lead balls, conical bullets, shot, canister shot, and other lead.

Figure 31. Lead and iron firearms projectiles, a. possibly modern buckshot (Target 1135), b. impact deformed ball (Target 1374a), c. ball with casting sprue (Target 1305), d. impact deformed ball (Target 1017), e. ball with fabric impression from patching in a rifle (Target 1647), f. slightly impact damaged cast lead ball (Target 1021), g. lead ball with antimony additive indicating a late nineteenth century date (Target 932), h. iron canister ball (Target 972), i. and j. high velocity impact balls (Targets 1194, 1470), k. lower rings of a Civil War Minié ball (Target 1281).

Figure 32. Other lead artifacts, unidentified impacted lead ball (Target 1690), left; lead ingot or bar fragment (Target 1489) middle; and barrel shaped lead or cylindrical item (probably a twentieth century blowout plug of Babbit metal for an early internal combustion engine, Target 1690) right.

Buttons
Three buttons were among the targets randomly selected for excavation. Two were not collected. Target 353 is a ½ diameter plain front brass button with an omega loop shank. Target 1704 is a plain brass button back fragment. Both the uncollected buttons are either nineteenth century in origin or later. Target 1255 was collected and is a small 7/16 inch diameter brass button (Figure 33). It is a cast button with an integral loop shank attachment that was straight and then bent to form the loop. Cast buttons of this type are consistent with sixteenth and seventeenth century manufacturing techniques (Tice 2002:2) although a later date cannot be entirely ruled out. A very similar button was found on the wreck of the Henry VIII ship *Mary Rose* which sank in 1545. XRF analysis indicated the trace element composition is different from other brass and copper items, especially those known to date in later seventeenth and eighteenth centuries.

Chauffeur's license
A brass tag with a circular defect, consistent with a bullet perforation, is Target 1101. The tag was bent by being struck by a projectile, but was approximately 1 ½ inches long and 1 inch wide. It is stamped with the letters **Color**(ado)/**Lice**(nse)/**Chauffeur**/**1936**/**16911**. It was a pin-back tag, but the pin is now missing.

Suspender buckle
The buckle (Target 1595) is 1 ½ inches long and ¾ inch wide. It retains much of its original gilding. The piece was manufactured by pressing and has a shell and tendril design in its front. One back bar has **PAT Dec 17 05** in raised letters on its surface. The piece was manufactured after 1905.

Sheet copper
Three pieces of sheet copper were collected (Figure 34). Target 934 is irregular in shape, approximately 1 ¼ inch long and 1 1/8 inch wide. Deeply incised lines are present on one edge, which is irregular, suggesting they were used to guide or facilitate bending the segment back and forth to break it away from a larger piece.

Target 1676 is also a piece of heavy sheet copper that is about ¾ inch long and about ½ inch wide, but is folded back on itself. It is somewhat irregular in shape and is likely scrap from a larger item. Target 1694 is another piece of irregularly shaped (1 ¼ x 1 inch) heavy sheet copper It too appears to be scrap. It was found in proximity to two shanks of hand wrought square shank iron nails. The nail shanks were recorded under the same target number and are 1 7/8 inch and 1 1/8 long, respectively.

XRF analysis of the sheet copper indicated the presence of copper with minor traces of other elements. The recovered pieces are consistent in trace element percentages as those found in sixteenth century copper kettles from Basque whaling sites in Canada (Fitzgerald et al. 1993)

In addition to the three collected sheet copper fragments three others are among the uncollected targets. Target 703 is a cut piece of sheet copper that is approximately 2 inches long by ½ inch wide. Target 1060 is another cut sheet copper piece that is 1 ¼ inches long and 5/8 inch wide. The final piece is about 1 inch long and ¾ inch wide.

Figure 33. Rendering of an early Colonial brass button with plain front and integral loop shank (Target 1255).

Zinc Item

Target 1710 is a fragment of curved thin zinc that resembles a body of a bell. It is about ½ inch in diameter, but accurate dimensions are difficult due to the nature of the fragment. XRF testing identified the metal as primarily zinc which was not manufactured prior to the late nineteenth century. Its function is not identified.

Lead, Babbitt metal plug

Target 1690 (Figure 32 right) is a barrel shaped plug. It is approximately ½ inch in diameter at the center and measures 0.66 inch long. It weighs 19.6 grams or 302.5 grains. Initially this was assumed to be a barrel shaped slug or bullet, but XRF analysis indicated it is composed of lead with a significant amount of antimony added as a hardener. This finding is consistent with Babbitt metal which was invented in 1939 and used in bearing surfaces and as a simple pressure relief device. The artifact is a blow-out plug from a twentieth century engine or mechanical device.

Unidentified iron

Six pieces of unidentified iron were found. Target 1191 is a small piece of thin flat sheet iron, approximately 1 inch long and 1/8 inch wide. Its function is unknown. One uncollected item, Target 1681 is also a fragment of sheet iron of unknown function. Target 1680, also uncollected, was a cluster of three items, a piece of sheet iron, a fragment of strap iron, and a small square iron drift pin. All were between 1 inch and 1 ½ inches long.

Target 1697 is a fragment of decorative iron that is unidentified as to function. It is 1 ½ inches long, one-half inch wide, and 3/8 inch thick. The artifact is solid at the top branching into two round legs that bifurcate, but are broken at the ends.

Cinder

Several pieces of burned material or cinder lumps were found during the metal detecting at the Lost Church. Two pieces, Target 1023, were collected as a representative sample. XRF analysis of the burned lump identified trace elements of local soils mixed with iron. The cinder lump suggests a burning episode was significant enough to cause iron to be bonded with burned soils.

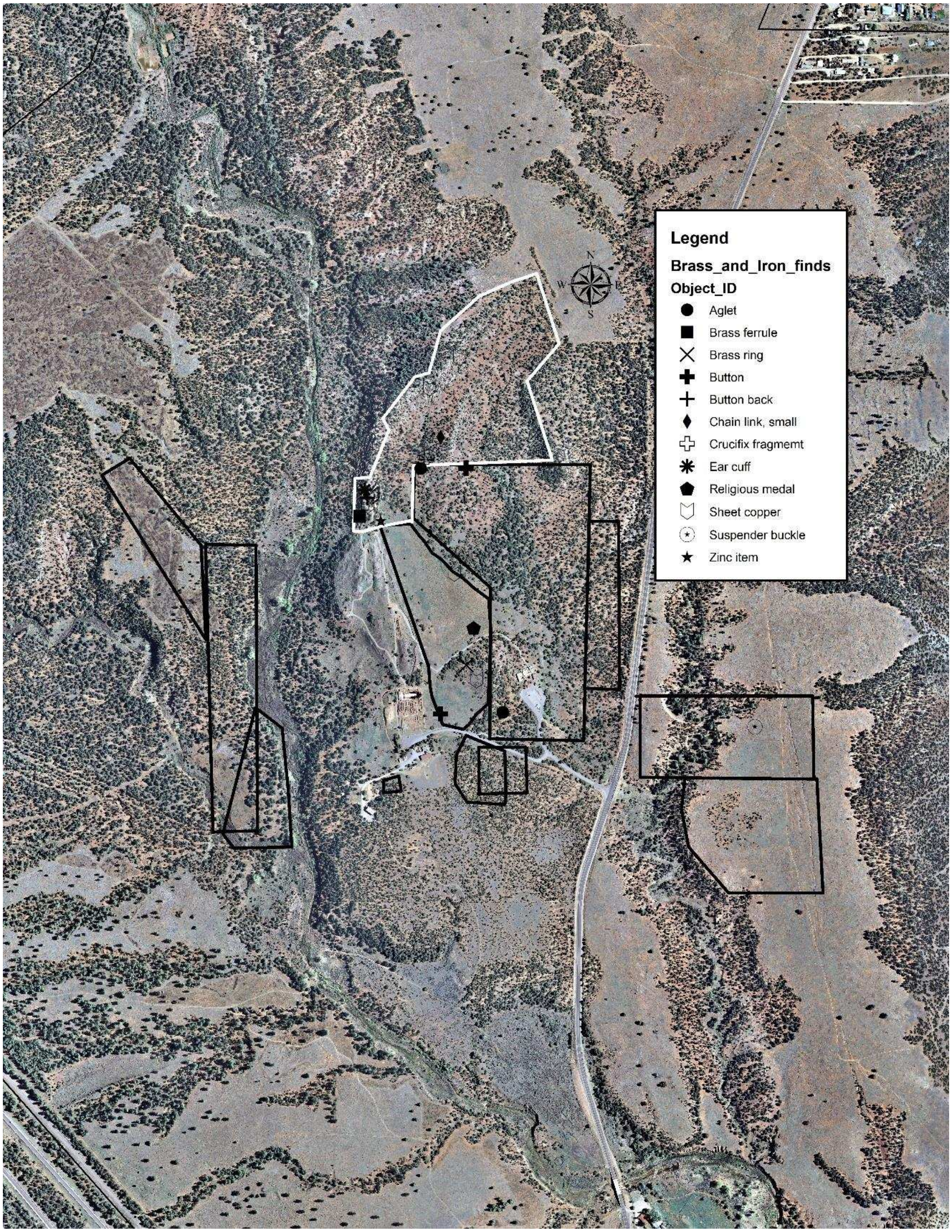


Figure 34. Miscellaneous brass and iron items found during metal detecting.

Project Findings and Interpretations

The goal of the intensive large area metal detecting was to obtain information on the distribution and content of metallic debris within the defined sample areas of within and around the Trade Fair Area. Having laid out broad research questions in the research methods section, and described the discoveries and their distributions, this section interprets the results of the 2012 metal detection. It emphasizes patterns within the data by Survey Area. To provide interpretive context, this section also briefly presents the results of some other research done at Pecos. Investigations done by James and Dolores Gunnerson and the geophysical investigations of Steven DeVore add special strength to the patterns seen in 2012

SA-1 –Survey Area East of the Church

Survey Area 1 yielded 599 targets of which 69 were excavated and 11 collected. By and large the excavated metal targets were twentieth century in origin and likely reflect the many activities related to park management, preservation, and visitation.

SA-1 included Gunnerson's Area C near the Mission Complex and Area E at the north end of SA-1. Gunnerson (1969; 1970) reported that Area C, located about 100 meters east of the church yielded possible Apache structural features, wickiups, associated with lithics, ceramics, and burned stick impressed soil, which he called adobe. He also identified one deep, circa 60 cm below ground surface deposit in a test pit that had similar materials and a heavily oxidized iron nail or spike. One important surface find was a double armed bronze or brass Christian cross thought to be hand cast and pre-dating 1680 (Accession PECO 51/ PECO 32335). A second cast bronze or brass cross, a single armed cross, is also in the park collections and attributed to the Gunnersons (Accession PECO 51/PECO32079). The provenience of the single armed cross is within LA 625, Apache House Site and is recorded as FS29SM 1-U.

In 1970, the Gunnersons returned to Pecos to conduct more extensive testing of their most promising areas (Gunnerson 1970). In Area C, they excavated what they believed to be an Apache structure about 100 meters east of the church ruins. There they found evidence of a 5 meter diameter "wickiup" that had been built with radially aligned poles covered with wattle and daub. The structure contained a basin-shaped central fire hearth, two fragmented Puebloan pots (a bowl and an olla, thought to date 1650-1680), a clay cloud blower, a copper tubular ornament, and a worked Chinese porcelain sherd.

Other testing in Area C about 100 meters southeast of the ruined church found four burials, all in a supine position. Gunnerson (1970:3) presumed these burials to be Spanish in origin and likely related to the seventeenth century church's *campo santo*. The burials were described as shallow, but no depth was noted. Three were left in place, but one was removed at the behest of NPS archeologist Alden Hayes.

Two other 1969 test pits in Area C thought to have evidence of pit houses were relocated and expanded in 1970. Both proved to be deliberately filled in gullies or shallow arroyos. One was likely filled during the 1600s and the other during the 1930s.

Metal detecting in 2011 (Haecker 2012) and by the 2012 project found the metal artifact density in the south end of SA-1, coinciding with the Gunnersons' Area C, was the highest in any of the survey areas. The vast majority of the metal targets excavated proved to be twentieth century in origin and reflect the fact that this area has been used by staff and visitors for over 100 years. A wagon bow staple or cleat, a harness buckle, and a brass button (Target 353) were the only pre-twentieth century objects excavated during the sampling. Modern materials essentially obscure any earlier metal deposits and create a highly modern culturally contaminated site area.

The large open area traditionally identified as the Trade Fair Area produced nearly 100 objects, but only two, a piece of sheet brass (Target 934) and a Civil War era canister ball (Target 972), are of pre-twentieth century origin. The remainder of the excavated targets are modern and as with the area near the church, reflect the ranching era and monument era of the history of Pecos.

Steven DeVore (2013) conducted geophysical investigations employing a variety of instruments in Gunnerson's Area C after metal detecting was completed. Devore designated his grid in SA 1 as Area A (Figure 35). He identified a number of rectilinear anomalies in his geophysical grid that may be Puebloan or Spanish Colonial structures (Figure 36). The central rectilinear anomaly may be in the vicinity of the location where Gunnerson (1969) reported finding burials. Several circular anomalies were also identified that may correspond to Gunnerson's (1969) wikiup sites. DeVore (2013) also identified two linear alignments that appear to be trails to the Mission Complex and Church. The date of the trails is not known, but could coincide with the Santa Fe Trail period as the alignment links to a segment in SA 2 identified as a possible Santa Fe Trail segment by Boyer et al. (2002).

Metal detecting indicates this area is virtually covered with twentieth century metal items. These later materials mask the earlier artifacts that are likely to be associated with the features noted by both Gunnerson and DeVore. Since Ivey (2005) does not identify any Spanish Colonial features east of the church the geophysical findings are extremely important as they suggest there are structures and features in this area that are not identified in historic or ethnographic records. These deserve testing to determine their date, cultural affiliation, and function.

DeVore (2013) also conducted geophysical investigations in the main Trade Fair area. His unit, designated B, was located on a low terrace on the southeast side of the Trade Fair area. The geophysics found only one anomaly, a likely burned feature in the unit. This area also yielded metal artifacts suggesting a late nineteenth or early twentieth century use of the area that may have been associated with a corral and livestock husbandry activities. The anomaly, if it is a burned feature, may be a fire hearth associated with livestock branding.

SA 2: This is a 2.5-acre area located approximately 200 meters east of the Pecos NHP administration building complex. This area comprises Survey Unit G-4, as defined in the August 2011 survey (Haecker 2012). According to park archeologist Sue Eininger (pers. comm. 2012), this general area of the park was subjected to mechanical ground disturbance. Nonetheless, analysis of 2009-dated aerial images of Unit G-4 suggests that there is at least one circular anomaly that is approximately eight meters in diameter. This anomaly(ies) could be an indicant of a Plains Indian tipi ring(s). Significantly, in 1761, priests at Pecos Pueblo reported over 100 tipis were located to the southeast of the mission church; SA 2 is to the southeast of the church. The work in SA 2 during the 2011 survey did not result in recovery of either Spanish Colonial or Territorial Periods artifacts.

A suite of remote sensing techniques were applied within this search area, in order to determine probable chronology and cultural affiliation(s) of these soil anomalies. DeVore (2013), designated his geophysical grid as Area D (Figure 35) and identified a possible Santa Fe Trail rut alignment and several circular anomalies (Figure 37). The linear alignment is consistent with Santa Fe Trail segment 4 identified by Boyer et al. (2002). The circular anomalies may be remains of tipi sites, wikiup sites, or wagon parks associated with the Santa Fe Trail. They deserve testing to identify and date them.

SA 2 metal detecting area was expanded to the west and south to include an additional 2 acres. Metal detecting of SA 2 and the expanded area yielded 67 metal detector targets of which 14 were excavated. Only two artifacts were collected. The majority of excavated artifacts were twentieth century in origin and consistent with intensive use of the area by the state and National Park Service. Two artifacts dated to the nineteenth century or possibly earlier. One square bar stock double pointed awl (Target 899) was identified, that could date anywhere from the seventeenth through the early nineteenth century. The other collected item is Target 1194, a high velocity impacted spherical lead bullet that dates to the late nineteenth century based on inclusion of antimony as a hardener. The excavated and collected artifact assemblage confirms the disturbed nature of the area, but also suggest that some historic Native American and potentially Santa Fe Trail era materials are present in the study unit.

SA 3: This is a reported Jicarilla Apache tipi ring (PECO 65/LA 14148) (Levine and LaBauve 1997) comprised of a linear array of rocks in association with a less defined rock concentration. The site is located approximately 200 meters southwest of park headquarters. Geophysical remote sensing, unit C, of this site provided comparative data with the surface stone array and identified an anomaly in the same area.

Metal detecting identified 16 targets in the study unit, three were excavated and one was collected. Targets 1138 and 1150 were a piece of modern fence wire and a 6 inch long wire nail or spike. Target 1135 is a spherical lead ball that is consistent with 00 buckshot or approximately .33-caliber. The shot could date to any period but the nineteenth or twentieth centuries would be most likely given its diameter and the fact that 00 buckshot was standardized in the mid-nineteenth century at .33-caliber.

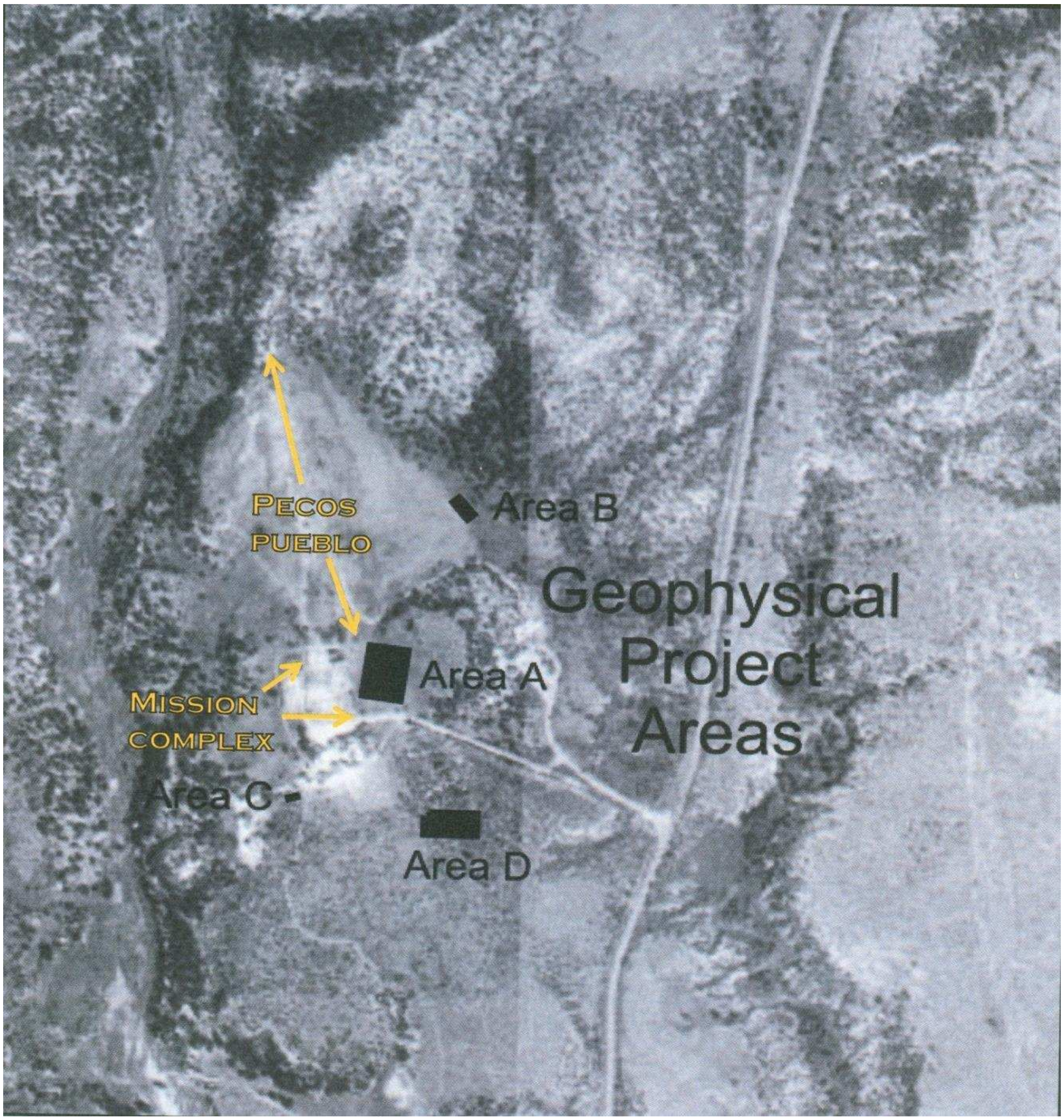


Figure 35. Locations of the geophysical grids investigated in 2012 by Steven DeVore (2013).

Figure 36. Locations of geophysical anomalies in Area A, SA 1 that may be culturally significant.

Figure 37. Circular anomalies located during the geophysical investigations of SA 2 (DeVore Area D (2013).

Metal detecting in Study Area 3 yielded no definitive artifact that could be associated with the possible tipi ring or date prior to the mid-nineteenth century.

SA 4

The original SA 4 area comprised an approximately 20-acre area that forms the northern, eastern and southern boundaries of SA 1. The fall 2012 reconnaissance work expanded the area to the north and encompassed an additional 15 survey acres. The two efforts are discussed under this survey area. Survey Area 4 and the expanded area yielded 415 metal targets of which 73 were excavated and 22 collected. Most of those collected artifacts were located in the boulder strewn area just south of the park trail and near the visitor center.

In 1969, the Gunnersons (Gunnerson 1969:6-7) identified a boulder strewn zone north of their Area C. They found a concentration of lithic materials and ceramics scattered around three very large boulders. This area, designated Area E, coincides with the geologic feature that breaks from the higher land surface where the mission church is situated to the lower eroded soil surface that defines the so-called Trade Fair Area. The boulder strewn area is on the south end of the Trade Fair Area and the current trail from the Visitor Center follows along the lower contour.

On the eastern side of the boulder strewn area are two more Gunnerson defined locales, Areas F and K. These two areas follow the eastern contour of the boulder strewn area southeasterly to an intermittent drainage. There they found surface finds of stone Plains-style snub nosed end scrapers (Gunnerson 1969:7).

Gunnerson’s Area E is located in part of SA 1 and SA 4, but is discussed here as a single metal artifact concentration area. The 2011 metal detecting reconnaissance survey recorded fourteen targets in this area (Haecker 2012:8-9). Seven were excavated: an 1836 Republic of Texas uniform button, a wrought iron S-shaped wire that is thought to be a coscojo hanger, a coscojo, a .50-caliber lead ball, a harmonica reed plate, and three fragments of brass that may be part of a Mexican-Territorial Periods belt plate. This same area was reinventoried during the 2012 survey. A total of 157 targets were recorded and nineteen were excavated. These targets are included with the greater SA 4 and expanded area total.

The piñon-juniper covered area immediately above the boulder strewn area, and at the north edge of Area E, had 33 targets of which nine were excavated. There were two fence staples, a small spoon (Target 592), an iron ring, an iron strap, a piece of salt glazed crockery (Target 710), a brass decorated ring or ear cuff (Target 768), an awl (Target 707), and a piece of sheet brass (Target 703). On the boulder strewn slope 115 targets were found and ten excavated. The excavated targets included two fence staples, a modern tin can, a sardine can key, two .22-caliber bullets, one .22-caliber long cartridge case, a modern .38-caliber Colt bullet, one .50-70-caliber bullet (Target 850) and a deformed lead ball (Target 837).

Gunnerson's Area E has a mixed depositional sequence. Much of the excavated material dates to the mid-twentieth century and probably reflects the ranching, dude ranch/park visitor, and park management uses of the area. However, the piñon-juniper covered area above the boulder strewn slope and the upper part of the boulder area contain good evidence of an early nineteenth century use, possibly Comanche or Apache which is consistent with Gunnerson's (1969) observations that this could be an Apache site.

Gunnerson's (1969) Areas F and K are on the east side of the boulder strewn slope and directly west of the modern visitor center parking lot. Forty-three metal detected targets were encountered in this area. The metal detector transects continued south to the pedestrian trail that links the Mission church to the Visitor Center. Fifteen targets were excavated in this area. A group of eight was dug north of the pedestrian visitor trail that all appear to be twentieth century in origin. The artifacts included a .22-caliber bullet, four wood screws, an iron barrel hoop fragment, a split rivet, and a harness buckle.

The area opposite the Visitor Center parking within SA 4 and Gunnerson's Areas F and K, yielded a large number of targets of which seven were excavated. Most are sixteenth to nineteenth centuries in origin and indicate a long use and reuse of the area by Native Americans. The excavated materials included a nineteenth century bag needle (Target 1637), a hand wrought nail (Target 1670), a worn gimlet (drill) (Target 1667), a lead ball fragment (Target 1665), a modern shotshell base (Target 1666), a lead bullet fragment (Target 1650), a .22-caliber modern bullet (Target 1660), and a copper aglet (Target 1655). A chert side-notched arrowhead was also noted during the inventory effort.

During the field investigations on the east edge of SA 4 and northeast of the Visitor Center, a possible road swale and alignment were noted. Boyer et al. (2002) identified this area as part of Historic Road 1, a segment of one branch of the Santa Fe Trail. Several metal detector sweeps were made along this area which expanded the SA 4 area about 100 meters to the east. Metal detecting identified 32 metal objects in the expanded area and five were excavated. All proved to be early twentieth century in origin, three sanitary tin can fragments, a piece of wire, and a washer. The presence of early twentieth century trash suggests that the road was in use at that time. However, the small number of targets that were dug may bias the range of metal debris present along the trail and road.

To the north of SA 4 is an area of small mesas and uplifts. The small mesa area north of SA 4 is the site of the early seventeenth century Spanish church, the so-called Lost Church or Ortiz church (Ivey 2005). This area was subject to limited reconnaissance level metal detecting work in July and more intensive reconnaissance work in October 2012.

The forested area of SA 4 and the mesa area around the Lost Church yielded 109 metal targets, most of which were judgmentally excavated. Some of the material was wire and modern bullets, but the vast majority of materials were Spanish Colonial or Native American related. Among the finds in the forested area leading up to the Lost Church mesa were hand wrought nails, an early style brass button (Target 1255), an iron awl (Target 1024), several Spanish bridle parts (coscojos – Targets 1019, 1231, 1261 and 1280 – bridle chain – Target 1232), a lug handle to a Spanish style ceramic canteen

(Target 1018), a Scala Sancta medal (Target 1016), a number of spherical lead balls (Targets 1017, 1262, 1714, 1715, 1724), and three caret head horseshoe nails (Targets 1022, 1712, and 1713), a strike-a-light flint (Target 1713), a possible crucifix fragment (Target 1247), and a piece of possible chainmail (Target 1240). Haecker (2012:8) found Spanish Colonial era materials during the 2011 sampling survey in this same area. His finds include a spur rowel, a hand wrought nail, and a hand wrought horse shoe nail of the late Spanish Colonial period.

A Civil War era bullet (Target 1281) and a circa 1870 era bullet (Target 1206) were also discovered in this area, as was a Civil War era fired musket style percussion cap (Target 1238). During the 2011 sampling survey, Haecker (2012:8) recorded a .36-caliber Colt Navy bullet, a .50-caliber lead ball, a pressed iron trouser button, and a .44-caliber Colt Army revolver ball. Along with the iron canister ball (Target 972) found in the Trade Fair Area, these items are clear evidence of the U.S. Army presence in the area from 1846 on, and in particular, of the 1862 Glorieta Battle that took place a few miles to the west.

In the immediate vicinity of the Lost Church a mix of twentieth century and seventeenth century material was found. Modern items included wire nails and conical lead bullets. Earlier materials included hand wrought nails (Target 1242, 1716), a possible iron crucifx arm (Target 1247) and a possible piece of chain mail (Target 1246). In addition several lumps of fire modified material containing iron were found during the metal detecting work. Analysis of the material (Target 1023) indicates this is local soil that was subject to enough heat to bind iron oxides and silica together to form the lumps.

The finding of seventeenth century metal artifacts at and near the Lost Church is important. The original excavators (Stubbs et al. 1957, see also Hayes 1971; 1974) reported that the church was unfinished and no metal artifacts were recovered during their investigations, nor was any evidence of burning noted. The field methods employed by Stubbs were clearly not adequate to find metal artifacts, although this is typical of early excavation efforts before screening and other more modern controls became de rigor. The presence of modern metal material is undoubtedly the result of the mid-twentieth century excavations and later stabilization efforts.

However, the presence of seventeenth century artifacts, including hand wrought nails, in and around the church site suggest the construction was farther along than Stubbs conjectured. The evidence is consistent with the conclusions reached by Ivey (2005) that the church was nearly complete or newly finished in 1621 when its dismantling began. Ivey (2005) also suggests that Father Ortiz may have lived in a temporary rude structure in the church during its construction. The oxidized soil and iron lumps could be remains of a fire hearth or another episode of burning. The presence of these early objects and burned material on the church site are consistent with Ivey's (2005) conclusions. The metal artifacts also suggest there may be more to be found and learned if intense metal detecting is done at this locale coupled with new excavations.

Just below the Lost Church mesa edge, in a boulder area, several additional finds were made. Two iron arrowheads (Targets 1253, 1269) were found there, as was a belt knife tip (Target 1251), a tang knife (Target 1250), and a lead ball (Target 1248). Three caret head nails and a strike-a-light also were discovered southwest of the Lost Church on an open flat area.

North of the Lost Church complex is another small uplift and mesa that open onto a broad open sage-brush flat. During October 2012, the reconnaissance survey made metal detector sweeps along the base of this higher mesa, along its top, and onto the sage brush flat as well as on either side of the Pueblo Defensive Wall and on the ridge north of the wall. Seventy-five targets identified, 57 were excavated, and 18 collected.

Sixteen artifacts were recorded on the uplift/small mesa north of the Lost Church, including cut sheet brass (Targets 1692, 1676), five cut pieces of sheet iron or iron straps (Targets 1679, 1680, 1681, 1683, and 1694), two metal arrowheads (Targets 1677, 1685), two iron awls (Targets 1682, 1686), a strike-a-light flint (Target 1691), and four lead balls or fragments of impacted bullets (Targets 1674, 1675, 1688, 1690).

At the northeast end of SA 4 is the area where Gunnerson (1970:4-5) excavated a large, circa 6 meter-diameter, stone circle. Designated by Gunnerson as Area J, it is located about 500 meters northeast of the Pecos Pueblo. The structure, located on the end of easterly trending ridge, was determined to be a Pueblo shrine. Two other similar rock ring structures located on similar terrain features were initially believed to be Apache in origin, but later determined to be Pueblo shrines. These sites were not tested or excavated by Gunnerson. The metal detecting effort avoided these areas as well.

The October 2012 reconnaissance work also investigated the boulder strewn areas and narrow neck of the mesa north of the Defensive Wall. The mesa neck yielded a few artifacts but was mostly devoid of metal; four artifacts were recorded. These include a brass button back (Target 1704), a brass ear cuff or earring (Target 1703), a piece of cut sheet brass (Target 1705), and a lead ball (Target 1709). The slopes on the west side of the mesa neck yielded seven collected artifacts scattered among the boulders. The collected artifacts consist of several pieces of cut iron (Targets 1694, 1695, 1698), an early seventeenth century gun spring (Target 1692), two pieces of cut sheet brass (Targets 1693, 1700), and an iron tang knife (Target 1699). Other non-collected metal artifacts were also recorded, including cut segments of sheet brass and sheet iron, and other recycled iron fragments.

On the east side of the mesa neck in a similar boulder strewn slope, four artifacts were collected. Three are cut sheet brass (Targets 1706, 1707, 1708) and a fragment of a zinc item (Target 1610). Like the west side slope, other non-collected metal artifacts were recorded. These included cut or manipulated iron and brass.

SA 5

The area west of Glorieta Creek includes Square Ruin and Gunnerson Areas Q, R, and S. These areas (Gunnerson 1969:7) yielded ceramic evidence of Apache presence in the form of Ocate Micaceous pottery sherds, with one (Area Q) identified as a pot break situated among boulders. A small circle of rocks near the sherd pile was thought to be a possible pot rest.

Square Ruin is a somewhat enigmatic structure at Pecos. There are a number of hypotheses to account for the origin and use of the structure. Hayes (1974) suggested the site was a trading compound while Jones (1966) suggested it was an assembly point, Plaza de Armas, for Pueblo or Spanish punitive expeditions. Jones further suggested this was the point where livestock and supplies were gathered, essentially a quartermaster depot concept.

Excavations by Nordby and Creutz (1993) were inconclusive in determining the origin or use of the area. They suggest the site predates 1640 for the majority of its construction, but suggest the construction techniques imply Spanish influence or possibly construction under Spanish direction. They further suggest that the presence of only two Euro-American items, a piece of iron, and a fragment of majolica, does not attest to significant Spanish or later historic use or occupation. Ivey (2005:78-95) reinterprets the archeological evidence from Square Ruin suggesting it was built between 1620 and 1640 possibly as a corral or branding area. He suggests there was no permanent residence and the site had no occupation after the 1680 Pueblo Revolt.

Boyer et al. (2002) identify at least three segments of road or trail, likely the Santa Fe Trail, in this same area but west of Square Ruin.

The survey area was metal detected and was expanded to the east and to the northwest with 333 targets being identified with 27 excavated and 4 collected. The expanded area at the northwest corner of the survey area covers a portion of what Boyer et al. (2002) identify as Historic Road 4, while the main area of SA 5 has portions of Historic Road 2 and 5. All are believe to be related to the Santa Fe Trail.

Sixteen targets were found in the Square Ruin proper, 10 in an area south of Square Ruin, 12 in an area west of Square Ruin, and the remainder to in the large area north of the ruin that are within the Gunnersons' (1969) areas R and S.

The targets found in Gunnersons' R and S areas were, with two exceptions, all twentieth century in origin. Those two exceptions are both iron awls, Targets 1430 and 1495. Both are relatively close to Glorieta Creek and appear to be near or within Gunnerson's R and S areas respectively where he found micaceous based pot sherds he believed were Apachean in origin. The iron awls suggest that these locations may be campsites and that they likely contain more extensive evidence of Apache presence than either the Gunnersons or the metal detecting survey suggest.

The excavated metal targets in the Square Ruin complex were largely late nineteenth and early twentieth century in origin. There were four pieces of iron scrap, two pieces of wire, two square cut nails, one wire nail, one tin can fragment, a boot eyelet, a coffee grinder fragment, three .22-caliber bullets, and one .22caliber cartridge case found. The metal artifacts do little to expand the conclusions drawn by Nordby and Creutz (1993) except to point out that there is far more metal debris on the site than they encountered. The excavated metal items suggest a late nineteenth and early twentieth century use of the site. No pre-1850 artifacts were found. The metal detecting findings indicate the site was used well after the Pueblo Revolt of 1680. Perhaps there was an occupation hiatus between 1680 and circa 1850.

The late use of Square Ruin may be related to sheep herding activities. Just to the south of Square Ruin, a concentration of metal items were noted that when sampled yielded two late nineteenth century wagon parts and a hand forged rose head nail. The location appears to be consistent with a sheep herders' camp, perhaps reused over time. The presence of the rose head hand forged nail deepens the mystery of the occupation dates for this site and for nearby Square Ruin.

We speculate that Square Ruin is a late seventeenth century or early eighteenth century construction as posited by Nordby and Creutz (1993) and Ivey (2005:78-96). The majolica sherd and hand forged nails suggest an early use of the area that is consistent with their hypotheses. The late nineteenth and early twentieth century artifacts strongly suggest the structure was used to corral sheep or other livestock, perhaps used and reused as a herder's camp. Both the ruin and adjacent areas appear to have long term intermittent occupations as a livestock tending camp.

Another concentration of 12 metal detected targets was found west of Square Ruin and scattered along a north to south trending intermittent drainage. A wagon bow staple or cleat, a hand-forged wagon chain and hook, a hole-in-cap tin can, a cut nail, and a large piece of iron reinforcing strap likely from a wagon bed were found along the arroyo banks and in the open flat to the east of the drainage. The concentration is consistent in location with the postulated location of Santa Fe Trail segments as proposed by Boyer et al. (1998). The metal artifacts are consistent with mid-nineteenth century wagon hardware and the tin can is an early style (based on field observation as it was not collected). The presence of wagon and domestic artifacts suggest this may have been a camp or wagon park during the heyday of the trail. Perhaps this is one of the locations where travelers stopped to rest their stock, visit the well-known ruins of Pecos and, prepare for the final run to Santa Fe.

Study Area 5 yielded strong evidence of multiple use and occupation in the historic period based on the metal detecting work. That effort found materials consistent with Apache use of the area as suggested by Gunnerson (1969). Metal detecting did not help to elucidate the construction date of Square Ruin, but it did show that there is significant metal present on the site that can most easily be interpreted as nineteenth and early twentieth century livestock herding activities and reuse of the structure. A few artifacts suggest a seventeenth or eighteenth century occupation of the ruin as well. The metal detecting did find good evidence of a wagon park or Santa Fe Trail camp west of Square Ruin, which adds a further dimension to the use of this area west of Glorieta Creek.

<u>SA 6</u>: This is an estimated 10-acre area east of State Road 63 and approximately 450 meters east of the Pecos Pueblo-Mission Complex. Similar to SAs 2 and 5, the broad

expanse of rolling grass-and-woodland extending east of State Road 63 is conducive for encampment. Although being slightly further away, it still is in proximity to both Pecos Pueblo and water sources. The area is divided by a deep intermittent drainage or arroyo. The east side was bulldozed at some time in the past to reduce tree cover and create an open grazing area.

During the metal detecting, the study area was expanded approximately 400 meters to the south adding about another 10 acres to the survey. A total of 100 targets were identified, 22 were excavated and 4 collected. A total of three zones or subunits were identified, two of which are within the original study area. One subunit is east of the dividing drainage and encompasses the larger flat open landscape. Forty-three metal objects were found in this area. The second sub-unit is the expanded area to the south which has the same open landscape. Twenty metal detector targets were found in this area. The west side of the creek along the highway corridor is the third sub-unit. Forty-one metal detector targets were identified in this area.

Seven targets were dug on the west side of the drainage. Most of these were related to twentieth century activities. The artifacts include fragments of aluminum foil, a cut piece of sheet aluminum, sheet iron scrap, a fence staple, and a steel clip or band. Two munitions artifacts were found. One is the brass case mouth and bullet for a .50-caliber cartridge (Target 1325) and a spherical cast lead ball (Target 1322). The area along the highway corridor appears heavily disturbed, but along the drainage edge where the two bullets were found appears relatively undisturbed. The two bullets do not make a site per se, but their presence and date of circa 1870 for the cartridge and a greater range for the lead ball suggest use of the water source as predicted.

The area east of the drainage and in the original study area had 10 items excavated. All were twentieth century in origin. They included a fragment of a sanitary tin can, three circa .38-caliber conical lead bullets, one piece of wire, two wrenches, a horseshoe, a wire nail, and a suspender buckle. The expanded survey area to the south had only four excavated artifacts and one prehistoric turquoise bead was observed on the surface and noted. Two of the four excavated targets were twentieth century in date, a tin can lid and a wire nail. The other two items are mid-nineteenth century or earlier in date. Target 1370 is a tip of belt/camp knife or butcher knife blade and Target 1332 is a 3 ½ inches long double pointed awl made of square stock. Both the knife and awl were found along the eastern edge of the arroyo, suggesting there are one or more Native American camps along the drainage.

The four artifacts representing pre-twentieth century use of the study area were found along the arroyo edge. Two were found on the east side and two on the west, suggesting multiple camps or uses of the water source are likely. The turquoise bead was found on prehistoric site that is also on the arroyo edge. The larger open areas do not appear to have colonial or later era materials, but those areas were significantly disturbed by vegetation clearing which may well have destroyed or disrupted evidence of historic era uses leaving with only those areas immediately along the arroyo banks remaining undisturbed and preserved.

Summary and Recommendations

The density of metal artifacts found during the field investigations indicates that metal objects are essentially ubiquitous within the Park. However, as evidenced by the distribution of recorded targets, the occurrence of metal artifacts across the landscape is variable in density. Since recorded targets were systematically sampled, the composition of the documented assemblages forms another result of the survey. Differences in the kinds of materials provide an insight, but not a complete understanding, of how the Trade Fair Area and the area surrounding the Pecos Pueblo Mission Complex were used by different communities at different points in time.

The metal detected artifact assemblage clearly indicates there are materials representing the range of historic periods, Spanish Colonial thorough early twentieth century, as defined by Boyer et al. (2002) throughout the survey areas. Results of the metal detecting survey indicate all periods of historic sites are abundantly represented in the park. Generally speaking, artifacts representing the different periods are spatially discrete, but some areas are intensely mixed with all eras represented in as little as 10 centimeters of undifferentiated deposits. Most of the material is clearly culturally distinctive, Spanish versus Apachean. The artifacts reflect how the various populations used the landscape, and the range of activities that were undertaken there. Certainly, short term occupation in "camps" and transportation reflected in "trail debris" are readily apparent.

To illustrate the utility of combining artifact distribution and composition results it is useful to consider the data recovered from Survey Area 1. This open area was included in the survey because it has long been thought to be an area used as a campground and trading area by Spanish, Mexicans, Comanche, and Apache peoples who came to Pecos from the Plains, Mexico, and other areas. Results presented indicate that many metal objects were found in this survey block. When the excavated and diagnostically identified objects were analyzed, they appear to fall within two chronological periods, indicating this area was most intensively utilized after the end of the nineteenth century and well into the twentieth century. Metal objects that may have been discarded or lost by people camping there before that time are either not present or are so thinly distributed that they are obscured by the mass of later material. In either case, this area does not seem to have been an important residential area while the pueblo was occupied. Limted geophysical investigations provided additional support for this supposition.

It is also important to point out that the Trade Fair Area, the low lying area immediately east of Pecos Pueblo, yielded very little metal material that can be associated with trading events. The landform at this locale may be aggrading or deflating, such that in either case the pre-twentieth century materials are buried or lost. Additional soil testing in the Trade Fair Area is recommended to determine the sequence of depositional and erosional context. Such information may help solve the issue of whether the Trade Fair Area is a disrupted landform with compromised archeological integrity or if the historically identified Trade Fair Area locale has been misinterpreted or mislocated.

In contrast, the north part of Survey Area 4 including the October 2012 reconnaissance area, have very few post-1880 artifacts present. The metal artifacts that are present suggest the boulder strewn slopes below the Lost Church, north of the Lost Church, and north of the northern section of the Defensive Wall, as well as the boulder strewn north slope area identified as Gunnerson's Area E, were all intensely used by various Native American groups during the late sixteenth through the early nineteenth centuries. The metal artifacts found along the mesa slopes and among the boulder strewn areas tend to be sheet iron and brass as well as other iron and brass objects that have been modified and reworked. The metal items appear to be waste or discards suggesting that these areas were some type of workshop or metal working areas. The boulder strewn areas give a feeling, today, of seclusion and privacy. Lithic reduction areas in the park appear to be in more open areas and areas that had good views of the surrounding area (Head and Orcutt 2002). The metal found in these secluded boulder strewn areas tends to date to the sixteenth and seventeenth centuries. It is tempting to suggest early Puebloan or Apache and Comanche metal workers desired privacy or felt a need to conduct metal working activities in a manner that was less observable to the general population. Whether this had religious or cultural overtones is not known, but could be the subject of further research. The key factor seems to be the seclusion offered by the boulder arrangement and not vegetation.

Since metal detecting was not undertaken in the Pecos Pueblo trash middens or in the room blocks it is not possible with the data at hand to offer more than a speculation and suggest the role of metal working in the early contact period is open to further fruitful investigations. It is also important to recognize the Lost Church area and the boulder strewn areas, as well as some of the small mesas and uplands are less impacted by ranching and later park management activities than the lower areas surrounding Pecos Pueblo and the Mission Complex. The lack of such activities may have resulted in better data and site preservation in these less intensively used areas.

The most striking diagnostic artifacts from the recovered assemblage were on the end of the small mesa and west and south of the Lost Church. This artifact sub-assemblage definitively dates to the mid-sixteenth century. Caret head or bi-faceted horseshoe nails, bridle parts, strike-a-light flints, and probably some of the spherical lead bullets indicate this may be the 1541 camp of Captain Tristán de Arellano of the Coronado Expedition. When his advance company returned to Pecos Pueblo in September open conflict erupted due to the Pecos Pueblo's inhabitants' mistrust of the Spanish by this time. Warriors launched periodic attacks against the company's encampment for four days. Arellano and his men killed two senior warriors and drove the other Pecos warriors back to the pueblo using their horses, swords, lances, and harquebuses (matchlock firearms). Hostilities ceased only with the arrival of the main body of the expedition led by Vázquez de Coronado (Flint and Flint 2005:413).

Some of the bullets found below the Lost Church and in the currently forested slopes above the open Trade Fair Area are consistent with early firearms use. From the context of discovery, they appear to be bullets fired toward the Pueblo not from it. These bullets may be evidence of the 1541 or 1591 attacks by the Spanish against the Pueblo. It must be stated, however, that these lead bullets are difficult to distinguish from later trade musket bullets fired from smoothbore guns. However, those later guns were usually about .69-caliber. The majority of spherical balls discovered are closer to .50-caliber in diameter. The smaller and more diverse diameters are more consistent with sixteenth or very early seventeenth century firearm calibers than those of later years (Harding 2012).

General site location and patterning in Pecos NHP is discussed in Head and Orcutt (2002). The 1995-1997 archeological survey of the park employed mean ceramic dating in an innovative manner to suggest that Native American occupation in the Upper Pecos Valley changed through time (Powell and Benedict 2002; Powell 2002). Mean ceramic dating for Period 4 (A.D. 1450-1575) suggests an increased clustering of activity to the north of Pecos Pueblo and intensification of activities in the site cluster to the northeast and above the river. Period 5 (A.D. 1575-1700) sees the apparent breakup of populations in the cluster of sites around Pecos Pueblo and more seasonal activity along the lowlands of the Pecos River to the east and northeast, with more special-use sites in the higher elevation areas on the east side of the river.

The cluster of sites above the river to the northeast of Pecos Pueblo persists in the next period, but a severe decline in the number of sites is clearly apparent during Period 6 (post A.D. 1700). The areas containing the late site clusters, to the north and east, were included in the metal detecting inventory. The presence of what can be interpreted to be early worked and reworked metal on the boulder slopes north of the pueblo and on the small mesas at and above the Lost Church is consistent with the dispersal and small size of sites suggested by the mean ceramic dating work. Both the ceramics and metal working dates to the sixteenth and seventeenth centuries. The fact that the two artifact groupings are consistent reinforces both the mean ceramic dating technique's value and the role of metal detecting to find metallic debris that is diagnostic and datable. The spatial patterning apparent in both data sets suggests the outlying areas near the Pueblo were in use when the Spanish arrived and continued so during the Colonial period.

Results of the 2012 survey cannot be assumed to show that the dispersed spatial pattern of artifacts was exclusively the result of the Pueblo inhabitants. Instead, the available archeological evidence suggests that many of the small sites situated on the boulder strewn slopes reflect temporary camps of the Pueblo's trading partners, the Apache and Comanche. And not all of their visits appear to have been peaceful. The presence of metal arrow points and lead bullets suggest that the occupants of these areas carried weapons. Hunting activities cannot be ruled out. But accidental loss of these items seems inconsistent with the fact that most of the bullets exhibit impact deformation. These bullets were fired.

Likewise the dispersed pattern of awls across the Pecos landscape may also reflect the presence of ethnically diverse temporary campsites associated with trade or Puebloan use. Although the sample is small, the distribution of awl discoveries appears concentrated either on the edge of drainages or in the boulder strewn slopes. They are certainly not randomly scattered across the landscape. This distribution may indicate that activities of domestic life occurred either near water or in areas that provide both a viewshed of the valley and the protective shelter from potential aggressors.

Evidence of the Santa Fe Trail is represented by materials found west of Glorieta Creek and west of Square Ruin. This location is entirely consistent with the historic record on the location of the trail and suggests travelers' debris will be found along its length. There are probably more wagon parks or campsites that could be found along the trail route if additional metal detection was conducted.

The function and chronology of Square Ruin continues to be an enigma. The metal detecting investigations indicate at least an eighteenth and nineteenth century use of the site. No earlier materials were identified. It is likely that earlier uses have been obscured by later stock herding activities, probably associated with sheep herding camping and corralling at and near Square Ruin.

Information on the distribution of metal objects within the park is the most obvious result of the 2012 survey. The recorded targets certainly indicate that metal objects are essentially ubiquitous within the Park. At the same time, the metal density shows that the distribution of metal in not completely uniform. The fact that metal use and discard has been concentrated in some areas reflects historic patterns of life and movement of those who occupied and used the landscape.

The 2011 and 2012 metal detecting investigations demonstrate the value of metal detecting as a complement to the earlier 100% pedestrian survey of the park by confirming certain site distribution patterns, identifying a wider variety of historic sites by the presence of datable metal artifacts, and identifying areas disturbed by modern activities that have no surface manifestations. The presence/distribution of these subsurface artifacts also alters and expands the site/activity area boundaries that were previously defined by surface manifestations alone. In essence the metal detecting inventory reminds us that human use of the area is nearly everywhere in the surveyed areas. Even where modern disturbances are evident, and even in areas that were not identified as sites during pedestrian survey metals are present. With more excavation of metal targets site boundaries can be confirmed or expanded and degrees of modern disturbance can be more clearly identified. Metal detecting also has minimal impact to archeological deposits or archeological integrity especially in areas that have been exposed to years of collecting and other forms of surface disturbance.

The metal detecting survey recorded 1438 metal targets. About 20% (304) of the metal targets were excavated and about 20% (65) of the excavated targets were collected for additional analysis. The metal distribution is patterned as far as the pre-twentieth century materials are concerned. The investigations:

1) may have found a Coronado era campsite in SA4
2) evidence that Ivey's (2005) interpretations of the construction and dismantling of 1617-1621 Ortiz or Lost Church is sustained,

3) that both the Pueblo occupants and their trading partners used the boulder strewn slopes to the north and east of the Pueblo, parts of SA1, SA4, and the 2012 reconnaissance area, as temporary camps and metal working sites.
4) The inventory also established there is good data present to identify mid-nineteenth century Santa Fe Trail routes and uses of the current park lands in SA1, SA2, and SA5,
5) and there is some evidence of Civil War era activity near the Pueblo in SA1, which has yet to be fully interpreted.
6) Metal detecting, which is a type of geophysical technique, coupled with Ground Penetrating Radar and Electrical Resistivity surveys conducted by Steve DeVore clearly show the value of applying multiple survey techniques for archeological investigations at Pecos National Historical Park.

DeVore's (2013) geophysical work identified several potential features in SA1 and SA3. Those features may be consistent with features noted or tested by the Gunnersons (1969) and identified by informants. At least one set of geophysical features in SA1 east of the church suggest a Spanish colonial era date. While no colonial era metal artifacts were found in the same area, the density of later metal artifacts may be obscuring the earlier component. Coupling visual inventory techniques with metal detecting and other geophysical methods demonstrates the potential to gain a greater understanding of past land use, site density, and spatial distributions through time. The metal detecting methods employed in this project could be modified in any future investigations to obtain greater amounts of information. As this project has shown targets could be excavated and with proper artifact identification expertise materials can be identified and recorded in the field then reburied with minimal disturbance to the archeological integrity. Significant artifacts, from a diagnostic or a potential interpretive value, could be collected on a limited and judgmental basis.

Future investigations employing metal detection, ground penetrating radar, resistivity, soil studies, and limited test excavation will be productive. Recommendations and research topics for additional work include:

1) Intensive metal detecting on the uplands east of the Pueblo could find more definitive evidence of the Spanish entradas including greater details of campsites and extent of aggression toward the Pueblo inhabitants.

2) Intensive metal detecting and perhaps limited testing in the boulder strewn areas and associated landforms in the vicinity of the Pecos Pueblo-Mission Complex could find clearer evidence of the distribution of trade-related camps and work areas.

3) Intensive metal detection and some limited test excavations at the Lost Church site could expand knowledge on its construction and abandonment.

4) Soil studies and limited testing in the Trade Fair Area could establish whether the area is a stable land surface, has deflated, or aggraded. If it has aggraded, then testing could determine if colonial or prehistoric surfaces are buried beyond current metal detecting technology's ability to find buried metals. Soil studies may also aid in explaining the absence of definitive trade-related sites in the Trade Fair area. One explanation is the sites are either buried or destroyed. While another is that trading partners camped on the higher ground and used the trade area as a meeting place to formally exchange goods. In any case further investigations of the Trade Fair area and the surrounding uplands may help answer the questions.

5) Additional metal detection coupled with extensive geophysical investigation of the Square Ruin complex may provide additional evidence of its construction sequence and dates of use.

6) Geophysical features discovered in SA1 and east of the church suggest a Spanish colonial era affiliation. This area should be tested to determine the nature, extent, and age of the buried deposit.

7) Metal detecting along and around Santa Fe Trail and other historic trail segments may reveal additional information on trail use and development through time which could lead to a better understanding of the role Pecos played as a stopping point on the road to Santa Fe.

References Cited

Anderson, Corby G.
2012 The Metallurgy of Antimony. *Chemie der Erde* 72(S4):3-8.

Barnes, Frank C.
2006 *Cartridges of the World 11th Edition*, edited by Stan Skinner. Krause Publications, Iola, WI.

Baugh, Timothy G.
1984 Southern Plains Societies and Eastern Frontier Pueblo Exchange during the Protohistoric Period. In *Collected Papers in Honor of Harry Hadlock*, edited by N.L. Fox, Papers of the Archaeological Society of New Mexico 9, pp, 157-166. Albuquerque, NM.

Beck, Lane
2006 Kidder, Hooton, Pecos, and the Birth of Bioarchaeology. In *Bioarchaeology: The Contextual Analysis of Human Remains*, edited by Jane E. Buikstra and Lane A. Beck, pp. 83-94. Elsevier, Amsterdam, The Netherlands.

Biddle, Martin, Jonathan Hiller, Ian Scott and Anthony Streeten
2001 *Henry VIII's Coastal Artillery Fort at Camber Castle, Rye, East Sussex*. English Heritage, Oxford, UK.

Boyer, Jeffrey L. James L. Moore, Natasha Williamson, and Genevieve N. Head
2002 Euro-American Sites. In *From Folsom to Fogelson: The Cultural Resources Inventory Survey of Pecos National Historic Park*, edited by G.N. Head and J.D. Orcutt. National Park Service, U.S. Department of the Interior, Washington, D.C.

Butterman, W. C. and J. F. Carling
2004 Minerals Commodity Profiles: Antimony. U.S. Geological Survey Openfile Report 03-019, Washington, DC.

Capone, Patricia
2010 Pecos Pueblo: The Natural, Cultural, and Historical Settings. In *Pecos Pueblo Revisted: The Biological and Social Context*. Papers of the Peabody Museum of Archaeology and Ethnology. No. 85. Edited by Michèlle E.Morgan, pp. 9-18. Harvard University, Cambridge, MA.

Connor, Melissa and Douglas D. Scott
1998 Metal Detector Use in Archaeology: An Introduction. *Historical Archaeology* 32(4):73-82.

Deagan, Kathleen and Jose Maria Cruxent
2002 *Archaeology at La Isabela: America's First European Town*. Yale University Press, New Haven, CT

DeVore, Steven
2013 Geophysical Evaluation of Four Areas within the Trade Fair Locality at Pecos National Historical Park, San Miguel County New Mexico. Midwest Archeological Center, National Park Service, Lincoln, NE.

Eininger, Susan
2002 Previous Archeological Work. In *From Folsom to Fogelson: The Cultural Resources Inventory Survey of Pecos National Historic Park*, edited by G.N. Head and J.D. Orcutt, pp. 21-38. National Park Service, U.S. Department of the Interior, Washington, D.C.

Fitzgerald, William R., Laurier Turgeon, Ruth Holmes Whitehead and James W. Bradley
1993 Late Sixteenth-Century Basque Banded Copper Kettles. *Historical Archaeology* 27(1):44-57.

Flint, Richard
2008 *No Settlement No Conquest, A History of the Coronado Entrada.* University of New Mexico Press, Albuquerque, NM.

Flint, Richard, and Shirley Cushing Flint (editors and translators)
1997 *The Coronado Expedition to Tierra Nueva: The 1540-1542 Route Across the Southwest.* University of Oklahoma Press, Norman, OK.

Flint, Richard, and Shirley Cushing Flint (editors and translators)
2005 *Documents of the Coronado Expedition, 1539-1542."They Were Not Familiar with His Majesty, nor Did They Wish to Be His Subjects"*. Southern Methodist University Press, Dallas, TX.

Forbes, Jack D.
1960 *Apache, Navaho, and Spaniard.* University of Oklahoma Press, Norman, OK.

Fox, Anne A. and Kristi M. Ulrich
2008 *Guide to Ceramics from Spanish Colonial Sites in Texas*. Special Report 33, Center for Archaeological Research, University of Texas at San Antonio.

Gunnerson, James H.
1969 Archaeological Survey on and near Pecos National Monument, Preliminary Report. Report on File, Pecos National Historical Park, Pecos, NM.

1970 Preliminary Report of 1970 Archaeological Investigations by Northern Illinois University. Report on File, Pecos National Historical Park, Pecos, NM.

Gunnerson, James H., and Dolores A. Gunnerson
1970 Evidence of Apaches at Pecos. *El Palacio* 76 (3):1-6.

Harding, D. F.
2012 Lead Shot of the English Civil War: A Radical Study. Foresight Books, London, UK.

Hackett, Charles W., editor and translator
1937 *Historical Documents Relating to New Mexico, Nueva Vizcaya, and Approaches Thereto, to 1773. Vol. 3*. Collected by Adolph Bandelier and Fanny R. Bandelier. English translation edited with introduction and annotations by C.W. Hackett. Carnegie Institution, Washington, D.C.

Haecker, Charles
2012 Metal Detection Sample Survey within the Trade Fair Area, Pecos National Historical Park, New Mexico., Intermountain Regional Office, National Park Service-Heritage Partnerships Program, Santa Fe, NM.

Hanson, James A. and Dick Harmon
2011 *Firearms of the Fur Trade, Volume 1, The Encyclopedia of Trade Goods*. Museum of the Fur Trade, Chadron, NE.

Harding, D. F.
2012 *Lead Shot of the English Civil War: A Radical Study*. Foresight Books, London, UK.

Hayes, Alden C.
1971 The Four Churches of Pecso. New Mexico Archeological Center, National Park Service, Santa Fe.

1974 *The Four Churches of Pecos*. University of New Mexico Press, Albuquerque.

Head Genevieve N. and Janet D. Orcutt
2002 *From Folsom to Fogelson: The Cultural Resources Inventory Survey of Pecos National Historic Park*. National Park Service, U.S. Department of the Interior, Washington, D.C.

Head, Genevieve N., Janet D. Orcutt, and Robert P. Powers
2002 Introduction. In *From Folsom to Fogelson: The Cultural Resources Inventory Survey of Pecos National Historic Park*, edited by Genevieve N. Head and Janet D. Orcutt , pp. 1-20. National Park Service, U.S. Department of the Interior, Washington, D.C.

Heckman, Elsa
2005 Geophysical Methodologies and Test Site for Battlefield Archaeology. Unpublished Masters thesis, Department of Anthropology, University of Arkansas, Little Rock, AR.

Hooton , Earnest Albert
1930 The Indians of Pecos Pueblo: A Study of their Skeletal Remains. Department of Archaeology, Phillips Academy, Yale University Press, New Haven, CT.
Hoyt, Cathryn A.
1992 Material Culture of the Spanish Explorers. *Bulletin of the Texas Archeological Society* 63:7-26.

Ivey, James E.
1996 Unique in All Respects: The Structural History of the Spanish Colonial Buildings at Pecos National Historical Park, 1617-1915. Unpublished Ms. of the Intermountain Cultural Resources Center, Professional Papers No. 59. History Program, National Park Service, Santa Fe, New Mexico.

2005 The Spanish Colonial Architecture of Pecos Pueblo, New Mexico: Archaeological Excavations and Architectural History of the Spanish Colonial Churches and Related Buildings at Pecos National Historical Park, 1617-1995. History Program, Division of Cultural Resource Management, Intermountain Region, Professional Paper No. 59, Santa Fe, New Mexico.

Jefferies, Richard W. and Christopher R. Moore
2013 Mission San Joseph de Sapala: Mission-Period Archaeological Research on Sapelo Island. In *Life Among the Tides: Recent Archaeology on the Georgia Bight*, edited by Victor D. Thompson and David Hurst Thomas, pp 345-374. *American Museum of Natural History Anthropological Papers, Number 98*.

Jones, Oakah L., Jr.
1966 *Pueblo Warriors and Spanish Conquest.* The University of Oklahoma Press, Norman, OK.

Kenner, Charles L.
1969 *A History of New Mexican-Plains Indian Relations.* The University of Oklahoma Press, Norman, OK.

Kessell, John L.
1979 *Kiva, Cross, and Crown, the Pecos Indians and New Mexico 1540-1840.* National Park Service, Washington, D.C.

2002 *Spain in the Southwest: A Narrative History of Colonial New Mexico, Arizona, Texas, and California*. University of Oklahoma Press, Norman, OK.

Kidder, Alfred V.
1932 *The Artifacts of Pecos.* Robert S. Peabody Foundation for Archaeology, Phillips Academy, Yale University Press, New Haven, CT.

1958 Pecos, New Mexico: Archaeological Notes. Papers of the Robert S. Peabody Foundation for Archaeology, Phillips Academy, Andover, MA.

Levine, Frances, and Anna LaBauve
1997 Examining the Complexity of Historic Population Decline: A Case Study of Pecos Pueblo, New Mexico. *Ethnohistory* 44 (1):75-112

Lindsay, Merrill
1967 *One Hundred Great Guns: An Illustrated History of Firearms*. Walker, New York.

Lintz, Christopher
1991 Texas Panhandle-Pueblo Interactions from the Thirteenth through the Sixteenth Century. In *Farmers, Hunters, and Colonists*, edited by Katherine A. Spielmann, pp. 89-106. University of Arizona Press, Tucson, AZ.

Mathers, Clay and Charles Haecker
2009 Social and Spatial Modeling of Historic Period Expeditions at El Morro National Monument (El Morro, New Mexico). National Park Service-Heritage Partnerships Program, Santa Fe, NM.

Morgan, Michèlle E.
2010 Introduction. In *Pecos Pueblo Revisted: The Biological and Social Context*. Papers of the Peabody Museum of Archaeology and Ethnology. No. 85. Edited by Michèlle E.Morgan, pp. 1-8. Harvard University, Cambridge, MA.

Nordby, Larry and A. William Cruetz
1993 Test Excavations at Square Ruin, Pecos National Historical Park, 1982. Manuscript on file Pecos National Historical Park, Pecos, NM.

Powell, Melissa
2002 Ceramics. In *From Folsom to Fogelson: The Cultural Resources Inventory Survey of Pecos National Historic Park*, edited by G.N. Head and J.D. Orcutt. National Park Service, U.S. Department of the Interior, Washington, D.C.

Powell, Melissa and Karl K. Benedict
2002 Ceramic Chronology. In *From Folsom to Fogelson: The Cultural Resources Inventory Survey of Pecos National Historic Park*, edited by G.N. Head and J.D. Orcutt. National Park Service, U.S. Department of the Interior, Washington, D.C.

Rhodes, Diane Lee
1992 Corando's American Legacy: An Overview of Possible Entrada Artifacts and Site Types, and a Discussion of Texas Sites. *Bulletin of the Texas Archeological Society* 63:27-52.

Rollins, John G.
2008 *Needlemaking*. Shire publications, Oxford, UK.

Rostker, William and Bennet Bronson
1990 Pre-Industrial Iron: Its Technology and Ethnology. Archaeomaterials Monograph No. 1, Philadelphia, PA.

Saidel, Benjamin Adam
2000 Matchlocks, Flintlocks, and Saltpetre: The Chronological Implications for the Use of Matchlock Muskets among Ottoman-Period Bedouin in the Southern Levant. *International Journal of Historical Archaeology* 4(3):191-216.

Schroeder, Albert H.
1979 Pecos Pueblo. In *Handbook of North American Indians, vol. 9, Southwest,* Alfonso Ortiz (ed.), pp. 430-437. Smithsonian Institution, Washington, D.C.

Schroeder, Albert H., and Dan S. Matson
1965 *A Colony on the Move. Gaspar Castaño de Sosa's Journal: 1590-1591*. School of American Research, Santa Fe, NM.

Scott, Douglas D.
2010 Investigating the Oxbows and Testing Metal Detector Efficiency at Little Bighorn Battlefield National Monument, Montana. Report on file Little Bighorn Battlefield National Monument, National Park Service, Crow Agency, MT.

2011 Identification and Preliminary Analysis of the Don Alberts Glorieta Battlefield Relic Collection. Connor Consulting, Lincoln, NE (prepared for Pecos National Historical Park, Pecos, New Mexico).

Scott, Douglas D., Richard A. Fox, Jr., Melissa Connor, and Dick Harmon
1989 *Archaeological Perspectives on the Battle of the Little Bighorn.* University of Oklahoma Press, Norman.

Simmons, Marc
1970 Governor Anza, The Lipan Apaches, and Pecos Pueblo. *El Palacio* 77(1):35-40.

Simmons, Marc and Frank Turley
1980 *Southwestern Colonial Ironwork: The Spanish Blacksmithing Tradition from Texas to California*. Museum of New Mexico Press, Santa Fe.

Smith, Julian
2009 A Tale of Two Trails. *American Archaeology* 13(1):39-43.

South, Stanley, Russell Skrowronek, and Richard Johnson (editors)
1988 Spanish Artifacts from Santa Elena. *Occassional Papers of the South Carolina Institute of Archaeology and Anthropology, Anthropological Studies 7*.

Spielman, Katherine A.
2010 The Sociopolitical Context of Pecos. In *Pecos Pueblo Revisted: The Biological and Social Context*. Papers of the Peabody Museum of Archaeology and Ethnology. No. 85. Edited by Michèlle E.Morgan, pp. 19-26. Harvard University, Cambridge, MA.

Stubbs, Stanley, Bruce T. Ellis, and Alfred E. Dittert, Jr.
1957 "Lost" Lost Pecos Church. *El Palacio* 64(3):67-92.

Tice, Warren K.
2002 *Dating Buttons: A Chronology of Button Types, Makers, Retailers, and their Backmarks*. Published by Warren K. Tice, Essex Junction, VT.

Woodbury, Richard B.
1993 *60 Years of Southwestern Archaeology: A History of the Pecos Conference*. University of New Mexico, Albuquerque, NM.

Appendix 1
Catalog of excavated and collected metal detected artifacts

Target No.	Approx. Depth	Object ID	Collected	Material	Measurements	Photo No.	Description/Comments
312	10cm	Pull tab	N	Aluminum			
321	10cm	Fence staple	N	Iron			
327	10cm	Nail	N	Iron			
337	3cm	Wire	N	Iron			
353	3cm	Button	N	Brass	approx. 5/8 inch	2	plain curved face, omega shank
373	3cm	Prince Albert can	N	Iron			
395	5cm	Wire	N	Iron			
403	4cm	Buckle	N	Iron	1/2in	1	harness strap buckle
415	10cm	Can, fragmented	N	Tin			
405	3cm	Can lid	N	Tin	2 1/2in. diameter		
426	2cm	22 shell long	N	Brass			
462	6cm	Wagon bow staple, 19th century bottle base frag	N	Iron, glass		1	bottle is dark green glass
464	0cm	Nail	N	Iron		2	
495	2cm	Strap metal	N	Iron	1/2 in.		
499	3cm	22 shell long	N	Brass			
507	5cm	2 wires	N	Iron			
512	2cm	22 shell short	N	Brass			
518	2cm	Nail	N	Iron			
523	4cm	Pull tab, fence staple	N	Iron, aluminum			
536	3cm	380 auto	N	Brass			
538	4cm	Bottle cap	N	Iron			
553	3cm	22 shell	N	Brass			

582	4cm	Fence nail	N	Iron		
588	1cm	Fence staple	N	Iron		
593	5cm	Spoon, broken in half	N	Iron		2
597	2cm	Fence staple	N	Iron		
601	4cm	Wire	N	?		
604	10cm	Beer can	N	Tin		
616	6cm	Wire	N	Iron		
617	2cm	Quadratic tag	N	Iron		
639	2cm	Fence staple, 2	N	Iron		
644	3cm	Fence staple	N	Iron		
648	2cm	Fence staple	N	Iron		
654	2cm	Fence wire	N	Iron		
693	5cm	Fence staple	N	Iron		
690	2cm	Mule shoe	N	Iron		1
703	3cm	Cut brass	N	Brass		1
707	4cm	Wire, made into awl	N	Iron		1
712	0cm	Iron ring	N	Iron	1/2in.	
710	0m	Ceramic	N	Ceramic		2
768	0cm	Brass ring	Y	Brass		1
728	2cm	Fence staple	N	Iron		
731	2cm	Modern can	N	Aluminum		
737	2cm	Barbed wire	N	Iron		
739	2cm	Wire	N	Iron		
740	4cm	Fence staple	N	Iron		
749	2cm	Sardine can key	N	Iron		
761	2cm	22 bullet	N	Lead		
764	3cm	22 high velocity impact bullet	N	Lead		
790	1cm	22 long	N	Brass		

811	2cm	22 long	N	Brass		
835	2cm	38 colt bullet	N	Lead		
837	4cm	Lead ball	N	Lead	2	
850	2cm	Bullet	N	Lead	1	
883	4cm	Modern wire	N	Iron		
899	4cm	Double pointed awl	Y	Iron		Tag 504
900	3cm	Gum wrapper	N	Aluminum		
932	7cm	Lead ball	Y	Lead		Tag 508
933	3cm	22 cartridge case	N	Brass		
914	4cm	Square can	N	Tin		
918	3cm	Wire	N	Iron		
934	Surface	Sheet brass	Y	Brass		
1016	Surface	Religious medal	Y	Metal		Tag 524
1017	3cm	Chewed lead ball	Y	Lead		Tag 103
1018	Surface	Ceramic handle	Y	Ceramic		Tag 522
1019	7cm	Coscojo	Y	Metal		Tag 501
1020	Surface	Bridal chain	Y	Metal		Tag 518
1021	Surface	Lead ball	Y	Lead		Tag 546
1022	3cm	Horse shoe nail	Y	Iron		Tag 530
1023	Surface	Slag	Y	Slag		Tag 216
1024	4cm	Awl	Y	Iron		Tag 526
964	3cm	22 cartridge	N	Brass		
950	Surface	22 long	N	Brass		
968	5cm	Copper electric wire	N	Copper		
1032	Surface	Iron wire	N	Iron		
972	20cm	Canister shot	Y	Iron		Tag 506
976	10cm	Aluminum pull tab lid	N	Aluminum		
986	5cm	Unidentified iron	N	Iron		

987	3cm	Wire	N	Metal			
994	2cm	Wire	N	Metal			
1114	4 cm	22 bullet	N	Lead			
1117	Surface	1991 & 1985 quarters	N	Nickel & copper			
1128	10 cm	Foil	N	Aluminum			
1135	3 cm	Buckshot	Y	Lead		1	Tag 520
1138	5 cm	Wire	N	Metal			
1150	5 cm	6 inch spike	N	Iron			
1109	5 cm	Metal can	N	Tin			
1101	Surface	Chauffeur tag	Y	Brass			Tag 513
1093	12 cm	Nail	N	Metal			
1085		False signal					
1066		False signal					
1037	20 cm	22 bullet	N	Lead			
1031	10cm	22 cartridge	N	Brass			
1060	5 cm	Metal band	N	Copper	5/8 inch	1	
1062	6 cm	Wire nail	N	Iron			
1156		False signal					
1157	8 cm	Rusted wire	N	Iron			
1162		False signal					
1171	10 cm	Can	N	Tin			
1165	Surface	Wire	N	Metal			
1168	8 cm	Washer	N	Iron			
1181	15 cm	Piece of can	N	Tin			
1191	10 cm	Flat metal	Y	Iron		1	
1192	6 cm	Shotgun shell	Y	Brass		1	
1193	5 cm	Wire	N	Iron			
1194	12 cm	Flattened bullet	Y	Lead			

1196		False signal				
1200	Surface	Copper wire	N	Copper	1	circa 18 inches long, bent, with end in open hook, utility wire?
1201		False signal				
1206	4 cm	50-70 bullet	N	Lead	1	impact damaged .50-450 grain bullet fired in Sprinfield
1208	5 cm	Rock with minerals	N	Rock		
1210	3 cm	Wire	N	Iron		
1214	5 cm	22 bullet	N	Lead		
1215	10 cm	45 bullet	N	Lead		
1220	Surface	Rock with minerals	N	Rock		
1230	Surface	Aglet	Y	Brass	2	Tag 543
1231	3 cmbs	Coscojo	Y	Metal	1	Tag 535
1232	Surface	Chain link	Y	Iron	1	Tag 545
1233	6 cm	Lead ball	N	Lead	1	circa .50-caliber
1234	5 cm	22 bullet	N	Lead		
1235	4 cm	22 short cartridge	N	Brass		
1236	3 cm	38 Bullet	N	Lead	1	
1237		22 bullet	N	Lead		
1238	3 cm	Percussion cap	N	Metal	1	fired musket cap
1239		22 bullet	N	Lead		
1240	2 cm	Foil	N	Aluminum	2	
1241		22 bullet	N	Lead		
1242	4 cm	Rose head nail	Y	Metal	4	approx. 1 inch long
1243	5 cm	Nail- modern	N	Metal		
1244	5 cm	Nail	N	Metal	1	hand wrought shaft fragment
1245	3 cm	.45 soft nose with brass jacket	N	Brass - lead	3	
1246	2 cm	Possible chain mail ring frag.	N	Metal	4	

1247	5 cm	Crucifix fragmemt	N	Metal	2	
1248	2 cm	Lead ball, circa .50 caliber	N	Lead	1	
1249	2 cm	22 bullet	N	Lead		
1250	5 cm	Tang knife	Y	Iron	1	Tag 521
1251	3 cm	Knife	Y	Iron	1	Tag 540
1252	5 cm	22 bullet	N	Lead	2	
1253	6 cm	Metal arrowhead	Y	Iron	1	Tag 112
1254	3 cm	38 bullet	N	Metal		
1255	2 cm	Button	Y	Metal	2	Tag 542
1256		22 bullet	N	Lead		
1257	2 cm	Modern nail	N	Iron		
1258		22 bullet	N	Lead		
1259		22 bullet	N	Lead		
1260	Surface	Horseshoe nail	N	Iron	1	
1261	3 cm	Coscojo fragment	Y	Metal	2	Tag 515
1262	20 cm	Lead bullet	N	Lead		
1263	3cm	Foil	N	Aluminium		
1264	3cm	Horse shoe nail frag	N	Iron		
1266	4cm	22 bullet	N	Brass		
1267	2cm	38 bullet	N	Lead		
1269	3cm	Metal point	Y	Iron		Tag 107
1270	3cm	Battery	N	Carbon		
1271	2cm	22 bullet	N	Lead		
1272	3cm	22 bullet	N	Lead		
1274	3cm	22 bullet	N	Lead		
1275	3cm	Modern wire nail	N	Iron		
1276	2cm	Rosehead nail	Y	Iron		Tag 537
1277		22 bullet	N	Lead		

1278	Surface	Shotgun shell	N	Brass			
1279	5cm	22 bullet	N	Lead			
1280	2cm	Hanger for coscojo	Y	Iron			Tag 544
1281	6cm	Blown out miniball	Y	Lead			Tag 547
1282	4cm	Fired modern bullet	N	Lead			
1283	3cm	Modern casing	N	Brass			
1284	4cm	22 bullet	N	Lead			
1285	8cm	Wagon chain	N	Iron		1	
1290		False signal					
1295	5cm	Aluminum container	N	Alum			
1300	3cm	Slag	N	Iron			
1305	6cm	Fired bullet 36 calliber	Y	Lead		1	Tag 523
1310	3cm	Metal clip trash	N	Iron			
1315	2cm	Fence staple	N	Iron			
1320	3cm	Foil trash	N	Aluminum			
1325	5cm	Cartridge case with bullet 50 caliber	Y	Lead			Tag 502
1330	Surface	Turquoise bead	N	Stone		1	
1332	2cm	Awl	Y	Iron		1	Tag 517
1337		Pinflag	N	Iron			
1340	3cm	Nail	N	Iron			
1345	Surface	Can lid	N	Iron			
1346	5cm	Wire	N	Iron			
1347	4cm	Horse shoe	N	Iron			
1348	5cm	Wire nail/light wagon staple	N	Iron	5cm	1	
1349	Surface	Paper staple	N	Steel			
1350	3cm	Tin can	N	Tin			
1351	6cm	Tin can	N	Tn			
1353	5cm	Two 22 cases	N	Brass			

1354	Surface	Can	N	Iron			
1355	10cm	Cut nail	N	Iron			
1356	3cm	Rose head nail	Y	Iron	3 1/2 inches	1	Tag 507
1357	10cm	Horse shoe	N	Iron		1	
1358	6 cm	Tin can	N	Tin			
1359	4cm	Nail	N	Iron			
1360	4cm	Iron fragment	N	Iron			
1361	2cm	Iron fragment	N	Iron			
1363	4cm	Wire frament	N	Iron			
1364	5cm	Wire fragment	N	Iron			
1365	4cm	22 bullet	N	Lead			
1366	8 cm	Boot eyelet	N	Iron			
1368	7cm	22 casing	N	Brass			
1369	4cm	Cut nail	N	Iron			
1370	4cm	Two cut nails	N	Iron			
1371	4cm	Cut nail	N	Iron			
1372	4cm	22 bullet	N	Lead			
1373	3cm	Strap metal	N	Iron			
1374	5cm	Coffee grinder/can lid	N	Iron			
1375	4cm	Wire	N	Iron			
1376	4cm	22 bullet	N	Lead			
1380	10 cm	Iron fragment	N	Iron			
1385	4cm	32 rifle cartridge	N	Brass			
1390	5cm	Tin can pieces	N	Tin			
1395		False reading					
1400	5cm	Tin can	N	Tin			
1405	Surface	Oil filter	N	Iron			
1410	5cm	30 cal rifle bullet	N	Lead		1	

1415	5cm	Iron hinge/ wire nail/ tin can	N	See object		
1420		False reading				
1425	5cm	Tin can	N	Tin		
1430	5cm	Awl	Y	Iron		
1435		False signal				
1440	3cm	Box nail	N	Iron		
1445		Hot rock				
1450		Hot rocks				
1455		Hot rock				
1460	3cm	Cut nail	N	Iron		
1465		Hot rocks				
1470	4cm	Flattened lead	Y	Lead	1	
1475		Pin flag				
1480	10cm	Square can	N	Iron	1	
1485	3cm	Wire	N	Iron		More wire found one meter away. Other wire was curved
1489	5cm	Iron ingot	Y	Iron		
1495	5cm	Awl	Y	Iron	1	
1500		Hot rocks				
1505	5cm	Tobacco tag	N	Brass	1	
1506	5cm	Wire nail	N	Iron		
1510	5cm	Nail	N	Iron		
1512	5cm	22 bullet	N	Lead		
1520	10cm	Tin can	N	Tin		
1525	Surface	Tincan	N	Tin		
1530	Surface	Tin can	N	Tin		
1535	7cm	Cut nail	N	Iron		
1540	Surface	Tin can	N	Tin		
1545	5cm	Hand forged chain with hook	N	Iron	1	hook and chain, side line or single tree

1550	15cm	Hole in top tin can	N	Tin			
1555	6cm	Link	N	Iron			
1557	5cm	Strap	N	Iron			
1560	20 cm	Forged wagon fitting	N	Iron		1	2 1/2 inch wagon staple
1564	15cm	.44 Henry cartridge case	Y	Brass			
1568	Surface	Projectile point	Y	Stone	1		
1575	1 cm	Wire nail	N	Iron			
1586	3 cm	Horseshoe	N	Iron			
1587	3 cm	Wire	N	Iron			
1591	Surface	Can	N	Tin			
1592	3 cm	38 caliber bullet	N	Lead			
1593	Surface	Wrench	N	Steel			
1595	5 cm	Suspender buckle	Y	Metal		1	Tag 505
1637	Surface	Needle	Y	Steel		1	Tag 525
1640	3 cm	Lead	Y	Lead			Tag 559
1645	2 cm	3 screws	N	Steel			
1647	10 cm	Lead ball	Y	Lead		1	Tag 102
1648	Surface	Buckle	N	Metal			
1649	Surface	Split rivet	N	Iron			
1650	Surface	Can	N	Tin			
1651	Surface	22 caliber bullet	N	Lead			
1652	Surface	Barrel hoop	N	Iron		1	
1655	3 cm	Aglet	Y	Brass		1	Tag 532
1660	3 cm	22 caliber bullet	N	Lead			
1665	2 cm	Impacted lead ball	N	Lead			
1666	Surface	Shotgun shell	N	Brass			
1667	Surface	Tool	Y	Iron		1	Tag 519
1670	2 cm	Spanish colonial nail	Y	Iron		1	Tag 560

1674	2 cm	Lead	N	Lead	1	
1675	3cm	Ball ca 45	N	Lead	1	
1676	2cm	Brass	Y	Brass		
1677	1 cm	Point	Y	Iron	2	
1679	1 cm	Iron pin	N	Iron	1	
1680	2cm	3 pieces iron pin	N	Iron	1	
1681	2 cm	Iron	N	Iron	1	
1682	2 cm	Awl	Y	Iron	1	
1683	2 cm	Flat iron	N	Iron	1	
1684	1 cm	Iron ball?	N	Iron	1	
1685	3 cm	Brass point tip	Y	Brass	1	
1686	2 cm	Awl?	Y	Iron	1	
1687	4 cm	Sheet brass	N	Brass	1	
1688	3 cm	Fired 44 ball	N	Lead	1	
1689	1 cm	Scrap cut iron 2 pieces	N	Iron		
1690	1cm	Bullet	Y	Lead		
1691	Surface	Gun flint	Y	Lithic		
1692	3 cm	Gun part?	Y	Iron		Tag 296
1693	3 cm	Brass ferrule	N	Brass		
1694	1 cm	Nails and copper	Y	Iron		Tag 1694
1695	2 cm	Nail iron	N	Iron		
1696	1 cm	Bullet	N	Lead		
1697	10 cm	Iron	Y	Iron		Tag 292
1698	1 cm	Iron	N	Iron		
1699	4 cm	Knife	Y	Iron		Tag 294
1700	4 cm	Flat copper	N	Copper		
1701	Surface	Rose head nail	N	Iron		
1702	3 cm	Caret head nail	Y	Iron		Tag 293

1703	1 cm	Ear cuff	Y	Brass	Tag 291
1704	Surf	Button back	N	Iron	
1705	Surf	Copper	N	Copper	
1706	2 cm	Copper/silver	N	Copper	
1707	1 cm	Copper	N	Copper	
1708	2 cm	Brass	N	Brass	
1709	3 cm	Ball	N	Lead	
1710	Surf	Bell	Y	Copper	
1711	2 cm	Tack nail	N	Iron	
1712	3 cm	Caret nail	Y	Iron	Tag 221
1713	2 cm	Caret nail	Y	Iron	Tag223
1714	3 cm	Ball	N	Lead	
1715	Surf	Ball	N	Lead	
1716	Surf	Ball	N	Lead	
1717	3 cm	Knife blade tip	N	Iron	
1718	2 cm	Brass	N	Brass	
1720	Surf	Ball	N	Lead	

Appendix 2
XRF Raw Data Files

Data	Al K12	As K12	Ca K12	Cr K12	Cu K12	Fe K12	K K12	Mn K12	Ni K12	Pb L1	Pb M1	Pd K12	Pd L1	Rb K12	Rh K12	Rh L1	Si K12	Sn K12	Sn L1	Sr K12	Sr L1	Ti K12	Y K12	Zn K12	Zr K12
FS 44 Canister Ball Mooers Mill	70	54	297	199	176	350360	144	1870	29	398	45	1314	200	266	3065	0	86	153	2	312	28	686	155	124	894
FS 75 Lead Bullet Moores Mill	13	18311	102	44	335	1357	4	2	1	426665	3604	1164	16	969	3160	0	1	491	-1	956	0	109	3323	47	841
FS 80 Pinfire Base Moores Mill	78	1066	262	1	1104856	1320	1	4	1130	8617	153	639	247	1	1860	0	42	228	8	85	30	179	357	2204	53
FS 80 Pinfire Top Moores Mill	1	18099	74	1	1981	1617	0	78	16	419179	3118	1067	32	1009	3020	0	1	1260	50	830	28	151	3134	61	893
FS 157 Lead Bullet Moores Mill Poss Confd	58	13792	28	54	234	720	-2	47	86	302968	2541	873	48	658	2289	0	1	254	-2	587	1	182	2434	146	604
FS 166 Lead Bullet Moores Mill	54	18259	55	53	243	900	1	40	50	420018	3526	1165	3	1050	3033	0	20	515	-1	851	-1	145	3318	43	822

Target 768 Ear Cuff Side 1 PECO	91	692	574	108	716063	17837	360	190	526	14547	64	781	171	30	1881	11	89	170	33	111	16	451	656	152129	124
Target 768 Ear Cuff Side 2 PECO	143	351	338	160	673728	11838	425	190	591	9816	36	892	210	68	1783	18	1	496	-1	66	47	368	610	171264	71
Target 899 Awl Side 1 PECO	21	27	197	59	231	247072	113	385	52	144	28	603	125	67	1260	2	35	103	16	95	14	388	49	68	97
Target 899 Awl Side 2 PECO	42	77	201	68	195	208867	223	442	40	110	20	895	127	155	1469	7	24	34	2	207	30	390	41	69	327
Target 932 Lead Ball Side 1 PECO	25	16633	1228	31	311	8411	62	112	36	360553	1820	1010	63	881	2845	0	55	380	-3	700	32	359	3237	31	1310
Target 932 Lead Ball Side 2 PECO	13	15900	2980	19	250	5724	75	59	1	356345	1663	1094	57	1081	2802	0	32	341	0	856	7	192	2921	75	881
Target 934 Copper Scrap Side 1 PECO	53	124	521	90	1018872	15496	487	114	818	140	7	667	238	68	2061	1	65	127	0	145	8	465	34	2213	109
Target 934 Copper Scrap Side 2 PECO	1	182	588	74	1092599	11614	271	86	1025	225	47	734	282	40	2079	17	70	95	0	64	36	471	40	2308	149
Target 972	1	21	465	2	17	40	35	2	9	10	8	1	1	21	2	1	7	9	1	2	2	78	6	10	8

Canister Ball Side 1 PECO	11			6	8	5424	9	221	2	4		246	40	1	831	7	4	9		59	1	7	4	8	00
Target 972 Canister Ball Side 2 PECO	47	2	507	122	144	449362	298	1623	51	96	26	1062	207	267	2970	0	38	110	0	242	29	649	68	76	879
Target 1016 Religious Medal Side 1 PECO	22	23297	468	58	889089	13567	183	58	2536	20393	100	895	223	91	2183	0	105	7048	538	135	5	413	869	49647	57
Target 1016 Religious Medal Side 2 PECO	80	22917	473	12	839408	16371	206	83	2231	20206	51	985	210	86	2142	0	55	7158	461	63	43	429	804	48748	62
Target 1017 Ball Side 1 PECO	80	15219	1677	131	300	16512	265	216	51	358879	496	1118	72	907	2925	0	66	403	2	862	36	489	3723	136	1036
Target 1017 Ball Side 2 PECO	37	13538	426	45	301	16399	73	121	34	327366	1464	1081	82	760	2938	0	87	235	11	766	1	523	3402	86	1760
Target 1019 Coscojo Side 1 PECO	64	442	3506	91	160	318966	348	516	47	403	30	915	123	296	23881	3	38	55	0	503	45	730	44	122	360
Target 1019 Coscojo Side 2 PECO	47	767	2113	65	152	346112	232	568	90	330	33	1015	108	167	21159	41	35	96	0	329	67	754	102	91	245
Target 1020 Slack Chain Side 1 PECO	69	81	260	85	183	2267	68	51	26	145	5	79	87	105	12	2	1	59	2	97	31	243	31	65	19

						78		7				2			94										6
Target 1020 Slack Chain Side 2 PECO	17	0	334	53	153	239183	108	467	36	138	8	679	76	89	12844	25	37	78	14	147	19	311	75	86	101
Target 1021 Ball Side 1 PECO	60	17325	262	83	429	5051	1	24	46	388444	2235	1018	21	886	2765	0	49	436	1	712	9	177	3382	27	812
Target 1021 Ball Side 2 PECO	36	15548	853	31	564	22215	195	149	46	368446	877	971	107	939	3081	0	80	484	0	849	14	735	4114	113	1429
Target 1022 Caret Bottom PECO	56	40	167	20	216	204812	212	464	48	120	25	823	76	114	1424	21	85	75	19	122	13	504	42	115	357
Target 1022 Caret Top PECO	69	33	197	103	182	260439	363	433	19	212	18	709	98	153	1754	26	53	77	1	110	34	582	128	100	702
Target 1023 Slag PECO	44	41	368	71	201	29152	50	281	38	142	47	3250	81	237	2913	18	41	33	12	2381	23	980	1554	72	6755
Target 1194 Impacted Ball Side 1 PECO	54	17465	112	45	315	4956	1	60	20	410018	2373	1024	97	1071	3203	0	56	447	1	798	-1	155	3350	97	874
Target 1194 Impacted Ball Side 2 PECO	6	14238	184	121	472	14793	99	272	46	358249	132	126	40	1192	314	0	91	411	-1	961	-1	558	373	95	146

											3	5			8								9		0
Target 1228 Civil War Side 1 PECO	24	16126	574	58	240	8299	23	112	43	374419	1579	975	48	837	2786	0	31	348	11	833	53	294	3401	47	956
Target 1228 Civil War Side 2 PECO	44	13234	506	121	345	21191	294	177	1	329564	247	1013	121	736	2950	0	81	375	1	846	57	937	3488	196	1445
Target 1230 Coin-Aglet Side 1 PECO	1	32	275	29	1095242	15612	357	90	810	23	18	699	270	74	2052	16	35	45	0	136	38	533	38	2482	96
Target 1230 Coin-Aglet Side 2 PECO	60	71	171	158	898653	8332	213	30	766	47	22	592	200	48	1705	1	46	93	8	94	32	377	116	1752	22
Target 1231 Coscojo Side 1 PECO	61	72	461	72	222	383924	217	614	65	250	19	975	98	238	2110	1	92	82	1	247	36	567	60	121	211
Target 1231 Coscojo Side 2 PECO	94	38	362	47	227	360149	147	478	47	132	5	809	131	225	1951	12	26	51	14	160	47	451	26	122	92
Target 1232 Iron Ring Side 1 PECO	37	61	284	41	397	160111	207	389	34	102	23	714	132	165	1200	8	12	50	8	199	44	416	48	73	208
Target 1232 Iron Ring Side 2 PECO	43	60	288	48	485	158892	161	378	16	70	31	829	84	126	1022	0	40	58	0	140	13	317	42	62	164

Target 1250 Knife PECO thick blade	12	457	554	264	178	373835	272	723	48	634	53	779	174	209	1808	1	48	52	0	176	17	568	85	88	157
Target 1250 Knife PECO	39	775	530	89	183	393136	234	609	30	539	45	901	163	199	2187	1	97	33	0	246	21	704	21	116	154
Target 1251 Knife Tip Side 1 PECO	39	35	671	155	148	491916	304	29224	73	331	45	1155	178	294	2731	0	81	129	1	544	31	741	57	175	91
Target 1251 Knife Tip Side 2 PECO	36	0	745	102	185	342987	366	1347	15	239	5	1256	184	355	2850	1	89	82	51	651	43	917	115	133	700
Target 1253 Iron Arrowhead Side 1 PECO	81	6	415	36	224	527201	257	792	32	134	42	1114	155	366	2754	0	87	115	13	199	55	646	44	70	108
Target 1253 Iron Arrowhead Side 2 PECO	38	10	387	132	220	527978	127	678	27	109	48	1013	159	299	2472	1	57	190	3	248	15	281	49	73	75
Target 1255 Brass-Copper Button Side 1 PECO	66	1924	411	93	763167	14542	364	29	470	7044	37	606	220	426	1828	61	81	784	1	44	12	419	391	120221	80
Target 1255 Brass-Copper Button Side 2 PECO	40	568	1073	58	403868	11506	273	67	186	3621	2	599	139	192	1397	4	55	2078	0	71	21	442	210	62078	122
Target 1269	9	7	348	1	21	51	34	9	3	69	5	1	2	30	2	1	1	1	-4	1	5	63	4	13	1

Arrowhead Side 1 PECO	0			44	0	1170	6	22	5		3	088	14	1	838		00	00		13	8	7	0	2	73
Target 1269 Arrowhead Side 2 PECO	54	16	584	76	188	491629	337	720	31	72	26	1107	211	382	2697	34	56	61	40	283	28	661	60	113	457
Target 1280 Coscojo Hanger Side 1 PECO	25	28	309	49	170	291185	134	518	45	197	28	835	150	116	1643	1	48	89	0	128	13	555	67	102	690
Target 1280 Coscojo Hanger Side 2 PECO	35	53	264	89	167	198819	111	474	39	71	14	676	93	60	1056	10	31	54	11	81	23	251	90	73	116
Target 1305 Ball Side 1 PECO	36	11762	931	55	265	4482	147	81	53	284227	1146	680	38	761	2130	0	82	234	-1	572	34	204	2209	73	538
Target 1305 Ball Side 2 PECO	30	9628	693	24	229	5658	57	63	14	226183	799	626	64	517	1723	0	30	127	0	418	0	349	1806	61	615
Target 1332 Awl Bottom PECO	80	31	542	111	180	351878	142	789	26	236	33	792	125	243	1814	1	61	122	1	282	12	469	12	76	132
Target 1332 Awl Top PECO	54	37	702	53	191	345077	130	728	41	100	2	859	120	140	1723	1	40	53	2	212	14	452	41	82	144
Target 1356 Cut Nail Bottom	39	18	124	42	131	3246	85	44	49	76	19	70	12	198	15	1	18	12	20	60	40	310	43	66	56

						53		2				6	2		18			2							
Target 1356 Cut Nail Middle	65	22	524	63	108	340631	201	550	8	143	23	829	170	207	18558	1	1	62	0	115	59	462	59	105	306
Target 1356 Cut Nail Top	24	5	656	128	176	474814	308	760	84	175	15	1059	175	333	2591	0	49	109	1	83	40	527	88	149	606
Target 1370A Knife Tip Side 1 PECO	93	8	1016	138	160	578180	233	982	56	89	11	1132	187	332	2859	56	36	158	29	111	40	656	14	95	191
Target 1370A Knife Tip Side 2 PECO	54	7	588	114	233	562691	301	1008	60	233	27	878	221	464	2634	27	72	200	76	167	58	636	82	97	572
Target 1489 Lead Ingot Side 1 PECO	25	34997	168	1	655	4308	6	36	37	458743	2087	1362	157	1133	3360	0	1	480	20	842	36	175	3557	109	927
Target 1489 Lead Ingot Side 2 PECO	31	35670	228	60	284	5931	18	134	4	384715	1553	937	53	885	2710	0	37	345	4	708	0	322	3155	93	991
Target 1495 Awl-Slack Chain Side 1 PECO	39	12	176	90	281	236620	123	559	12	169	41	882	147	192	1639	1	21	87	1	182	24	352	31	95	222
Target 1495 Awl-Slack Chain Side 2 PECO	54	71	254	64	211	209372	176	643	54	110	16	893	87	189	162	23	50	72	6	244	34	547	35	92	378

															6										
Target 1637 Bag Needle Side 1 PECO	60	174	208	67	276	263080	121	1329	36	229	23	743	72	154	1511	2	32	53	0	53	29	326	39	63	227
Target 1637 Bag Needle Side 2 PECO	77	217	245	54	318	270931	83	1347	42	229	27	629	64	55	1343	0	4	84	8	101	24	357	20	108	111
Target 1640 UID Lead Side 1 PECO	55	15205	667	97	188	11052	24	56	0	347384	1585	1020	90	865	2833	0	52	449	15	691	2	434	3357	104	851
Target 1640 UID Lead Side 2 PECO	41	17278	1059	128	287	9498	55	86	-3	407902	1353	1120	108	1232	2976	0	65	382	3	760	22	341	3717	103	872
Target 1655 Aglet Side 1 PECO	33	58	892	71	455715	27811	342	123	314	33	28	817	179	267	1809	0	50	69	6	250	51	758	53	1252	373
Target 1655 Aglet Side 2 PECO	45	74	220	27	347334	24358	263	37	269	46	6	600	112	201	1240	5	33	50	-1	184	27	625	126	962	652
Target 1667 Awl Side 1 PECO	61	49	323	68	233	326320	213	526	4	188	27	862	152	176	2120	2	83	107	1	288	25	499	60	136	445
Target 1667 Awl Side 2 PECO	90	-1	401	65	172	297964	338	606	23	206	3	1014	155	254	2068	0	59	93	8	447	49	606	98	106	269

Target 1670 Rosehead Bottom PECO	38	95	378	97	221	191450	159	367	58	254	30	819	87	130	13886	1	43	62	15	486	23	445	38	119	420
Target 1670 Rosehead Top PECO	68	70	486	65	226	346609	330	489	28	286	0	1184	194	222	25033	1	66	16	0	471	43	616	14	101	95
Target 1676 Copper Scrap Side 1 PECO	108	14416	422	63	540	8062	74	294	14	343785	1229	1127	53	856	2775	0	59	2618	2	696	18	337	3221	38	921
Target 1676 Copper Scrap Side 2 PECO	98	17121	400	1	492	6220	1	159	4	393624	1570	1235	72	1020	3259	0	72	2931	81	819	4	190	3716	50	824
Target 1677 Arrowhead Side 1 PECO	47	33	580	53	209	491750	245	885	36	238	38	1126	160	322	2680	2	49	144	3	169	24	680	64	106	317
Target 1677 Arrowhead Side 2 PECO	38	17	436	54	234	539414	278	777	39	259	19	1005	184	324	2666	0	89	122	0	137	0	521	24	126	137
Target 1685 Arrowhead Side 1 PECO	97	503	418	77	703333	34069	451	19	636	6263	49	1039	206	107	2457	1	94	3663	-2	128	76	873	664	158529	85
Target 1685 Arrowhead Side 2 PECO	145	381	291	97	695951	29307	327	14	826	5853	91	907	224	123	2162	1	114	3673	51	69	57	895	632	146724	75
Target 1690 Slug	7	21	189	9	45	24	9	4	4	38	2	1	5	11	2	0	3	3	0	7	0	24	2	79	7

Side 1 PECO	9	718	4	6	3	77		50		5255	132	190	4	04	836		7	85		26		8	991		79
Target 1690 Slug Side 2 PECO	66	24771	616	1	451	3585	0	223	10	413248	2299	1178	38	1063	3093	0	27	476	1	658	-8	138	3427	-1	806
Target 1692 Gun Part Side 1 PECO	89	3	544	44	186	412909	311	623	50	153	38	1199	159	258	2552	1	57	76	7	257	19	567	66	164	203
Target 1692 Gun Part Side 2 PECO	52	27	240	100	176	433064	54	690	9	112	24	1062	175	180	2259	1	12	147	0	105	29	343	50	111	175
Target 1694 Copper Scrap Side 1	92	142	3739	55	773358	17794	317	221	518	107	53	981	240	103	2131	0	48	249	0	473	54	639	64	2269	342
Target 1694 Copper Scrap Side 2	43	87	1805	44	857185	16956	328	147	698	61	24	815	194	194	1958	13	10	126	0	362	35	490	81	2325	89
Target 1697 UID Side 1 PECO	79	55	2189	152	186	190485	489	377	37	108	15	1529	87	282	2910	1	95	104	0	3321	22	930	171	558	839
Target 1697 UID Side 2 PECO	28	92	417	69	180	102678	220	167	23	88	8	839	84	193	1339	11	33	84	6	670	18	439	40	269	320
Target 1699 Knife PECO	35	167	1350	83	188	2631	318	37	13	225	22	13	10	340	28	0	10	12	0	48	15	833	70	191	10

						56		8	1			70	2		12		2	2		5					35
Target 1702 Hold Nail Bottom PECO	73	81	193	25	221	217390	139	600	14	149	33	654	131	53	11170	1	6	150	13	71	32	402	10	58	215
Target 1702 Hold Nail Top PECO	33	78	355	184	320	462762	382	1586	59	265	61	967	186	349	2501	1	43	121	10	213	48	670	45	60	103
Target 1703 Ear Cuff Side 1 PECO	102	106	288	55	1069003	7531	103	124	814	74	38	614	269	67	1859	10	1	77	9	127	101	420	69	2453	124
Target 1703 Ear Cuff Side 2 PECO	66	66	398	37	791378	10220	219	1	643	66	53	517	233	76	1445	1	58	132	1	83	40	389	69	1750	94
Target 1710 Bell Fragment Side 1 PECO	65	31	1289	29	312	9687	235	215	59	270	0	673	302	94	1866	26	70	53	10	79	29	388	171	1299551	105
Target 1712 Caret bottom PECO	54	65	296	78	485	287659	133	492	42	183	45	785	131	89	1509	7	13	40	0	198	35	289	54	80	136
Target 1712 Caret top PECO	40	72	1076	49	705	515233	307	939	78	261	60	1118	179	342	2716	0	34	118	0	357	70	585	36	81	85
Target 1713 Caret PECO bottom	1	72	433	44	269	395109	96	639	45	188	17	832	128	155	200	37	46	108	0	224	15	444	66	63	255

															8										
Target 1713 Caret PECO	33	72	381	159	295	479398	124	619	49	302	46	1084	176	281	2453	52	30	25	9	222	29	372	57	47	142

Appendix 3

MIDWEST REGION MIDWEST ARCHEOLOGICAL CENTER SMALL ARCHEOLOGICAL PROJECT REPORT

Geophysical Evaluation of Four Areas within the Trade Fair Locality at Pecos National Historical Park, San Miguel County, New Mexico

Prepared by

Steven L. De Vore

This report has been reviewed against the Criteria contained in 43CFR Part 7, Subpart A, Section 7.18(a)(1) and, upon recommendation of the Midwest Regional Office and the Midwest Archeological Center, has been classified as *Available*. Making this report available meets the criteria of 43CFR Part 7, Subpart A, Section 7.18(a)(1).

National Park Service Midwest Archeological Center Lincoln, Nebraska
2013

PARK: Pecos National Historical Park

DATE: February 6, 2013

DATES OF FIELD WORK: June 24-30, 2012

ABSTRACT: The geophysical survey of the four selected areas within the Trade Fair Locality at Pecos National Historical Park was conducted between June 24 and 30, 2012. The Midwest Archeological Center provided technical assistance for the geophysical investigations of the four geophysical project areas. The geophysical investigations consisted primarily of a magnetic survey with a dual fluxgate gradiometer. A limited conductivity survey with an electromagnetic induction meter was also conducted on two of the four geophysical project areas. A total of 8,876 m^2 or 2.19 acres were surveyed during the geophysical investigations of the four geophysical project areas. The geophysical survey resulted in the identification of numerous subsurface archeological features associated with the Pecos Pueblo occupation, historic Spanish and American activities, and the modern National Park Service use of the property.

PURPOSE OF ARCHEOLOGICAL WORK PER SOW and PROJECT DESIGN: The Intermountain Regional Office's Heritage Partnership Programs (IMRO-SF) staff in Santa Fe, New Mexico, requested the archeological assistance from the Midwest Archeological Center (MWAC) to conduct a geophysical survey of the Trade Fair Locality within the Pecos National Historical Park (Figure 1). The purpose of the geophysical project was to identify and evaluate buried archeological resources within selected areas at Pecos National Historical Park (Haecker 2012a). The geophysical survey techniques consisted of a magnetic survey of Areas A, B, C, and D with a dual fluxgate gradiometer and limited conductivity surveys in Areas A and C with a ground conductivity meter set in the quadrature phase (De Vore 2012). These techniques offered an inexpensive, rapid, and relatively non-destructive and non-invasive method of identifying buried archeological resources and site patterns that were detectable and also provided means for sampling relatively large areas in an efficient manner (Roosevelt 2007:444-445; Von Der Osten-Woldenburg 2005:621-626).

ARCHEOLOGICAL PROJECT LOCATION AND AREA OF INVENTORY OR EXTENT OF TESTING: Pecos National Historical Park was established for its exceptional historic and archeological importance. The park contained the remains of a seventeenth century mission and an ancient Indian pueblo. The monument was originally established in 1965 by President Lyndon Johnson (P.L. 89-54). The park was designated a National Historical Park in 1987 (P.L. 100-225) and expanded to include the Glorieta Battlefield unit to commemorate the Civil War Battle of Glorieta Pass (P.L. 101-536) in 1990. The present geophysical project is located within the Pecos unit.

The Trade Fair Locality contained an estimated 20-acre open expanse located immediately east of the Pecos Pueblo-Mission Complex. The geophysical project Area A within the Trade Fair Locality was located approximately 40 meters east of the Mission and Convento (Figure 2). Area A consisted of grasses mixed with cacti and brush. The geophysical project area was located on the east facing slope below the Mission and Convento complex. Area B was located approximately 200 meters northwest of the park's visitor center. The area is located at the base of the ridge in the valley between the Visitors Center and the Pecos Pueblo-Mission Complex (Figure 3). The vegetation included mixed grasses and juniper. Area C contained a rock concentration that has been identified as a Jicarilla Apache tipi ring (PECO 65/LA 14148). It was located approximately 100 meters southwest of park headquarters in a stand of juniper (Figure 4). Area D was located approximately 160 meters southeast of the park headquarters. Area D consists of open grasslands along an arroyo (Figure 5). The Santa Fe Trail swale is located on the west side of the geophysical project area.

ARCHEOLOGICAL PROJECT PERSONNEL: MWAC archeologist Steven L. De Vore directed and conducted the magnetic and conductivity surveys. Jacque Miller, Bailey Lathrop, Kasey Mathieson, Jessica Albertz, and Carl Haberstick of the University of Nebraska-Lincoln (UN-L) archeological field school through the Volunteers-In-Park (VIPs) program assisted during the geophysical grid stakeout and global positioning system mapping, and geophysical data collection of the four geophysical project areas. During the course of the project, the UN-L volunteers provided 64 hours towards the geophysical investigations at the park.

ENVIRONMENTAL DESCRIPTION OF PROJECT AREA: Pecos National Historical Park in San Miguel County, New Mexico, is located within the transition zone between the Southern Rocky Mountains province of the Rocky Mountain System division (Fenneman 1931:92-132), the Raton and the Pecos Valley sections of the Great Plains province of the Interior Plains division (Fenneman 1931:37-50), and the Sacramento section of the Basin and Range province of the Intermontane Plateau division of the North American continent (Fenneman 1931:393-395). The region is part of the Southern Rocky Mountain Foothills major land resource area (USDA 2006:132-134) of the Rocky Mountain Range and Forest land resource region (USDA 2006:113-114). The region consists of broad, elevated, complex strips of north-south trending mountains with steeply dipping intermountain sedimentary basins. The Pecos River and its tributaries, including Glorieta Creek, drain the project area. The upper Pecos River valley is bordered by the Sangre de Cristo Mountains on the north, the Tecolote Range on the east, and Gloria Mesa to the west (Johnson et al. 2011:5). Bedrock consists of Pennsylvanian and early Permian conglomerates, limestones, sandstones, shales, and siltstones of the Sangre de Cristo Formation (Johnson et al. 2011:5; USDA 2006:133). The limestone Magdalena group underlies the Sangre de Cristo Formation and outcrops along the Pecos River. Igneous and metamorphosed Precambrian rocks outcrop along Glorieta Creek. The Pecos River valley is covered with Pleistocene and Holocene alluvium.

The dominate soils in the region are Mollisols, Alfisols, Inceptisols, and Entisols (Foth and Schafer 1980; USDA 2006:133-134). The soils are dominated by a mesic or frigid soil temperature regime with an ustic soil moisture regime. The soils typically have a smectitic or mixed mineralogy. The soils of the Pecos National Historical Park lie within the Laporte-Rock outcrop soil association of *shallow, moderately undulating to hilly, well drained soils that formed in material weathered from limestone, and Rock outcrop on hills and ridges* (Hilley et al. 1981:9-10) and the Vibo-Tapia soil association of *deep, moderately undulating to moderately rolling, well drained soils that formed in mixed material and in alluvial and eolian material on fans, valley sides and uplands* (Hilley et al. 1981:10). Soils within the Pecos unit of the park include the undulating Vibo-Ribera association, the moderately sloping Ribera-Sombordoro-Vibo association, the moderately sloping Tuluso-Sombordoro-Rock outcrop complex, and the steep Laporte-Rock outcrop complex (Johnson et al. 2011:5-6). Areas A, C, and D are located within the moderately sloping Ribera-Somboro-Vibo association, which is located on uplands and valley sides (Hilley et al. 1981:32,72-74,78-79). The Ribera soil is moderately deep and well drained, the Somboro soil is very shallow and well drained, and the Vibo soil is deep and well drained. The Ribera soil is a fine sandy loam that formed in sandstone and shale derived alluvial and eolian deposits, which has a moderate permeability with a moderate available water capacity, and a neutral to moderately alkaline pH. The Somboro soil is a very stony fine sandy loam that formed in material derived from sandstone, which has a slow permeability with a very low available water capacity, medium runoff, and a mildly to moderately alkaline pH. The Vibo soil is a fine sandy loam that formed in alluvial and eolian sediments, which have a moderate permeability with a high available water capacity, medium runoff, and a neutral to moderately alkaline pH. Area B is located within the undulating Vibo-Ribera association, which is located on fans with one to nine percent slopes (Hilley et al. 1981:40-41,72,78-79). The hazard of water erosion ranges from moderate to high, while wind erosion ranges from slight to high in the park.

The area also lies within the Navahonian biotic province (Dice 1943:39-42). The Pecos River valley lies within the Rocky Mountain conifer vegetation zone (Johnson et al. 2011:8-9). Stands of pinyon and juniper occur across the park with ponderosa pine and Douglas fir found at higher elevations. Open grasslands and juniper grasslands occur below the timber stands containing a mixture of short grasses along with a variety of shrubs, forbs, yucca, and cacti. Cottonwoods are found along Glorieta Creek and the Pecos River. Native grasses include blue grama, Indian ricegrass, sand dropseed, threeawn, hairy grama, broom snakeweed, pinyon ricegrass, little bluestem, and sideoats grama (Hilley et al. 1981:22,32,38,41; Johnson et al. 2011:8-10,82-85). Cottonwoods are the dominate forest species along the streams. The major wildlife species in the region include mule deer, bighorn sheep, elk, black bear, mountain lion, jackrabbit, cottontail rabbit, and rodents, turkey, mourning dove, as well as several species of songbirds, owls, and raptors (Britton and Ferrell 2006; Johnson et al. 2011:6-8; USDA 2006:134). Waterfowl can be found along lakes and perennial streams. Numerous reptiles, amphibians, fish, and insects are also present in the region (Britton and Ferrell 2006; Johnson 2011:7,92-124; Parmenter and Lightfoot 1996).

The climate in the region is a middle-latitude dry climate with warm summers and cold, dry winters (Dice 1943:39-40; Houghton 1981:1-2,80; Trewartha and Horn 1980:360-364). The average yearly temperature ranges from an average daily minimum of 1.6° C to an average daily maximum of 17.78° C. Temperatures can range from below -20° C in the winter to over 43 ° C in the summer. Precipitation averages 36.8 cm with the majority of it falling in summer thunder storms. The growing season is approximately 150 frost free days. Prevailing winds are generally out of the southwest. These resources provide the basis of the aboriginal subsistence of prehistoric times and the historic and modern ranching economy.

GENERAL DESCRIPTION OF THE GEOPHYSICAL PROJECT and METHODS:

Overall Research Design: The present geophysical inventory project is designed to provide a baseline geophysical data set for the evaluation of buried archeological resources within four areas of the Trade Fair Locality at Pecos National Historical Park (Haecker 2012a). The geophysical investigations were part of an intensive remote sensing investigation of the Trade Fair Locality and other selected locations within the park. The investigations were to identify and define historic activities that occurred within the project area, which were described in written accounts and oral histories concerning the Pecos Pueblo.

Previous Work: The project area lies within the Anasazi sub-region of the Southwest archeological culture area (Willey 1966:178-245). Historic contexts have been identified for the region in David Stuart and Rory Gauthier's (1981) compilation of the state's prehistoric resources. Genevieve Head, Janet Orcutt, and Robert Powers (2002:2-13) also provide a detailed review of the Upper Pecos Valley cultural history.

Archeological investigations of the Pecos National Historical Park began in the late 1800s. Adolph Bandelier compiled a set of notes and archeological drawings of the Pecos Pueblo and the Mission complex during his archeological investigations of the upper Pecos River valley in 1880 (Bandelier 1881,1892:127-138). Edgar Hewett continued the work of Bandelier in the early 1900s (Hewett 1904:426-439). From 1915 to 1929, A. V. Kidder conducted systematic archeological excavation within the boundary of today's Pecos National Historical Park. Kidder's excavations and analyses of the ceramics provided a basis for the chronological framework for the development of a regional synthesis (Kidder 1916a,1916b,1917a,1917b,1921, 1922,1924,9125,1926a,1926b,1932,1951,1958). The Pecos State Monument was established in 1935. In the years to follow, archeological work at the Pecos Pueblo concentrated on ruins stabilization or smaller sites around the periphery of the main complex (Hayes 1974:19; Ivey 2005; Metzger 1990; Stubbs et al. 1957). With the establishment of the Pecos National Monument in 1965, emphasis was directed to site display, interpretation, and ruins protection (Eininger 2002:28-34). Archeological activity shifted to back to the Pecos Pueblo and Mission complex on the mesilla (Hayes 1970; Matlock 1974; Metzger 1990, Nordby 1990, Nordby et al. 1975, Oinkley 1968, White 1993,1994). Although most of the NPS archeological activities focused on the mesilla, James Gunnerson conducted archeological investigations searching for Apache sites near the Pecos Pueblo (Gunnerson 1969,1970; Gunnerson and Gunnerson 1970). During the course of three field seasons, Gunnerson identified at least nine Apache sites within the park. The archeological investigation of the park continued to the present. Many of the projects represented small-scale investigations associated with park undertakings while a Systemwide Archeological Inventory Program (SAIP) inventory was undertaken in the mid to late 1990s (Head and Orcutt 2002).

The park staff has incorporated archeological prospection investigative techniques into park's archeological research beginning in 1998 with the hosting of the National Park Service's *Non-destructive Investigative Techniques for Cultural Resource Management* workshop (De Vore 1998a). Magnetic, resistance, conductivity and magnetic susceptibility, and ground penetrating radar surveys were conducted in an area south of the park's headquarter building (Bevan 1998a; McNeil 1998). A pit structure was identified in the conductivity/susceptibility data (McNeil

1998). In 1998, geophysical investigations were conducted at the location of the Civil War's Union encampment of Camp Lewis (Haecker 1998; De Vore 1998b). The investigations included a metal detector survey, a magnetic survey with a fluxgate gradiometer, and the analysis of aerial photographs. Metal detector surveys of the Civil War's Glorieta Battlefield and the Pigeon's Ranch site were conducted in 2005 (Scott 2005). Metal detector surveys have also been used within the Trade Fair area and the adjacent uplands in 2011 (Haecker 2012b).

For addition information on the National Park Service archeological investigations see the summary of archeological investigations by Susan Eininger (2002:28-37). Besides the archeological resource investigations, an ethnographic overview (Levine et al. 1994) and a cultural landscape overview (Cowley et al. 1998) have been conducted. The ethnographic overview identified several ethnic groups that were traditionally associated with the park and provided information on the traditional land use by these groups within the park. The cultural landscape overview examined the cultural and natural forces that have affected the park's landscape features.

Description of Investigations: Geophysical prospection techniques available for archeological investigations consist of a number of techniques that record the various physical properties of the earth, typically in the upper couple of meters; however, deeper prospection can be utilized if necessary (David 1995). Geophysical techniques are divided between passive and active techniques. Passive techniques are primarily ones that measure inherently or naturally occurring local or planetary fields created by earth related processes (Heimmer and De Vore 1995:7,2000:55; Kvamme 2001:356). The primary passive method utilized in archeology is magnetic surveying. Other passive methods with limited archeological applications include self-potential methods, gravity survey techniques, and differential thermal analysis. Active techniques transmit an electrical, electromagnetic, or acoustic signal into the ground (Heimmer and De Vore 1995:9,2000:58-59; Kvamme 2001:355-356). The interaction of these signals with buried materials produces alternated return signals that are measured by the appropriate geophysical instruments. Changes in the transmitted signal of amplitude, frequency, wavelength, and time delay properties may also be observable. Active methods applicable to archeological investigations include electrical resistivity, electromagnetic conductivity (including ground conductivity and metal detectors), magnetic susceptibility, and ground penetrating radar. Active acoustic techniques, including seismic, sonar, and acoustic sounding, have very limited or specific archeological applications. In order to identify any buried archeological resources in the at the Pecos National Historical Park, the National Park Service's MWAC and IMSF-SF staffs, along with student volunteers from the University of Nebraska-Lincoln archeological field school, applied magnetic and conductivity survey techniques to investigate and identify the nature, extent, and the location of possible archeological features associated with historic Native American, Spanish, and American occupations and activities within the four geophysical project areas.

Field Methods: Using an Ushikata S-25 TRACON surveying compass (Ushikata 2005) and a 100-meter tape measure, the four geophysical grids were fitted to the landforms in the four geophysical project areas (Figure 6). Wooden two by two inch hub stakes were placed at the grid unit corners or at points along the edges of the grid units at a specified meter interval where access was not obstructed by natural (e.g., trees, bushes, arroyos) or cultural features (e.g., buildings, fences, pavement).

Area A consisted of 12 complete 20-m by 20-m grid units measuring 60 meters east-west by 80 meters north-south oriented on magnetic north. The total survey area measured 4,800 m^2 or 1.19 acres. Area B consisted of two complete 20-m by 20-m grid units measuring 40 meters east-west by 20 meters north-south oriented 42 degrees east of magnetic north. The total survey area measured 800 m^2 or 0.20 acres. Area C, the potential Apache stone circle site, consisted of one partial 20-m by 20-m grid unit measuring 20 meters east-west by 10 meters north-south oriented 24 degrees west of magnetic north. The total survey area measured 156 m^2 or 0.04 acres. Area D consisted of seven complete and one partial 20-m by 20-m grid units measuring 80 meters east-west by 40 meters north-south oriented 8 degrees west of magnetic north. The total survey area measured 3,120 m^2 or 0.78 acres. A total of 8,876 m^2 or 2.19 acres were surveyed during the geophysical investigations of the four geophysical project areas.

During the establishment of the grid units of the four PECO geophysical project areas, the grid corners of the project areas were recorded with a global positioning system (gps) unit (Figure 7). The gps unit consisted of a Trimble GeoXH handheld receiver and external antenna (Trimble 2007a). The gps readings at stationary points (i.e., grid unit corners and individual surface features) were collected with 30 readings from five or more satellites. The field gps data were collected in the Universal Transverse Mercator (UTM) projection for the Zone 13 North coordinates using the North American Datum of 1983 (NAD83) horizontal datum. The data were transferred to a laptop computer via the Trimble TerraSync software (Trimble 2007b,2007c). The data was then differentially corrected with the Trimble Pathfinder Office software (Trimble 2007d) using the continuously operating reference station CORS Santa Fe (NMSF) located 28 kilometers away in Santa Fe, New Mexico. After the raw survey data in the standard storage format (SSF) were post processed, the corrected data were exported to excel data files. The data were imported into the SURFER 10 contouring and 3d surface mapping program (Golden Software 2011) for the generation of the UTM project map (Figure 8). One thousand eight hundred forty-seven (99.95%) of 1,848 selected positions were code corrected by post-processing against the two base providers. One thousand eight hundred forty-six (99.89%) of 1,848 selected positions were carrier corrected by post-processing against the two base providers. The estimated accuracy for the 1,847 corrected positions resulted in 99.95% percent of the corrected positions for points within 5 to 15 cm of the actual landscape position and 0.05% within 0.5 to 1.0 m of the actual position.

Twenty-meter ropes were placed along the base lines connecting the grid unit corners. These ropes formed the traverse boundaries of each grid unit during the gpr profile data collection phase of the survey (Figure 9). The ropes were marked with different color tape at half-meter and meter increments, which were designed to help guide the survey effort. In addition to the survey ropes at the ends of the project grid units, traverse ropes were placed perpendicular to the baseline ropes at the two meter intervals to serve as additional guides during the data collection along each traverse. The survey ropes were moved to the next grid unit once the data collection was completed for each traverse lines. The first traverse was oriented towards the north during the magnetic survey of the four geophysical project areas. The magnetic data were acquired across the grid units beginning in the lower left hand corner of grid facing the direction of travel along the first traverse. In addition to the gps mapping of the geophysical project area, sketch maps of the above ground features were made during the magnetic survey when the survey ropes were placed on the grid units for each geophysical project area (Figures 10 through 13 for Areas A through D, respectively).

Magnetic Survey—Dual Fluxgate Gradiometer:

Instrument: Bartington Grad601-2 Magnetic (Fluxgate) Gradiometer (Bartington 2007)

Specifications: dual system with two sensor tubes spaced one meter apart, 1 m sensor spacing between sensors on individual sensor tubes, 0.05 nT (nanotesla) resolution, 0.1 nT absolute accuracy

Survey type: magnetic

Operator: Steven De Vore

A magnetic survey is a passive geophysical survey technique used to measure local changes in the earth's magnetic field (see Aspinall et al. 2008; Bevan 1991,1998b:29-43; Breiner 1973;1992:313-381; Burger 1992:389-452; Clark 2000:92-98,174-175; David 1995:17-20; Davenport 2001:26,50-71; Dobrin and Savit 1988:633-749; Gaffney and Gater 2003:36-42,61-72; Gaffney et al. 1991:6,2002:7-9; Hanson et al. 2005:151-175; Heimmer and De Vore 1995:13,2000:55-56; Kvamme 2001:357-358,2003:441,2005:434 436,2006a:205-233,2006b:235-250; Lowrie 1997:229-306; Milsom and Eriksen 2011:65-84; Mussett and Khan 2000:139-180; Neubauer et al. 1996; Nishimura 2001:546-547; Oswin 2009:43-54,126-135; Robinson and Çoruh 1988:333-444; Scollar et al. 1990:375-519; Sharma 1997:65-111; Telford et al. 1990:62-135; Weymouth 1986:343; and Witten 2006:73-116 for more details on magnetic surveying). Magnetometers depend upon sensing subtle variations in the strength of the earth's magnetic field in close proximity to the archeological features being sought. Variation in the magnetic properties of the soil or other buried material induces small variations in the strength of the earth's magnetic field. Its application to archeology results from the local effects of magnetic materials on the earth's magnetic field. These anomalous conditions result from magnetic materials and minerals buried in the soil matrix. Iron based materials have very strong effects on the local earth's magnetic field. Historic iron artifacts, modern iron trash, and construction material, like metal fence posts, woven and barbed fencing wire, and fencing staples, as well as agricultural machinery parts, can produce such strong magnetic anomalies that nearby archeological features are masked by the strong magnetic fields of these materials and are therefore not detectable. Other cultural features, which affect the earth's local magnetic field, include fire hearths and soil disturbances (e.g., pits, mounds, wells, pithouses, and dugouts), as well as, geological strata.

Magnetic field strength is measured in nanoteslas (nT; Sheriff 1973:148). In North America, the earth's magnetic field strength ranges from 40,000 to 60,000 nT with an inclination of approximately 60° to 70° (Burger 1992:400; Milsom and Eriksen 2011:68; Weymouth 1986:341). Magnetic anomalies of archeological interest are often in the ±5 nT range, especially on prehistoric sites. Target depth in magnetic surveys depends on the magnetic susceptibility of the soil and the magnetic mass associated with buried features and objects. For most archeological surveys, target depth is generally confined to the upper one to two meters below the ground surface with three meters representing the maximum limit (Clark 2000:78-80; Kvamme 2001:358). Magnetic surveying applications for archeological investigations have included the detection of architectural features, soil disturbances, and magnetic objects.

The Bartington Grad601-2 magnetic gradiometer is a fluxgate gradiometer that uses a dual fluxgate sensor system for the recordation of two lines of data for each traverse walked during the collection of magnetic data (Figure 14). It is a vector magnetometer, which measures the strength of the magnetic field in a particular direction (Bartington 2007). The two magnetic sensors in each gradiometer sensor tube on the fluxgate gradiometer are spaced 1.0 meters apart.

The sensor tubes are carried on a bar with a meter separation between the two sensor tubes. The instrument is carried so the two sensors are vertical to one another with the bottom sensor approximately 30 cm above the ground. Each sensor reads the magnetic field strength at its height above the ground. The gradient or change of the magnetic field strength between the two sensors is recorded in the instrument's memory. This gradient is not in absolute field values but rather voltage changes, which are calibrated in terms of the magnetic field. The dual fluxgate gradiometer provides a continuous record of the magnetic field strength across each traverse. The sensors must be accurately balanced and aligned along the direction of the field component to be measured. The reference point for balancing and aligning the dual gradiometer for the survey of all four PECO geophysical project areas is located at N0/E0 in Area A. The gradiometer is aligned on magnetic north.

The magnetic survey was designed to collect eight samples per meter along 1.0-meter traverses or 8 data values per square meter. The data were collected in a zigzag fashion with the surveyor alternating direction of travel for each traverse across the grid. A total of 3,200 data measurements were collected during the survey of a complete grid unit. The magnetic data were recorded in the memory of the gradiometer and downloaded to a laptop computer after the completion of survey effort. The magnetic data were directly imported into DW Consulting's ArcheoSurveyor software (DW Consulting 2012) for processing. The grid files for individual grid units were combined into a site composite file (DW Consulting 2012:3-4). Both shade relief and trace line plots were generated in the field before the instrument's memory was cleared. Upon completion of the magnetic survey at each area, the data were processed in ArcheoSurveyor. After the grid data files were assembled into a composite file, the destripe processing routine was applied to remove any traverse discontinuities or striping effects that may have occurred from operator handling, heading errors, instrument setup, or instrument drift during the survey (DW Consulting 2012:69-70). Upon completion of the destripe function, the data were interpolated by expanding the number of data points in the traverse direction and by reducing the number of data points in the sampling direction to provide a smoother appearance in the data set and to enhance the operation of the low pass filter (DW Consulting 2012:71).

This changed the original 8 x 1 data point matrix into 4 x 4 data point matrix for the survey area. The low pass filter was then applied over the entire data set to remove any high frequency, small scale spatial detail (DW Consulting 2012:81). This transformation resulted in the improved visibility of larger, weak archeological features. The data were then exported as an ASCII data file (DW Consulting 2012:41) and placed in the SURFER 10 program (Golden Software 2011) for final the display (Oswin 2009:86-95). The dual fluxgate gradiometer data from the Area A after the application of the destriping traverse function ranged from -100.0 nT/m to 100.0 nT/m with a mean of -0.17 nT/m and a standard deviation of 7.659 nT/m. Image and contour plots of the magnetic data were also generated for Area A in Surfer 10 (Figure 15). The dual fluxgate gradiometer data from the Area B after the application of the destriping traverse function ranged from -10.6 nT/m to 12.9 nT/m with a mean of -0.01 nT/m and a standard deviation of 0.996 nT/m. Image and contour plots of the magnetic data were also generated for Area B in Surfer 10 (Figure 16). The dual fluxgate gradiometer data from the Area C after the application of the destriping traverse function ranged from -53.8 nT/m to 89.0 nT/m with a mean of -0.23 nT/m and a standard deviation of 5.721 nT/m. Image and contour plots of the magnetic data were also generated for Area C in Surfer 10 (Figure 17). The dual fluxgate gradiometer data from the Area D after the application of the destriping traverse function ranged from -98.2 nT/m to 99.7 nT/m with a mean of 0.07 nT/m and a standard deviation of 6.351 nT/m. Image and contour plots of the magnetic data were also generated for Area D in Surfer 10 (Figure 18).

Electromagnetic Induction Survey—Conductivity:

Instrument: Geonics EM38 ground conductivity meter (Geonics 2006a) with an Archer ultra-rugged Field PC (Geonics 2006b; Juniper Systems 2009)

Specifications: apparent conductivity of the ground in millisiemens per meter (mS/m); measurement precision ±0.1% of full scale deflection; 100 and 1000 mS/m conductivity ranges (4 digit digital meter).

Survey type: conductivity in the quadrature phase operating mode

Operator: Steven De Vore

The electromagnetic induction (EM or EMI) survey in the conductivity or quadrature phase is an active geophysical technique, which induces an electromagnetic field into the ground (see Bevan 1983,1998:29-43; Clark 2000:171; Clay 2006:79-107; Dalan 1995; Davenport 2001:72-88; David 1995:20; Dobrin and Savit 1988:773-837; Fitterman and Labson 2005:301-355; Gaffney and Gater 2003:42-44; Gaffney et al. 1991:5,2002:10; Heimmer and De Vore 1995:35-41, 2000: 60-63; Klien and Lajoie 1992:383-535; Kvamme 2001:362-363,2003:441-442; Lowrie 1997:222-228; Mussett and Khan 2000:210-219; Nishimura 2001:551-552; Robinson and Çoruh 1988:490-500; Scollar et al. 1990:520-590; Sharma 1997:265-308; Telford et al. 1990:343-521; Weymouth 1986:317-318,326-327, and Witten 2006:147-213 for more details of electromagnetic induction conductivity surveys). This survey technique measures the apparent soil conductivity, which is in millisiemens per meter (mS/m: Sheriff 1973:197). Conductivity is also the reciprocal of resistivity.

An electromagnetic field is induced into the ground through the transmitting coil. The induced primary field causes an electric current flow in the earth similar to a resistivity survey. In fact, a conductivity survey is the inverse of a resistivity survey. High conductivity equates to low resistivity and vice versa. The materials in the earth create secondary eddy current loops, which are picked up by the instrument's receiving coil. The interaction of the generated eddy loops or electromagnetic field with the earthen materials is directly proportional to terrain conductivity within the influence area of the instrument. The receiving coil detects the response alteration (secondary electromagnetic field) in the primary electromagnetic field. This secondary field is out of phase with the primary field (quadrature or conductivity phase). The in-phase component of the secondary signal is used to measure the magnetic susceptibility of the subsurface soil matrix.

Changes result from electrical and magnetic properties of the soil matrix. Changes are caused by materials buried in the soil, differences in soil formation processes, or disturbances from natural or cultural modifications to the soil. EM instruments are also sensitive to surface and buried metals. Due to their high conductivity, metals show up as extreme values in the acquired data set. On occasion, these values may be expressed as negative values since the extremely high conductivity signal of the metals cause the secondary coil to become saturated.

In archeology, the instrument has been used to identify areas of compaction and excavation as well as buried metallic objects. It has the potential to identify cultural features that are affected by the water saturation in the soil (Clark 2000; Heimmer and De Vore 1995:35-41). Its application to archeology results from the ability of the instrument to detect lateral changes on a rapid data acquisition, high resolution basis, where observable contrasts exist. Lateral changes in anthropogenic features result from compaction, structural material changes, buried metallic objects, excavation, habitation sites, and other features affecting water saturation (Heimmer and De Vore 1995:37). The conductivity survey can sometimes detect the disturbed soil matrix within the grave shaft. It can also locate large metal objects. Metallic trash on the surface and other small objects buried in the upper portion of the soil can degrade the search of the buried archeological resources including graves (Bevan 1991:1310).

The present EMI survey is conducted with a Geonics EM38 ground conductivity meter (Geonics 2006). The instrument is lightweight and 1.45 meters in length (Figure 19). The self-contained dipole transmitter (primary field source) and self-contained dipole receiver (sensor) coils are located at opposite ends of the meter. The intercoil spacing is 1 meter. The meter was connected to the Archer ultra-rugged Field PC for digital data acquisition (Geonics 2006a, Juniper Systems 2009). The conductivity survey was designed to collect in the continuous or automatic mode with readings collected every quarter of a second resulting in four samples per meter. The data were collected in a parallel fashion or unidirectional mode with the surveyor conducting the data acquisition in the same the direction of travel for each traverse across the grid. The conductivity data were collected along 1.0-meter traverses at a sampling density of four samples per meter. A total of 1,600 data measurements were collected in a complete grid unit. The data and header files stored in the polycorder were downloaded into the laptop computer at the end of the survey. The survey of the grid unit began in the lower left hand or southwest corner of the grid. The EM38 was used in the quadrature or conductivity phase, the vertical dipole mode, and one orientation parallel to the direction of travel along the traverses. It provided an exploration depth of approximately 1.5 meters with its effective depth around 0.6 meters in the vertical dipole mode. The instrument was nulled and calibrated before the start of the survey at the same reference point that was used to balance and align the dual fluxgate gradiometer in Area A. A single grid unit, located at N40/E20, in Area A was surveyed using the conductivity meter. The conductivity survey was also conducted at Area C. The conductivity surveys were conducted to provide complementary data in the two areas and to check on the possibility of using it on sites within PECO in the future.

The data were downloaded to a laptop computer at the end of the survey of the geophysical project. The data were processed using the DAT38W software (Geonics 2002). After the transfer of the data and header files to the laptop computer, the files were automatically converted from the raw EM38 format to DAT38 format with the extension name of G38 (Geonics 2002:12-14). The data were then displayed as data profile lines (Geonics 2002:14-15). The individual EM38 data file was then converted to XYZ coordinate file in the Surfer data format. To create the XYZ file, the orientation or direction of the survey line was selected in the DAT38W program along with the data type and format (Geonics 2002:20-23). The resulting XYZ data file was transfer to the SURFER 10 mapping software (Golden Software 2011). The conductivity data were reviewed and an image plot was generated in SURFER 10. To further process the conductivity data, it was transferred to GEOPLOT (Geoscan Research 2003). The conductivity data were stripped of the X and Y coordinates and then the Z values (measurements) were imported into GEOPLOT for further processing (Geoscan Research 2003:4/1-4/29). The resulting grid was formatted to form a composite file in GEOPLOT. A zero mean traverse was then applied to remove any traverse discontinuities that may have occurred from operator handling or heading errors (Geoscan Research 2003:6/107-6/116). The interpolation routine was applied to the data set to arrange the data from the 4 x 1 data matrix to an equally spaced 4 x 4 square matrix (Geoscan Research 2003:6/53-6/56). A high pass filter was then applied over the composite data set (Geoscan Research 2003:6/49-6/52). The high pass filter was used to remove low frequency, large scale spatial detail such as a slowing changing geological 'background' trend. The data were then exported as an ASCII data file (Geoscan Research 2003: 5/4-5/7) and placed in the SURFER 10 mapping program (Golden Software 2011). The data were then exported as an ASCII dat file and placed in the SURFER 10 mapping program. The conductivity data from Area A before additional processing ranged from -8.3 mS/m to 16.0 mS/m with a mean of 11.92 mS/m and a standard deviation of 1.713 mS/m. The image and contour plots of the conductivity data from Grid Unit N40/E20 in Area A were generated for the survey area in SURFER 10 (Figure 20). The conductivity data from Area C before additional processing ranged from 6.8 mS/m to 11.8 mS/m with a mean of 8.22 mS/m and a standard deviation of 0.657 mS/m. An image and contour plots of the conductivity data from Area C were also generated for the survey area in SURFER 10 (Figure 21).

DESCRIPTION OF GEOPHYSICAL INTERPRETATION OF CULTURAL RESOURCES LOCATED: Andrew David (1995:30) defines interpretation as a *holistic process and its outcome should represent the combined influence of several factors, being arrived at through consultation with others where necessary*. Interpretation may be divided into two different types: the geophysical interpretation of the data and the archaeological interpretation of the data. At a simplistic level, geophysical interpretation involves the identification of the factors causing changes in the geophysical data. Archeological interpretation takes the geophysical results and tries to apply cultural attributes or causes. In both cases, interpretation requires both experience with the operation of geophysical equipment, data processing, and archeological methodology;

and knowledge of the geophysical techniques and properties, as well as known and expected archeology. Although there is variation between sites, several factors should be considered in the interpretation of the geophysical data. These may be divided between natural factors, such as geology, soil type, geomorphology, climate, surface conditions, topography, soil magnetic susceptibility, seasonality, and cultural factors including known and inferred archeology, landscape history, survey methodology, data treatment, modern interference, etc. (David 1995:30). It should also be pointed out that refinements in the geophysical interpretations are dependent on the feedback from subsequent archeological investigations. The use of multiple instrument surveys provides the archeologist with very different sources of data that may provide complementary information for comparison of the nature and cause (i.e., natural or cultural) of a geophysical anomaly (Clay 2001; Kvamme et al. 2006). Each instrument responds primarily to a single physical property: magnetometry to soil magnetism, electromagnetic induction to soil conductivity in the quadrature phase component and magnetic susceptibility in the in-phase component, resistivity to soil resistance, and ground penetrating radar to dielectric properties of the soil (Weymouth 1986:371).

Interpretation of the magnetic data (Bevan 1998:24) from the project requires a description of the buried archeological feature of object (e.g., its material, shape, depth, size, and orientation). The magnetic anomaly represents a local disturbance in the earth's magnetic field caused by a local change in the magnetic contract between buried archeological features, objects, and the surrounding soil matrix. Local increases or decreases over a very broad uniform magnetic surface would exhibit locally positive or negative anomalies (Breiner 1973:17). Magnetic anomalies tend to be highly variable in shape and amplitude. They are generally asymmetrical in nature due to the combined effects from several sources. To complicate matters further, a given anomaly may be produced from an infinite number of possible sources. Depth between the magnetometer and the magnetic source material also affect the shape of the apparent anomaly (Breiner 1973:18). As the distance between the magnetic sensor on the magnetometer and the source material increases, the expression of the anomaly becomes broader. Anomaly shape and amplitude are also affected by the relative amounts of permanent and induced magnetization, the direction of the magnetic field, and the amount of magnetic minerals (e.g., magnetite) present in the source compared to the adjacent soil matrix. The shape (e.g., narrow or broad) and orientation of the source material also affects the anomaly signature. Anomalies are often identified in terms of various arrays of dipoles or monopoles (Breiner 1973:18-19). A magnetic object in made of magnetic poles (North or positive and South or negative). A simple dipole anomaly contains the pair of opposite poles that relatively close together. A monopole anomaly is simply one end of a dipole anomaly and may be either positive or negative depending on the orientation of the object. The other end is too far away to have an effect on the magnetic field. Complex magnetic anomalies are combinations of dipoles and/or monopoles. In addition to the physical properties of the geophysical anomalies (shape size, strength, etc.), pattern recognition is an important component in the interpretation and potential identification of archeological features. The grouping of anomalies in circular, square, rectangular, or linear patterns may suggest the location of buried building foundations, wells, cellars, privies, room blocks, kivas, pit houses, stone circles or teepee rings, fence lines, utility lines, roads, earthworks, mounds, and other cultural features.

Magnetic anomalies of archeological objects tend to be approximately circular in contour outline. The circular contours are caused by small size of the objects. The shape of the object is seldom revealed in the contoured data. The depth of the archaeological object can be estimated by half-width rule procedure (Bevan 1998:23-24; Breiner 1973:31; Milsom 2003:67-70). The approximations are based on a model of a steel sphere with a mass of 1 kg buried at a depth of 1.0 m below the surface with the magnetic measurements made at an elevation of 0.3 m above the ground. The depth of a magnetic object is determined by the location of the contour value at half the distance between the peak positive value of the anomaly and the background value. With the fluxgate gradiometer, the contour value is half the peak value since the background value is approximately zero. The diameter of this contour (Bevan 1998:Fig. B26) is measured and used in the depth formula where **depth = diameter – 0.3 m** (Note: The constant of 0.3 m is the height of the bottom fluxgate sensor above the ground in the Geoscan Research FM36 were I carry the instrument during data acquisition. This value needs to be adjusted for each individual that carries the instrument.). The mass in kilograms of the object (Bevan 1998:24, Fig. B26) is estimated by the following formula: **mass = (peak value - background value) * (diameter)^3/60**. It is likely that the depth and mass estimates are too large rather than too small, since they are based on a compact spherical object made of iron. Archeological features are seldom compact but spread out in a line or lens. Both mass and depth estimates will be too large. The archaeological material may be composed of something other than iron such as fired earth or volcanic rock. Such materials are not usually distinguishable in the magnetic data collected during a survey (Bevan 1998:24). The depth and mass of features comprised of fired earth, like that found in kilns, fireplaces, or furnaces could be off by 100 times the mass of iron. If the archeological feature were comprised of bricks (e.g., brick wall, foundation, or chimney), estimates could be off by more than a 1000 times that of iron. The location of the center of the object can also be determined by drawing a line connecting the peak positive and peak negative values. The rule of thumb is that the center of the object is located approximately one third to one half of the way along the line from the peak positive value for the anomaly. One should also be cautious of geophysical anomalies that extend in the direction of the traverses since these may represent operator-induced errors. The magnetic gradient anomalies may be classified as three different types: linear, 2) dipole, and 3) monopole.

Analyses of the geophysical data from the four PECO geophysical project areas indicate the presence of numerous magnetic anomalies. Complementary data from the limited complementary conductivity surveys provide additional data on the nature or source of the geophysical anomalies. The geophysical anomalies appear to be associated with the Native American occupation of the Pecos Pueblo, the Spanish occupation of the Mission and Convento, historic Apache campsites, and the Santa Fe Trail along with historic ranching activities, historic State park activities, and modern National Park Service operations. Area A contains numerous individual dipole and monopole anomalies along with several clusters of magnetic anomalies across the grid area (Figure 22). Two linear magnetic anomalies in the southwestern section of Area A appear to represent roads/trails to the mission site. They are also represented as swales on the landscape. These may be associated with the Santa Fe Trail or with park visitor access for parking and/or stabilization activities at the mission ruins. A series of strong dipole anomalies extend across the center of the grid in a northerly direction. It is possible that they represent fence post locations or other archeological features. One anomaly located near N55/E30 may be a fire related feature such as a fire hearth. Several clusters of magnetic anomalies appear square or rectangular in shape. The anomaly outlines are represented by clusters of dipoles or monopoles along with relatively strong linear anomalies adjacent to weaker anomalies. It is possible that these clusters represent rectangular Puebloan room blocks or square Spanish houses (Charles Haecker, personal communications 2012). The magnetic data from Area B contains one relatively strong dipole anomaly (Figure 23). It ranges from approximately -10 to 10 nT/m. It is probably a ferrous metal object. The area is relatively quiet with a range of -3 to 3 nT/m. Area C contains the possible Apache stone circle (Figure 24). In the area of the exposed rocks in the southwestern part of the grid, there are several relatively weak dipole anomalies ranging between -5 and 8 nT/m. These anomalies appear to be associated with the rocks. Three relatively strong or strong dipoles have ranges of -15 to 10 nT/m, -43 to 8 nT/m, and -47 to 45 nT/m. The two stronger dipoles may probably represent ferrous metal objects, rocks, fired adobe brick fragments. The two strongest anomalies may be the wire from pin flags. Pin flags are made from high tensile steel with a very strong magnetic field. The magnetic field associated with a pin flag can obscure an area from one meter to five meters in diameter. Area D contains a swale associated with the Santa Fe trail in the southwestern corner of the grid (Figure 25). The outside edges of the swale are represented by relatively weak positive linear anomalies. In the southwest corner of the grid, a linear magnetic anomaly with alternating strong positive and weak negative values represents a buried utility line or buried wire. The alternating strong positive and weak negative bead like magnetic anomaly represents the cooling of the ferrous wire or pipe and the formation of connected bar magnets (North/ positive – S/negative) in the earth's magnetic field during its manufacture.

Interpretation of the conductivity data results in the identification of lateral changes in the soil matrix. The conductivity data may be divided into three classes of anomalies including linear anomalies, point anomalies, and broad anomalous areas. Linear anomalies may represent foundations of buildings, trenches, buried utility lines, paths, trails, or roads that are longer that they are wide. Point anomalies tend to represent buried objects or vertical structures such as cisterns, wells, or storage pits. Occasionally, these anomalies may have negative values resulting from the saturation of the receiving coil by the overwhelming conductive metal response of buried metals to the generated electromagnetic field. Comparisons between these negative conductivity anomalies and the magnetic anomalies can elucidate the nature of the buried object. If the magnetic and conductivity point anomalies coincide, it is assumed that the buried object is made from ferrous material. The presence of a magnetic anomaly and the lack of a corresponding conductivity anomaly suggest that the magnetic anomaly is composed of non-metallic material such as fired clay typically found in fire related features (i.e., fire hearths or pits, concentrated areas of ceramics, or bricks). The presence of a negative conductivity anomaly and the absence of a corresponding magnetic anomaly strongly suggest that the buried object is some type of non-ferrous metal (e.g., brass, copper, lead, etc.). Broad anomalous areas typically represent large areas of soil disturbances or compaction often found associated with gardens, basements or cellars, parking pads, compacted dirt floors, or areas of concrete or asphalt.

The conductivity data from Grid Unit 8 located at N40/E20 in Area A contains five conductivity anomalies (Figure 26). Four conductivity anomalies have the metal signature where the receiving coil has been overwhelmed the eddy signal. A fifth conductivity anomaly near N47/E28 appears similar to a dipole with a strong and weak side. Comparing the magnetic and conductivity data from Grid Unit N40/E20, the four conductivity anomalies appear to be associated with four magnetic dipole anomalies in the same locations (Figure 27). It is highly probable that both types of anomalies are associated with ferrous metal objects. One conductivity anomaly does not appear to have a corresponding magnetic anomaly, which suggests that the source of the anomaly is non-ferrous metal. Four magnetic anomalies do not have corresponding conductivity anomalies suggesting that the sources for these anomalies are fire related features, such as fire hearths, ovens, or burned adobe bricks, or soil disturbances such as post holes or refuse/cache pits.

A different way of looking at the geophysical data collected during the investigations of the geophysical project area is to combine the complementary data sets into one display. A number of the different geophysical anomalies overlap, suggesting a strong correlation between the geophysical data and the buried archeological features (Ambrose 2005; Kvamme 2007:345-374). These areas of overlap would be considered areas of high probability for ground truthing and the investigations of buried archeological resources. While these correlations are important, individual isolated occurrences also need ground truthing in order to determine their unique nature as well. Complementary data (Clay 2001) from the conductivity and associated magnetic survey area at Area A (Figure 28) indicate the locations of foundation remnants, ferrous and non-ferrous metal objects, fire related features, and possible refuse and/or cache pits. The combined conductivity and magnetic data from Area C indicate a possible Apache stone circle and more recent ferrous objects related to the archeological investigations at the site and park activities.

NATIONAL REGISTER EVALUATION OF CULTURAL RESOURCES LOCATED: The geophysical survey of the four PECO 2012 geophysical project areas was conducted as part of the National Park Service's archeological investigations of the Trade Fair Locality within Pecos National Historical Park (Haecker 2012a). The MWAC staff provided technical support for the geophysical investigations of the four geophysical project areas with volunteers from the University of Nebraska-Lincoln archeological field school. The geophysical inventory of the four geophysical project areas consisted of a dual fluxgate gradiometer survey of all four areas and limited conductivity surveys of Grid Unit N40/E20 in Area A and the partial grid unit in Area C. The total area investigated at the geophysical project area consisted of a total of 8,876 m^2 or 2.19 acres. The surveys resulted in the identification of numerous subsurface anomalies. The magnetic and conductivity data collected at the four Trade Fair geophysical project areas provided information of the physical properties (magnetic and soil conductivity properties) of the subsurface materials. Standard methodology for conducting geophysical investigations was used with standard 20-meter by 20-meter grid sizes where it was feasible. The geophysical survey of the site resulted in the identification of numerous subsurface anomalies associated with the historic Pecos Pueblo occupation, the historic Spanish occupation connected with the Mission and Convento, the historic Apache use of the area, the commerce along the historic Santa Fe trail, modern National Park Service activities.

This report has provided a review and analysis of the geophysical data collected during the geophysical investigations of four PECO geophysical project areas. The use of geophysical survey techniques at PECO indicates the usefulness in collecting basic background geophysical data concerning the nature and extent of the buried archeological resources. Based on the information provided by the geophysical survey methods, it is apparent that the geophysical data set yielded useful information for the determination of the integrity and significance of the buried archeological resources associated with the historic Native American, historic Spanish, and historic American periods, as well as the National Park Service use of the project areas. While the magnetic and conductivity surveys results provided data on the nature of the buried archeological resources, ground truthing through archeological excavation will provide definitive information on the nature of these geophysical anomalies.

Finally, refinement of the geophysical interpretation of the survey data is dependent on the feedback of the archeological investigations following geophysical survey (David 1995:30). Should additional archeological investigations occur at the four PECO geophysical project areas investigated during this project, the project archeologist is encouraged to share additional survey and excavation data with the geophysical investigator for incorporation into the investigator's accumulated experiences with archeological problems. Throughout the entire geophysical and archeological investigations, communication between the geophysicist and the archeologist is essential for successful completion of the archeological investigations. It is also important for the investigators to disseminate the results of the geophysical survey and archeological investigations to the general public. It is through their support in funds and labor that the National Park Service will continue to make contributions to the application of geophysical techniques to the field of archeology.

National Register Recommendations with Justifications for Eligible, Not Eligible, Need More Information from Testing, Etc: The geophysical survey of four PECO 2012 geophysical project areas yielded baseline data for the evaluation of the archeological deposits and modern activities. Areas A, C, and D have the potential to yield information on the Native American, Spanish, and American use of the Trade Fair area under Criterion D of the National Register of Historic Places. The three geophysical project areas have the potential to answer research questions related to chronology, subsistence, environmental change, regional interaction and trade, and technological change (Orcutt and Head 2002:421-433). The geophysical investigations have provided potential information on the integrity of the buried archeological resources at Area A, B. C, and D.

Site Integrity and Conservation/Stabilization/Avoidance Recommendations: The geophysical project areas contain archeological remains associated with occupation of the historic Pecos Pueblo, the Spanish missionary use of the area, and 19th and 20th century American activities, as well as more recent National Park Service stabilization activities. The resulting archeological integrity of buried archeological resources is good and the historic features represent significance resources associated with local, regional, and national historic contexts. Additional archeological investigations are needed to ground truth the geophysical anomalies to determine their shape, nature, extent, and chronological placement.

EFFECTS OF PROJECT ON RESOURCES: The application of geophysical survey techniques at the PECO Trade Fair Locality indicates the usefulness in collecting basic background geophysical data concerning the nature and extent of the buried archeological resources. These techniques should be applied to future archeological investigations conducted by the Pecos National Historical Park archaeological staff at other archeological sites within the national park. Based on the information provided by the geophysical survey methods, it is apparent that the geophysical data set yielded useful information for the determination of the integrity and significance of the buried archeological resources associated with the use of the site during the Native American, Spanish, and American historic occupation of the Trade Fair Locality. This information will be used by the Midwest Archeological Center, the Pecos National Historical Park, the Intermountain Regional Office's Heritage Partnership Program staffs to guide further archeological inquiry into the nature of the archeological resources of the Trade Fair Locality at PECO and help direct future National Park Service geophysical surveys and archeological excavations at other archeological sites across the Nation.

LOCATION OF ARTIFACTUAL MATERIALS AND RECORDS FROM THE WORK: No artifacts were collected during the geophysical investigations of the four project areas. The geophysical data and associated documentation are part of the PECO accession number 641. The materials are also temporarily curated under MWAC accession number 1514 until the entire collection is returned to PECO.

REFERENCES CITED:

Ambrose, Heather M.
2005 *Quantitative Integration and Three-dimensional Visualization of Multi-archaeological Geophysics Survey*. ProQuest Information and Learning Company, Ann Arbor, Michigan.

Aspinall, Arnold, Chris Gaffney, and Armin Schmidt
2008 *Magnetometry for Archaeologists*. AltaMira Press, Lanham, Maryland.

Bandelier, Ad. F.
1881 A Visit to the Aboriginal Ruins of the Valley of the Rio Pecos. *Papers of the Archaeological Institute of America, American Series* 1:36-133.
1892 Final Report of Investigations among the Indians of the Southwestern United States, Carried on Manly in the Years from 1880 to 1885. *Papers of the Archaeological Institute of America, American Series* 4(2):1-591 .

Bartington Instruments
2007 *Operation Manual for Grad 601 Single Axis Magnetic Gradiometer*. OM1800. Bartington Instruments, Oxford, England.

Bevan, Bruce W.
1983 Electromagnetics for Mapping Buried Features. *Journal of Field Archaeology* 10(1):47-54.
1991 The Search for Graves. *Geophysics* 56(9):1310-1319.
1998a Resistivity and Radar Surveys at Pecos National Historical Park. Ms. on file, Pecos National Historical Park, Pecos, New Mexico.
1998b *Geophysical Exploration for Archaeology: An Introduction to Geophysical Exploration*. Special Report No. 1. Midwest Archeological Center, Lincoln, Nebraska.

Breiner, Sheldon
1973 *Applications Manual for Portable Magnetometers*. GeoMetrics, Sunnyvale, California.
1992 Magnetics: Applications for Portable Magnetometers. In *Practical Geophysics II for the Exploration Geologist*, compiled by Richard Van Blaricom, pp. 313-381, Northwest Mining Association, Spokane, Washington.

Britton, William and Sean Ferrell
2006 Santa Fe National Forest Management Indicator Species Assessment. Ms. on file, Santa Fe National Forest, Santa Fe, New Mexico.

Burger, H. Robert
1992 *Exploration Geophysics of the Shallow Subsurface*. Prentice Hall PTR, Englewood Cliffs, New Jersey.

Clark, Anthony
2000 *Seeing beneath the Soil: Prospecting Methods in Archaeology*. Reprint. Routledge, London. Originally published in 1996 by B. T. Batsford Ltd., London.

Clay, R. Berle
2001 Complementary Geophysical Survey Techniques: Why Two Ways are always Better than One. *Southeastern Archaeology* 20(1):31-43.
2006 Conductivity Survey: A Survival Manual. In *Remote Sensing in Archaeology: An Explicitly North American Perspective* by Jay K. Johnson, pp. 79-107. University of Alabama Press, Tuscaloosa.

Cowley, Jill, Maureen Joseph, and Diane Rhodes
1998 Cultural Landscape Overview, Pecos National Historical Park, New Mexico. Ms. on file, Pecos National Historical Park, Pecos, New Mexico.

Dalan, Rinita A.
1995 Geophysical Surveys for Archaeological Research: Electromagnetic Conductivity Surveys. Ms. on file, Midwest Archeological Center, National Park Service, Lincoln, Nebraska. <http://www.cast.uark.edu/nadag/EducationalMaterials/EM/Dalan1.pdf>.

Davenport, G. Clark
2001 *Where is it? Searching for Buried Bodies & Hidden Evidence*. SportWork, Church Hill, Maryland.

David, Andrew
1995 *Geophysical Survey in Archaeological Field Evaluation*. Research & Professional Services Guidelines No. 1. English Heritage, Swindon, England.
2001 Overview—The Role and Practice of Archaeological Prospection. In *Handbook of Archaeological Sciences*, edited by D. R. Brothwell and A. M. Pollard, pp. 521-527. John Wiley & Sons, Ltd., Chichester, England.

De Vore, Steven L.
1998a Non-destructive Investigative Techniques for Cultural Resource Management Workshop, May 18-22, 1998, Pecos National Historical Park. Workbook on file, Pecos National Historical Park, Pecos, New Mexico.
1998b Magnetic Survey of Camp Lewis, Pecos National Historical Park, San Miguel County, New Mexico. In *Archeological Remote Sensing Survey of the Civil War Site of Camp Lewis, Pecos National Historical Park, San Miguel County, New Mexico*, by Charles M. Haecker, pp. 91-98. PECO-01. National Park Service, Santa Fe, New Mexico.
2012 Geophysical Survey of Selected Areas within Pecos National Historical Park, New Mexico (June 24-30, 2012). Trip Report on file, Midwest Archeological Center, Lincoln, Nebraska.

Dice, Lee R.
1943 *The Biotic Provinces of North America*. University of Michigan Press, Ann Arbor.

Dobrin, Milton B., and Carl H. Savit
1988 *Introduction to Geophysical Prospecting*. Fourth Edition. McGraw-Hill Book Company, New York.

DW Consulting
2012 *ArcheoSurveyor User Manual Program Version 2.5.x, Issue 16.* DW Consulting, Barneveld, The Netherlands.

Eininger, Susan
2002 Previous Archeological Work. In *From Folsom to Fogelson: The Cultural Resources Inventory Survey of Pecos National Historical Park, Volume I,* edited by Genevieve N. Head and Janet D. Orcutt, pp. 21-38. Intermountain Cultural Resources Management Professional Paper No. 66. National Park Service, Santa Fe, New Mexico.

Fenneman, Nevin M.
1931 *Physiography of Western United States*. McGraw-Hill Book Company, New York.

Fitterman, David V., and Victor F. Labson
2005 Electromagnetic Induction Methods for Environmental Problems. In *Near-Surface Geophysics*, edited by Dwain K. Butler, pp. 301-355. Society of Exploration Geophysicists, Tulsa, Oklahoma.

Foth, Henry D., and John W. Schafer
1980 *Soil Geography and Land Use*. John Wiley & Sons, New York.

Gaffney, Chris, and John Gater
2003 *Revealing the Buried Past: Geophysics for Archaeologists*. Tempus, Stroud, Great Britain.

Gaffney, Chris, John Gater, and Sue Ovenden
1991 *The Use of Geophysical Techniques in Archaeological Evaluations*. Technical Paper Number 9. Institute of Field Archaeologists, University of Birmingham, Birmingham, England.
2002 *The Use of Geophysical Techniques in Archaeological Evaluations*. IFA Paper No. 6. Institute of Field Archaeologists, University of Birmingham, Birmingham, England.

Geonics
2002 *DAT38W Version 1.10 Computer Program Manual (Survey Data Reduction Manual).* Geonics Limited, Mississauga, Ontario, Canada.

2006a *EM38 Ground Conductivity Meter Operating Manual*. Geonics Limited, Mississauga, Ontario, Canada.

2006b *EM38xp Operating Instructions EM38 Data Logging System for Windows XP Based Field Computer*. Geonics Limited, Mississauga, Ontario, Canada.

Geoscan Research

2003 *Geoplot Version 3.00 for Windows Instruction Manual, Version 1.95*. Geoscan Research, Bradford, England.

Golden Software

2011 *Surfer 10 User's Guide: Contouring and 3D Surface Mapping for Scientists and Engineers*. Golden Software, Golden, Colorado.

Gunnerson, James H.

1969 Archaeological Survey on the near Pecos National Monument: Preliminary Report. Ms. on file, Pecos National Historical Park, Pecos, New Mexico.

1970 Preliminary Report of 1970 Archaeological Investigations by Northern Illinois University. Ms. on file, Pecos National Historical Park, Pecos, New Mexico.

Gunnerson, James H., and D. A. Gunnerson

1970 Evidence of Apaches at Pecos. *El Palacio* 76(3):1-6.

Haecker, Charles M.

1998 *Archeological Remote Sensing Survey of the Civil War Site of Camp Lewis, Pecos National Historical Park, San Miguel County, New Mexico*. PECO-01. National Park Service, Santa Fe, New Mexico.

2012a Archeological Remote Sensing Investigations within and around the Pecos Pueblo Trade Fair Area, Pecos National Historical Park, New Mexico. Scope of work on file, National Park Service, Santa Fe, New Mexico.

2012b *Metal Detection Sample Survey within the Trade Fair Area, Pecos National Historical Park, New Mexico*. Park Papers PECO-01 NMCRIS 123066. National Park Service, Santa Fe, New Mexico.

Hayes, Alden C.

1970 Convento Room Notes, 1970. Field notes on file, Pecos National Historic Park, Pecos, New Mexico.

1974 *The Four Churches of Pecos*. University of New Mexico Press, Albuquerque.

Head, Genevieve N., and Janet D. Orcutt (editors)

2002 *From Folsom to Fogelson: The Cultural Resources Inventory Survey of Pecos National Historical Park*. Two Volumes. Inermountain Cultural Resources Management Professional Paper No. 66. National Park Service, Santa Fe, New Mexico.

Head, Genevieve N., Janet D. Orcutt, and Robert P. Powers

2002 Introduction. In *From Folsom to Fogelson: The Cultural Resources Inventory Survey of Pecos National Historical Park, Volume I*, edited by Genevieve N.

Head and Janet D. Orcutt, pp. 1-20. Intermountain Cultural Resources Management Professional Paper No. 66. National Park Service, Santa Fe, New Mexico.

Heimmer, Don H., and Steven L. De Vore
1995 *Near-Surface, High Resolution Geophysical Methods for Cultural Resource Management and Archeological Investigations*. Revised Edition. National Park Service, Denver.
2000 Near-Surface, High Resolution Geophysical Methods for Cultural Resource Management and Archeological Investigations. In *Science and Technology in Historic Preservation*, edited by Ray A. Williamson and Paul R, Nickens, pp. 53-73. Advances in Archaeological and Museum Science Volume 4. Kluwer Academic/Plenium Publishers, New York.

Hewett, Edgar L.
1904 Studies on the Extinct Pueblo of Pecos. *American Anthropologist* 6:426-439

Hilley, Terry E., Tom E. McCarty, Paul G. Martin, and Steven L. Sellnow
1981 *Soil Survey of San Miguel County Area, New Mexico*. U.S. Government Printing Office, Washington, D.C.

Houghton, Frank E.
1981 Climate. In *Soil Survey of San Miguel County Area, New Mexico*, by Terry E. Hilley, Tom E. McCarty, Paul G. Martin, and Steven L. Sellnow, pp. 1-2,88-90. U.S. Government Printing Office, Washington, D.C.

Ivey, James E.
2005 *The Spanish Colonial Architecture of Pecos Pueblo, New Mexico: Archaeological Excavations and Architectural History of the Spanish Colonial Churches and Related Buildings at Pecos National Historical Park, 1617-1995*. Professional Paper No. 59. Division of Cultural Resources Management, Intermountain Region, National Park Service, Santa Fe, New Mexico.

Johnson, Kristine, Teri Neville, and Jacqueline Smith
2011 *Pecos National Historical Park Natural Resource Condition Assessment*. National Resource Report NPS/PECO/NRR—2011/441. Natural Resource Stewardship and Science, Fort Collins, Colorado.
.
Juniper Systems
2009 *Ultra-rugged Field PC Reference Guide*. Juniper Systems, Inc., Logan, Utah.

Kidder, Alfred V.
1916a Archaeological Explorations at Pecos, New Mexico. *Proceedings of the National Academy of Sciences* 2:119-123.
1916b *The Pueblo of Pecos*. Papers of the School of American Archaeology 33. Archaeological Institute of America, Cambridge, Massachusetts.

1917a The Condition of the Main Pecos Ruin. *El Palacio* 4(1):18-21.
1917b *The Old North Pueblo of Pecos*. Papers of the School of American Archaeology 38. Archaeological Institute of America, Cambridge, Massachusetts.
1921 Excavations at Pecos in 1920. *El Palacio* 10(1&2):1-4,13-16.
1922 Excavations at Pecos, 1922. *El Palacio* 13(9):107-109.
1924 *An Introduction to the Study of Southwestern Archaeology with a Preliminary Account of the Excavations at Pecos*. Papers of the Southwestern Expedition No. 1. Yale University Press, New Haven, Connecticut.
1925 *Pecos Expedition of 1924*. Papers of the School of American Research No. 11. Archaeological Institute of America, Santa Fe, New Mexico.
1926a *The Excavations at Pecos in 1925*. Papers of the School of American Research No. 14. Archaeological Institute of America, Santa Fe, New Mexico.
1926b *Early Pecos Ruins on the Forked Lightning Ranch*. Papers of the School of American Research No. 16. Archaeological Institute of America, Santa Fe, New Mexico.
1932 *The Artifacts of Pecos*. Papers of the Phillips Academy Southwest Expedition No. 6. Yale University, New Haven, Connecticut.
1951 Pecos Pueblo. *El Palacio* 58(3):82-89.
1958 *Pecos, New Mexico, Archaeological Notes*. Papers of the Robert S. Peabody Foundation for Archaeology No. 5. The Robert S. Peabody Museum of Archaeology, Phillips Academy, Andover, Massachusetts.

Klien, Jan, and Jules J. Lajoie
1992 Electromagnetics: Electromagnetic Prospecting for Minerals. In *Practical Geophysics II for the Exploration Geologist,* compiled by Richard Van Blaricom, pp. 313-381, Northwest Mining Association, Spokane, Washington.

Kvamme, Kenneth L.
2001 Current Practices in Archaeogeophysics: Magnetic, Resistivity, Conductivity, and Ground-Penetrating Radar. In *Earth Sciences and Archaeology*, edited by Paul Goldberg, Vance T. Holliday, and C. Reid Ferring, pp. 353-384. Kluwer Academic/Plenium Publishers, New York.
2002 Electrical Resistance Survey at Fort Vancouver, Washington. Ms. on file, Fort Vancouver National Historic Site, Vancouver, Washington.
2003 Geophysical Surveys as Landscape Archaeology. *American Antiquity* 68(3):435-457.
2005 Terrestrial Remote Sensing in Archaeology. In *Handbook of Archaeological Methods*, edited by Herbert D. G. Maschner and Christopher Chippindale, pp. 423-477. AltaMira Press, Lanham, Maryland.
2006a Magnetometry: Nature's Gift to Archaeology. In *Remote Sensing in Archaeology: An Explicitly North American Perspective,* edited by Jay K. Johnson, pp. 205-233. University of Alabama Press, Tuscaloosa.
2006b Data Processing and Presentation. In *Remote Sensing in Archaeology: An Explicitly North American Perspective*, edited by Jay K. Johnson, pp. 235-250. University of Alabama Press, Tuscaloosa.

2007 Integrating Multiple Geophysical Datasets. In *Remote Sensing in Archaeology*, edited by James Wiseman and Farouk El-Baz, pp. 345-374. Springer, New York.

Kvamme, Kenneth L., Jay Johnson, and Brian S. Haley
2006 Multiple Methods Surveys: Case Studies. In *Remote Sensing in Archaeology: An Explicitly North American Perspective*, edited by Jay K. Johnson, pp. 251-267. University of Alabama Press, Tuscaloosa.

Levine, Frances, Marilyn Norcini, and Morris Foster
1995 An Ethnographic Overview of Pecos National Historical Park. Ms. on file, Pecos National Historical Park, Pecos, New Mexico.

Lowrie, William
1997 *Fundamentals of Geophysics*. Cambridge University Press, Cambridge, United Kingdom.

Matlock, Gary
1974 Stabilization Field Notes, 1971-1974. Field notes on file, Pecos National Historical Park, Pecos, New Mexico.

McNeil, Duncan
1980a *Electrical Conductivity of Soils and Rocks*. Technical Note TN-5. Geonics Limited, Mississauga, Canada.
1980b *Electromagnetic Terrain Conductivity Measurements at Low Induction Numbers*. Technical Note TN-6. Geonics Limited, Mississauga, Canada.
1998 EM38/EM38B Survey Data. Ms. on file, Pecos National Historical Park, Pecos, New Mexico.

Metzer, Todd R.
1990 Ruins Preservation Guidelines, Pecos National Monument, New Mexico. Ms. on file, Pecos National Historical Park, Pecos, New Mexico.

Milsom, John, and Asger Eriksen
2011 *Field Geophysics*. Fourth Edition. John Wiley & Sons, Chichester, United Kingdom.

Mussett, Alan E., and M. Aftab Khan
2000 *Looking into the Earth: An Introduction to Geological Geophysics*. Cambridge University Press, Cambridge, United Kingdom.

National Park Service (NPS)
2006 *Federal Historic Preservation Laws: The Official Compilation of U.S. Cultural Heritage Statues*. 2006 Edition. National Park Service, Washington, D.C.

Neubauer, W., P. Melichar, and A. Eder-Hinterleitner
1996 Collection, Visualization, and Simulation of Magnetic Prospection Data. In *Interfacing the Past: Computer Applications and Quantitative Methods in Archaeology, CAA95, Volume 1*, edited by H. Kamermans and K. Fennema, pp. 121-129. Analecta Praehistorica Leidensia No. 28. University of Leiden, Leiden, The Netherlands.

Nishimura, Y.
2001 Geophysical Prospection in Archaeology. In *Handbook of Archaeological Sciences*, edited by D. R. Brothwell and A. M. Pollard, pp. 543-553. John Wiley & Sons, Ltd., Chichester, England.

Nordby, Larry V.
1990 Pecos Revisited: Small Site Survey along the Eastern Pueblo Frontier. Ms. on file, Pecos National Historical Park, Pecos, New Mexico.

Nordby, Larry V., Gary M. Matlock, and A. William Creutz
1975 A Stabilization History of Pecos National Monument, 1971-1974. Ms. on file, Pecos National Historical Park, Pecos, New Mexico.

Orcutt, Janet D., and Genevieve N. Head
2002 Summary and Conclusions. In *From Folsom to Fogelson: The Cultural Resources Inventory Survey of Pecos National Historical Park*, *Volume I*, edited by Genevieve N. Head and Janet D. Orcutt, pp. 421-433. Intermountain Cultural Resources Management Professional Paper No. 66. National Park Service, Santa Fe, New Mexico.

Oswin, John
2009 *A Field Guide to Geophysics in Archaeology*. Springer-Praxis Books, Chichester, United Kingdom.

Parmenter, R. R., and D. C. Lightfoot
1996 *A Field Survey of the Faunal Resources of the Pecos Unit, Pecos National Historical Park, Pecos, New Mexico*. The University of New Mexico, Albuquerque.

Pinkley, Jean
1968 Archeological Field Notes, 1966-1968. Field notes on file, Pecos National Historical Park, Pecos, New Mexico.

Robinson, Edwin S., and Cahit Çoruh
1988 *Basic Exploration Geophysics*. John Wiley & Sons, New York.

Roosevelt, A. C.
2007 Geophysical Archaeology in the Lower Amazon: A Research Strategy. In *Remote Sensing in Archaeology*, edited by James Wiseman and Farouk El-Baz, pp. 443-4475. Springer, New York.

Scollar, I., A. Tabbagh, A. Hesse, and I. Herzog
1990 *Archaeological Prospection and Remote Sensing*. Topics in Remote Sensing 2. Cambridge University Press, Cambridge, Great Britain.

Scott, Douglas D.
2005 Detecting Glorieta: A Metal Detecting Archeological Reconnaissance of the Glorieta Battlefield, Pigeon's Ranch Sub-unit, Pecos National Historical Park, New Mexico. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Sharma, Prem V.
1997 *Environmental and Engineering Geophysics*. Cambridge University Press, Cambridge, United Kingdom.

Sheriff, Robert E.
1973 *Encyclopedic Dictionary of Exploration Geophysics*. Society of Exploration Geophysicists, Tulsa, Oklahoma.

Somers, Lewis
2006 Resistivity Survey. In *Remote Sensing in Archaeology: An Explicitly North American Perspective*, edited by Jay K. Johnson, pp. 109-129. University of Alabama Press, Tuscaloosa.

Stuart, David E., and Rory P. Gauthier
1981 *Prehistoric New Mexico: Background for Survey*. University of New Mexico Press, Albuquerque.

Stubbs, Stanley A., Bruce T. Ellis, and Alfred E. Dittert, Jr.
1957 "Lost" Pecos Church. *El Palacio* 64(3-4):67-85.

Telford, W. M., L. P. Geldart, and R. E. Sheriff
1990 *Applied Geophysics*. Second Edition. Cambridge University Press, Cambridge, United Kingdom.

Trewartha, Glen T., and Lyle H. Horn
1980 *An Introduction to Climate*. Fifth Edition. McGraw-Hill Book Company, New York.

Trimble Navigation Limited (Trimble)
2007a *Getting Started Guide TerraSync Software, Version 3.00*. Trimble Navigation Limited, Westminster, Colorado.
2007b *Reference Manual TerraSync Software, Version 3.00*. Trimble Navigation

Limited, Westminster, Colorado.
2007c *Getting Started Guide GPS Pathfinder Office Software, Version 4.00*. Trimble Navigation Limited, Westminster, Colorado.

United States Department of Agriculture (USDA)
2006 *Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin*. Agriculture Handbook 296. United States Department of Agriculture, Washington, D.C.

Ushikata
2005 *Tracon & Surveying Compasses Operation Manual*. Ushikata Mfg. Co., Ltd., Tokyo, Japan.

Von Der Osten-Woldenburg, Harald
2005 Applications of Ground-Penetrating Radar, Magnetic and Electrical Mapping, and Electromagnetic Induction Methods in Archaeological Investigations. In *Near-Surface Geophysics*, edited by Dwain K. Butler, pp. 621-626. Society of Exploration Geophysicists, Tulsa, Oklahoma.

Weymouth, John W.
1986 Geophysical Methods for Archaeological Site Surveying. In *Advances in Archaeological Method and Theory, Volume 9*, edited by Michael B. Schiffer, pp. 311-395. Academic Press, Orlando, Florida.

White, Joseph Courtney
1993 Documentation of Original Architectural Fabric in the Church/Convento Complex at Pecos National Historical Park, Pecos, New Mexico. Ms. on file, Pecos National Historical Park, Pecos, New Mexico.
1994 A History of the Preservation and Archeological Activities in the Spanish Convento at Pecos National Historical Park, 1939 to Present. Ms. on file, Pecos National historical Park, Pecos, New Mexico.

Willey, Gordon R.
1966 *An Introduction to American Archaeology, Volume One North and Middle America*. Prentice-Hill Inc., Englewood Cliffs, New Jersey.

Witten, Alan J.
2006 *Handbook of Geophysics and Archaeology*. Equinox Publishing Ltd., London.

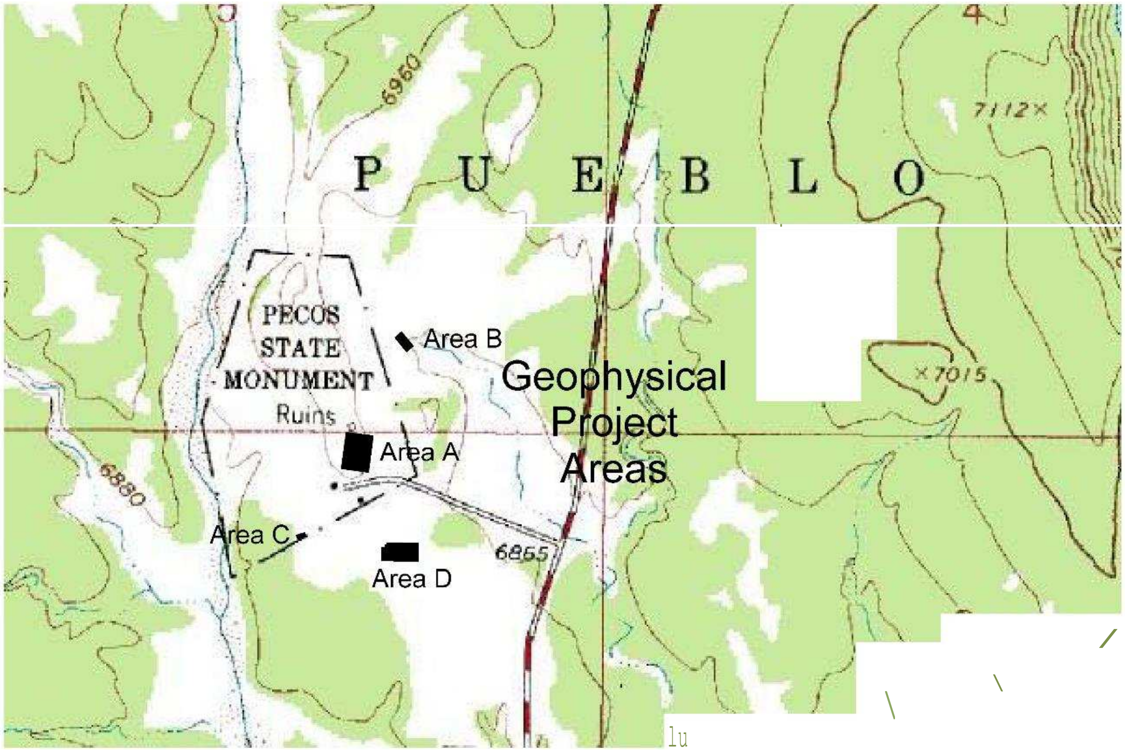
SUMMARY MANAGEMENT RECOMMENDATIONS:

[ ] CLEARANCE NOT RECOMMENDED (explain):

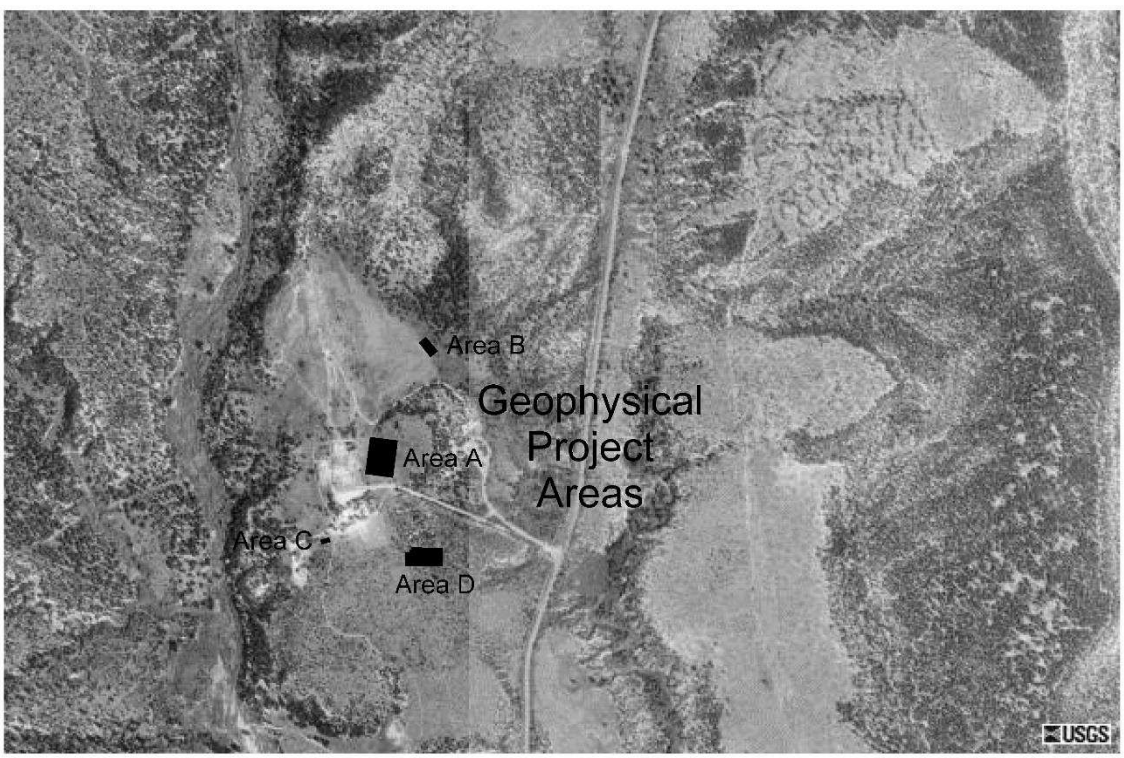
[ ] CLEARANCE RECOMMENDED (explain):

[X] CLEARANCE RECOMMENDED WITH CONDITIONS (explain): The present geophysical project were part of an intensive archeological investigation of Trade Fair Locality at the Pecos Pueblo at the Pecos National Historical Park, san Miguel County, New Mexico. The results of the geophysical investigations provided geophysical data the location of potential archeological features and objects related to the use of the Trade Fir Locality by Native Americans, the Spanish, and Americans, including modern park stabilization activities. Additional archeological excavations are needed to ground truth the geophysical anomalies identified during the survey to determine the nature and extent of the buried archeological resources.

FIGURES



a) USGS topographic map 3 km S of Pecos, New Mexico (dated 01 July 1994)



b) USGS aerial photograph map 3 km S of Pecos, New Mexico (dated 05 October 1997)

Figure 1. Location of the geophysical project areas within Pecos National Historical Park, San Miguel County, New Mexico.

Figure 2. General view of the Area A (view to the north northwest).

Figure 3. General view of Area B (view to the north).

Figure 4. General view of Area C (view to the northeast).

Figure 5. General view of Area D (view to the north northwest).

Figure 6. Laying out Area A with a surveying compass and 100-m tape (view to the northwest).

Figure 7. Collecting grid coordinate locational data with gps unit and external antenna (view to the south southwest).

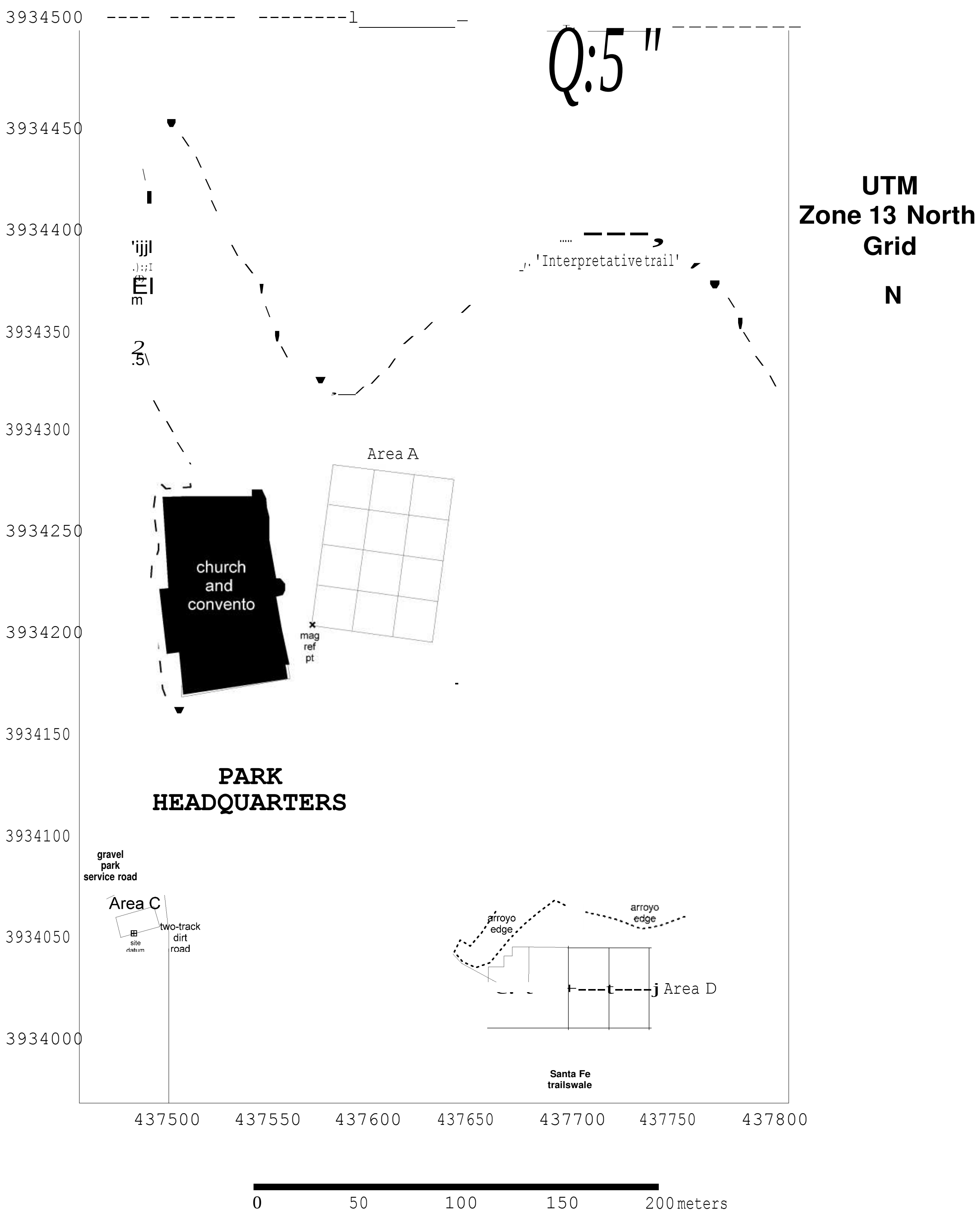


Figure 8. UTM grid of the PECO geophysical project areas.

Figure 9. Laying out the geophysical survey ropes (view to the northeast).

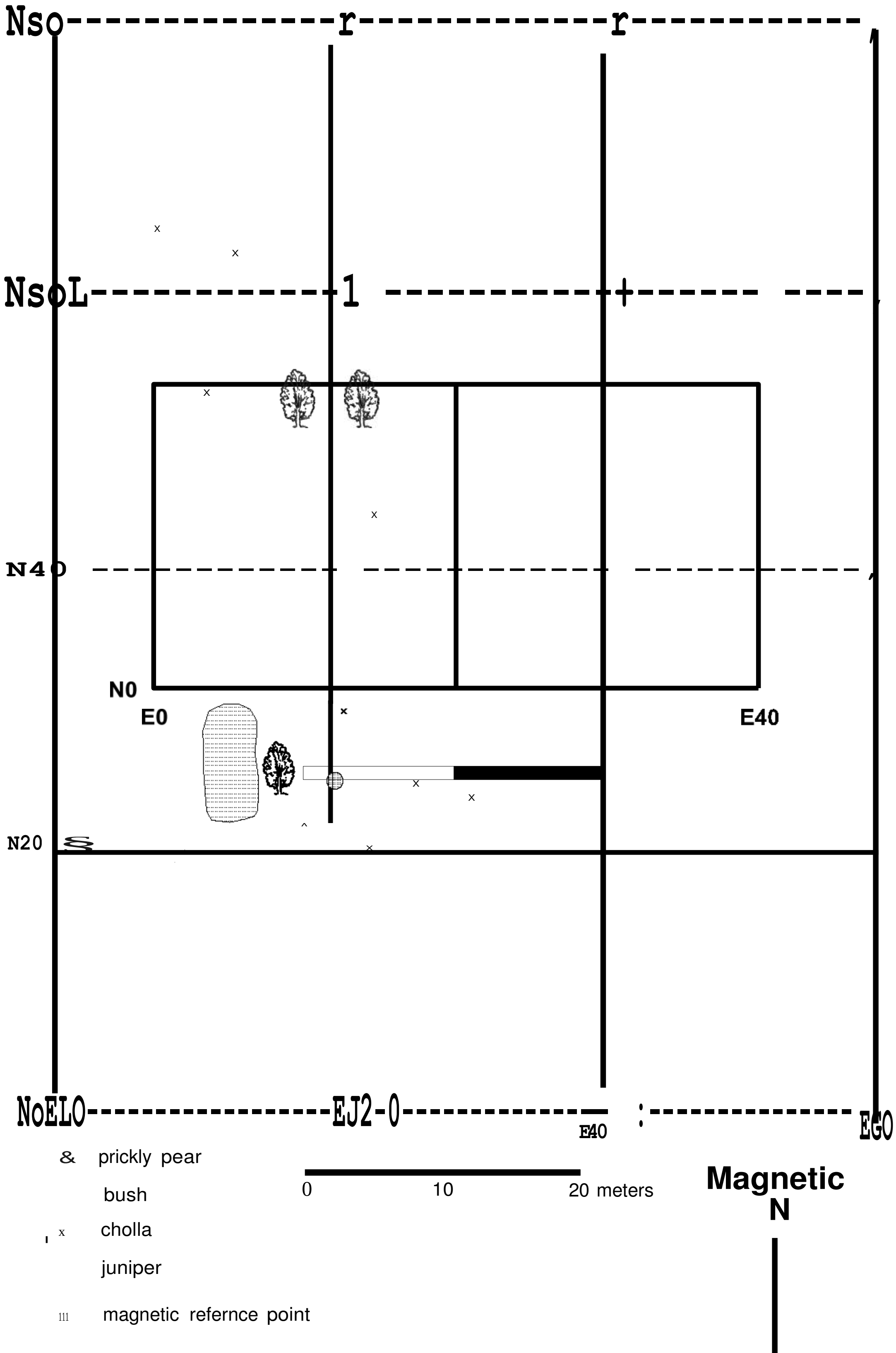


Figure 10. Sketch map of Area A.

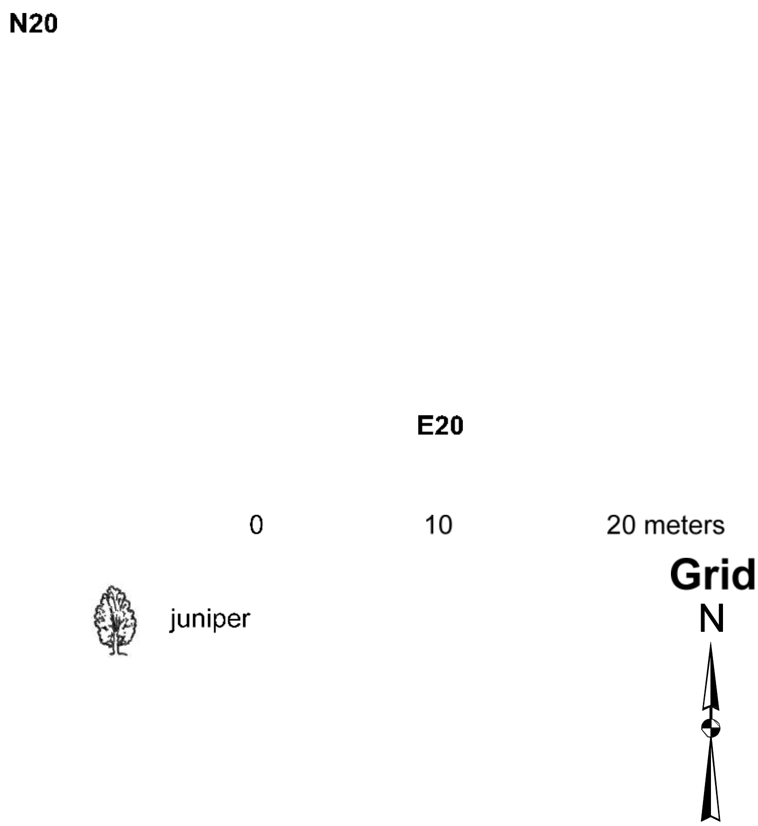


Figure 11. Sketch map of Area B.

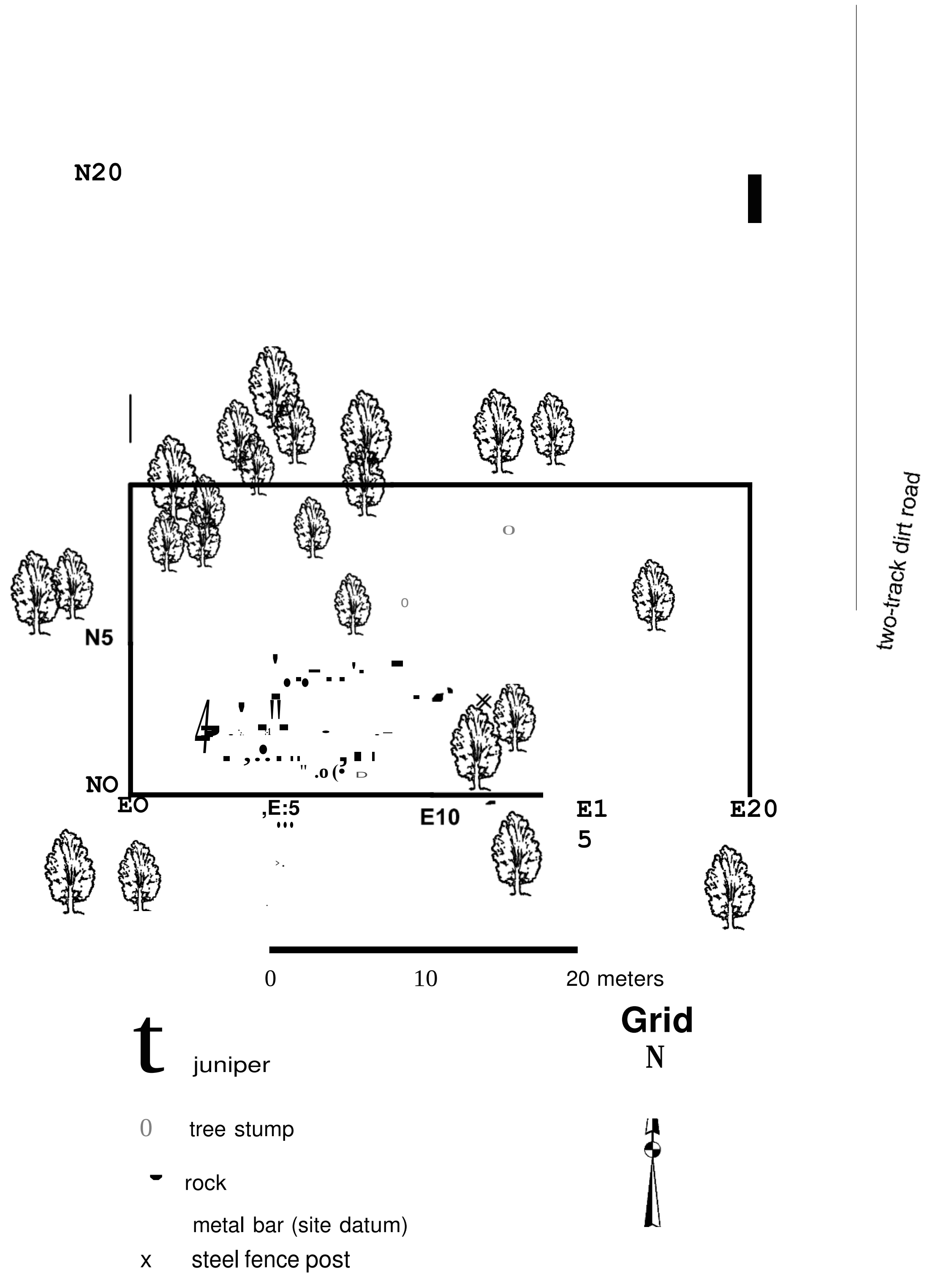


Figure 12. Sketch map of Area C.

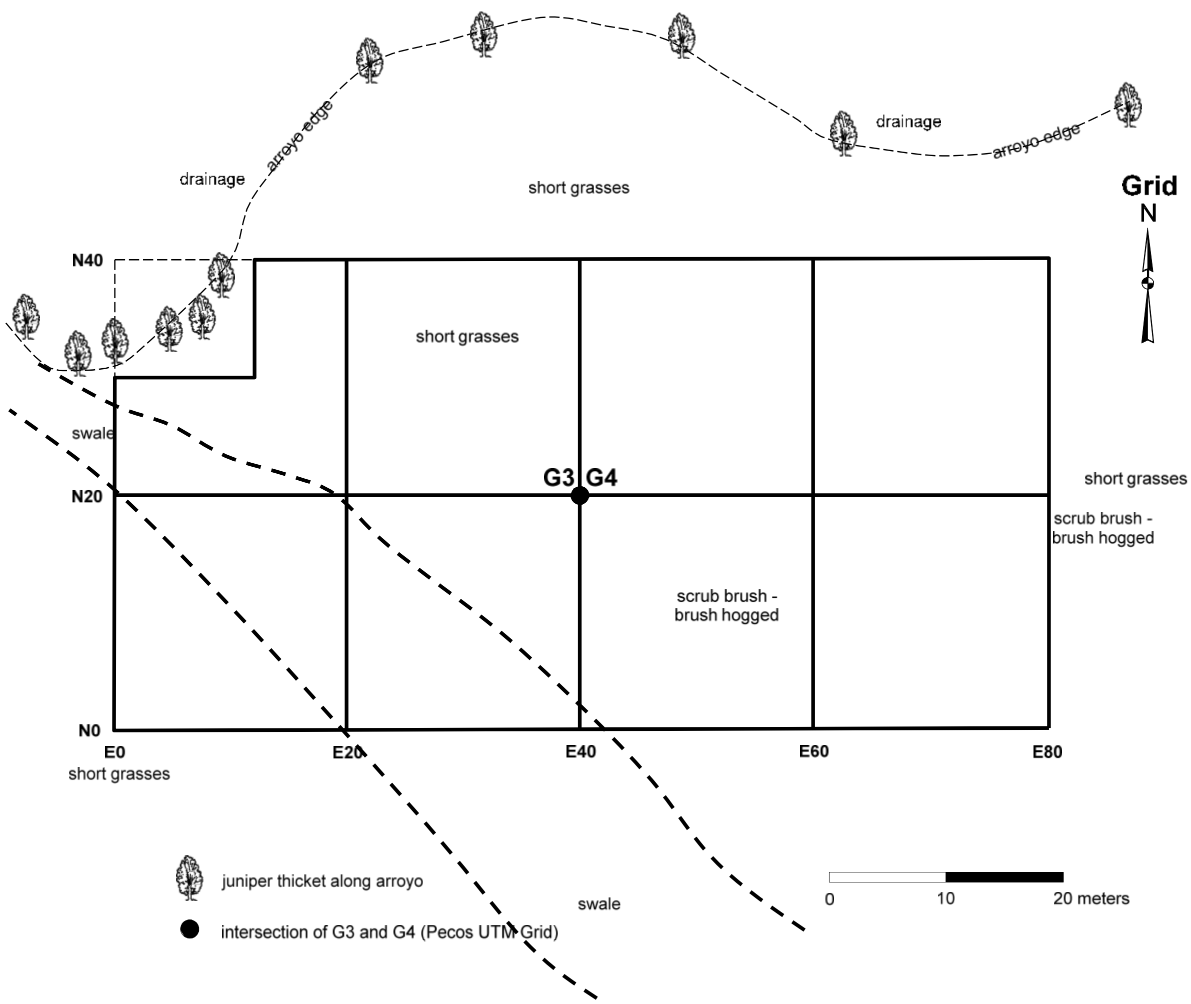


Figure 13. Sketch map of Area D.

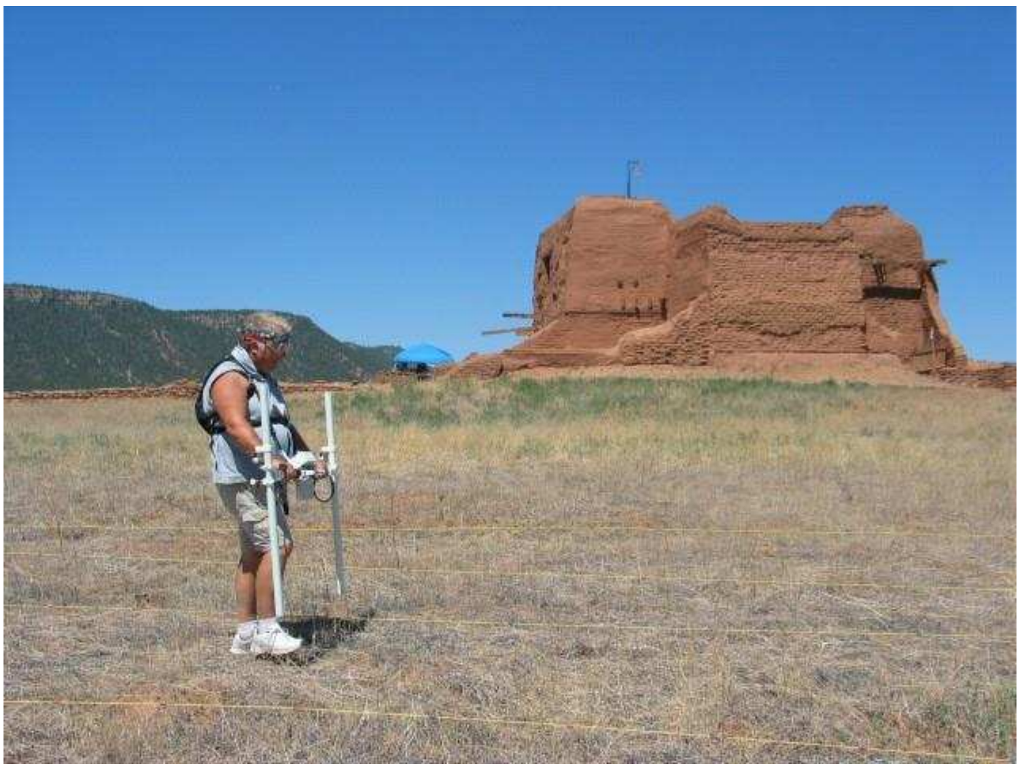


Figure 14. Conducting the magnetic survey with the dual fluxgate gradiometer (view to the west southwest)

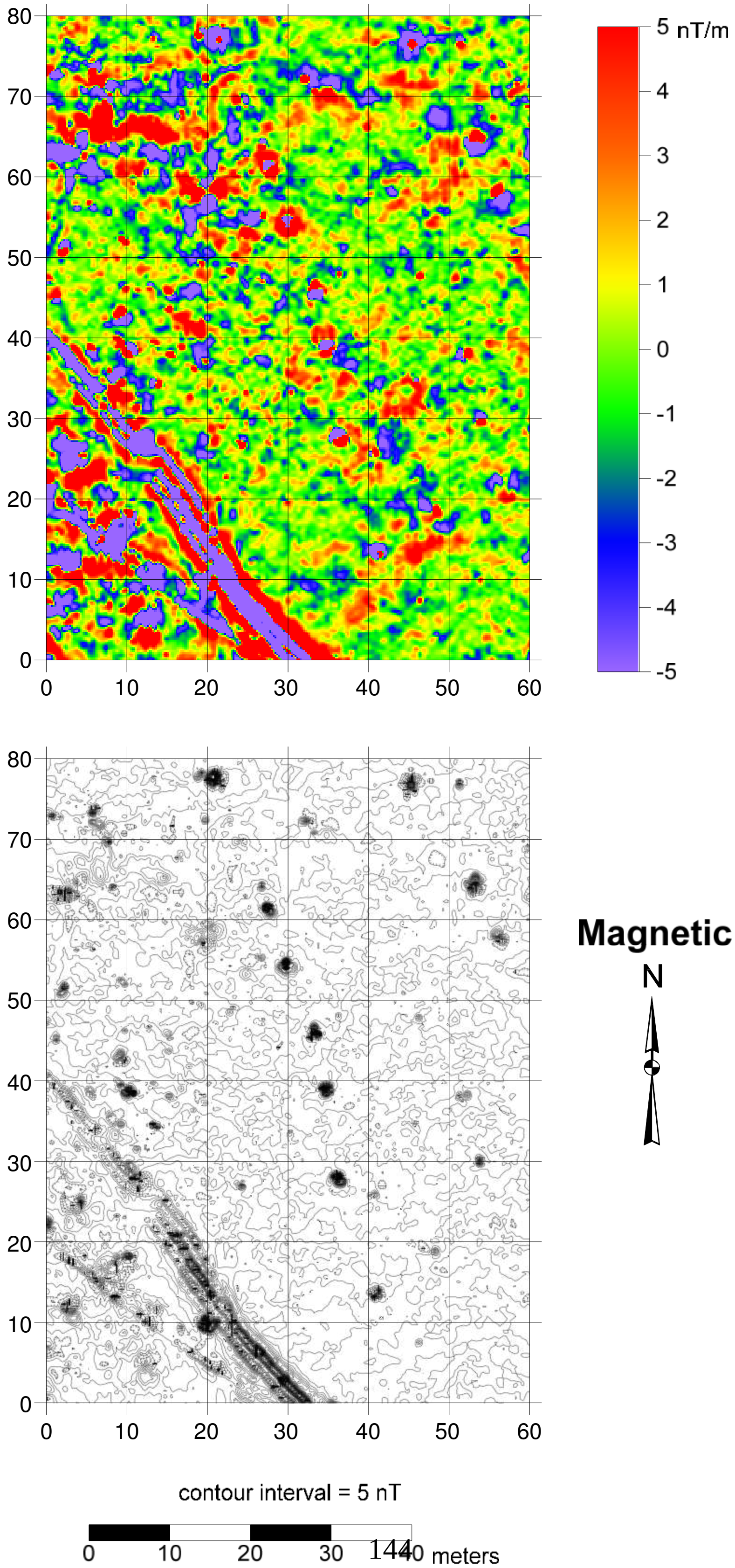

5 nT/m
4
3
2
1
0
-1
-2
-3
-4
-5
0 10 20 30 40 50 60
0 10 20 30 40 50 60 70 80
Magnetic
N
contour interval = 5 nT
0 10 20 30
meters

Figure 15. Image and contour plots of the magnetic data from Area A.

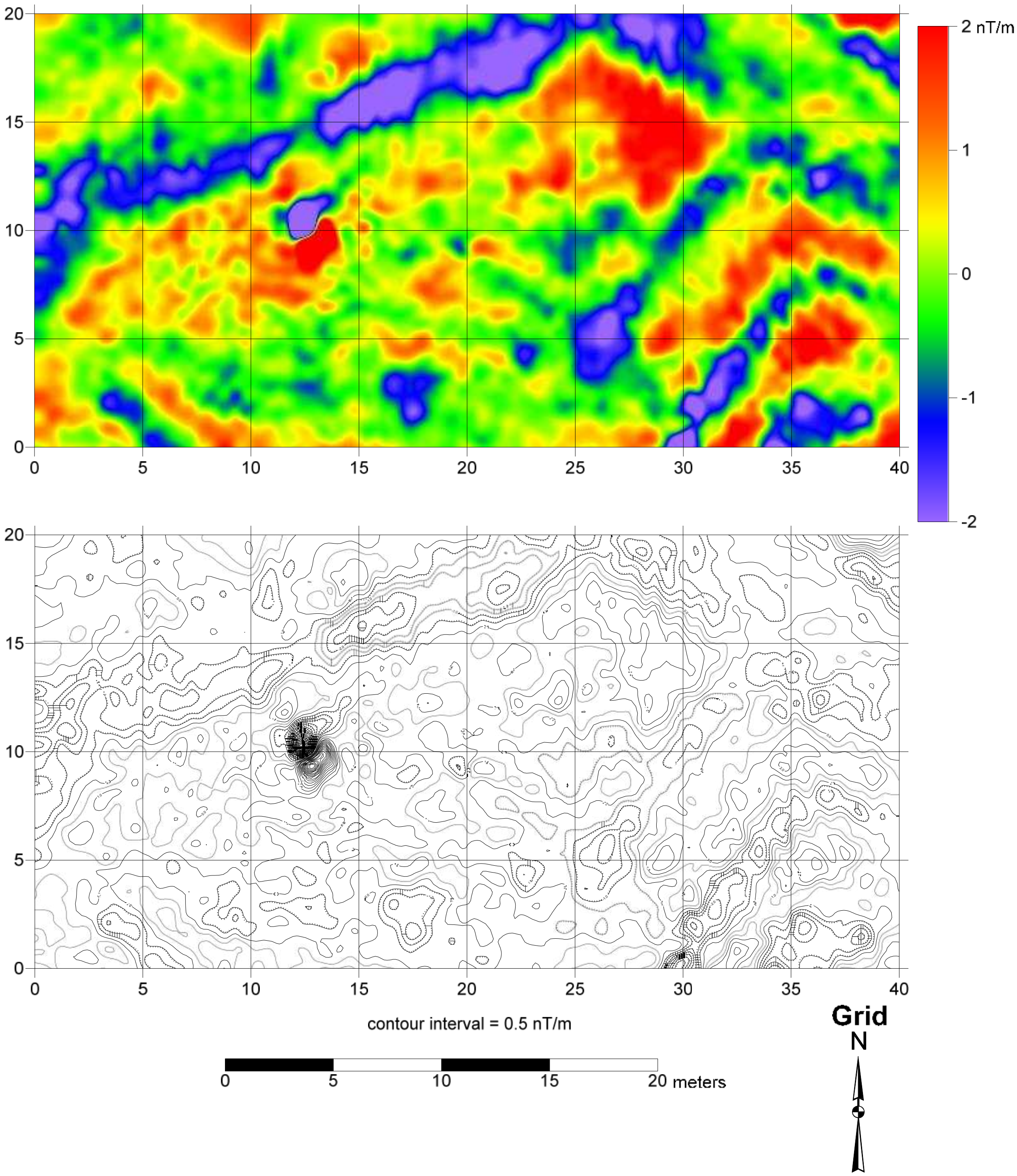
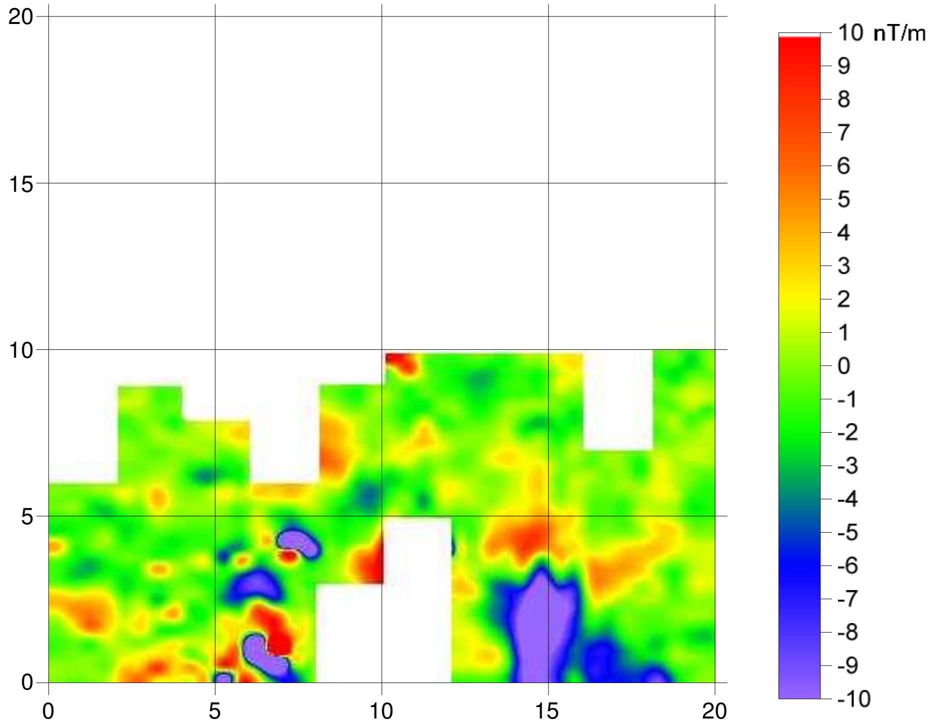


Figure 16. Image and contour plots of the magnetic data from Area B.


20
15
10
5
0
0
5
10
15
20
10 nT/m
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10

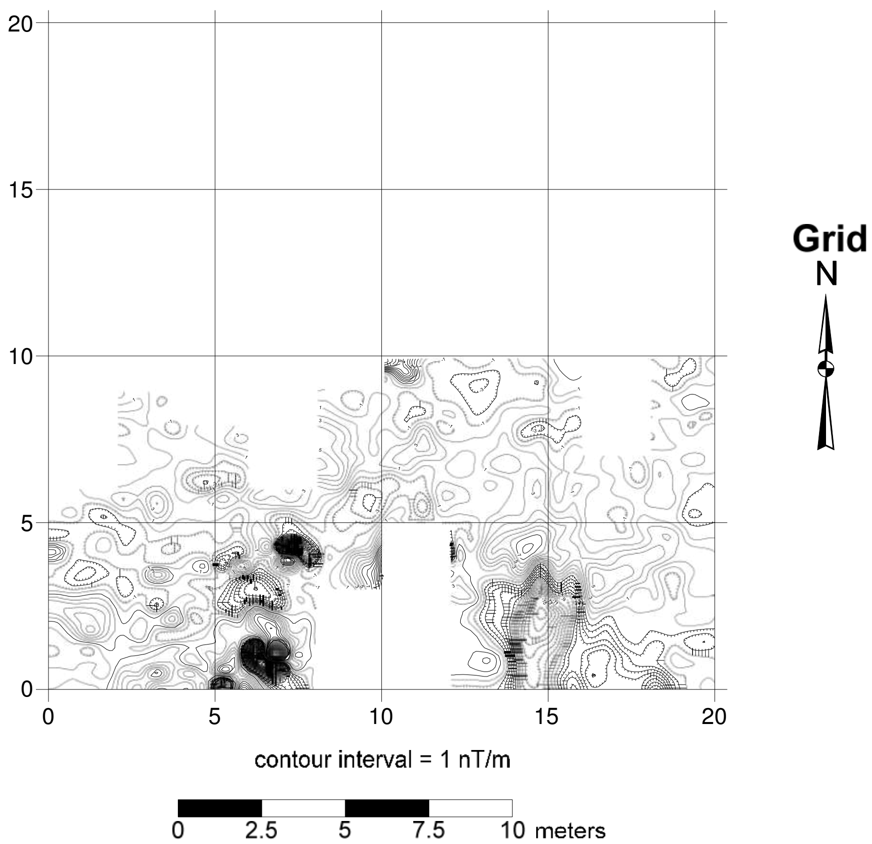

20
15
10
5
0
0
5
10
15
20
Grid
N
contour interval = 1 nT/m
0
2.5
5
7.5
10 meters

Figure 17. Image and contour plots of the magnetic data from Area C.

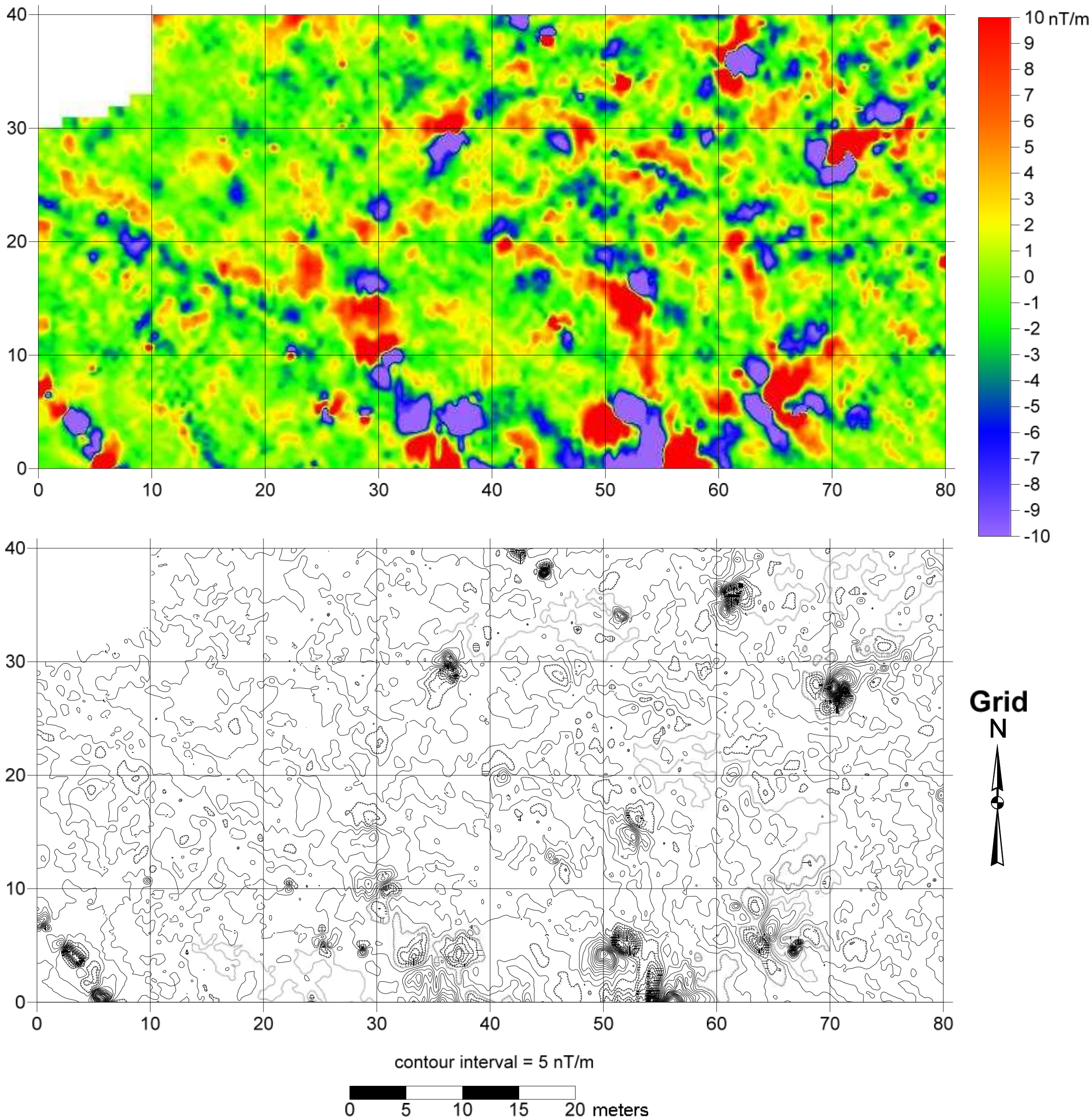


Figure 18. Image and contour plots of the magnetic data from Area D.

Figure 19. Demonstrating the use of the electromagnetic induction meter for conductivity surveying (view to the north).

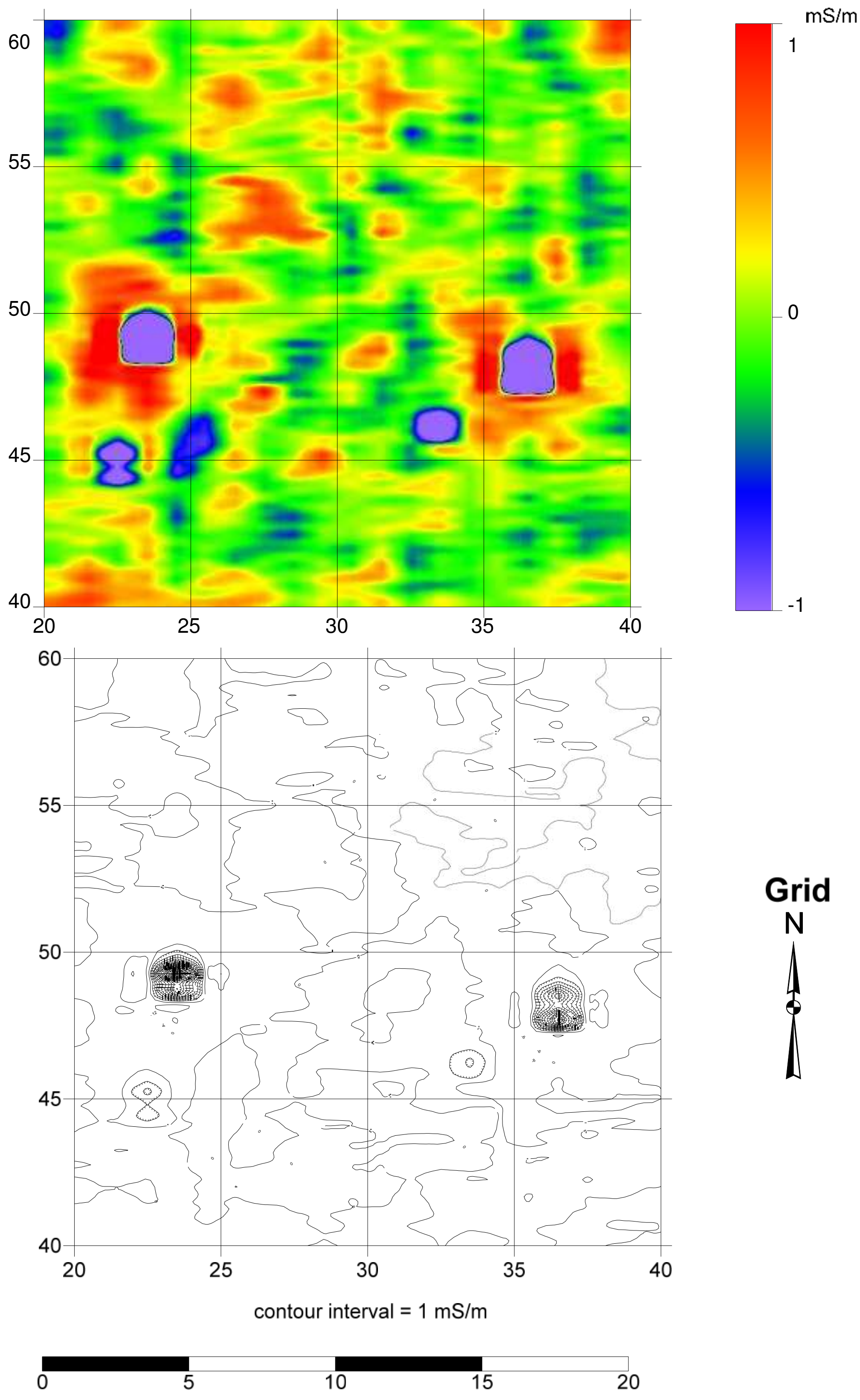


Figure 20. Image and contour plots of the conductivity data from Grid Unit N40/E20 in Area A.

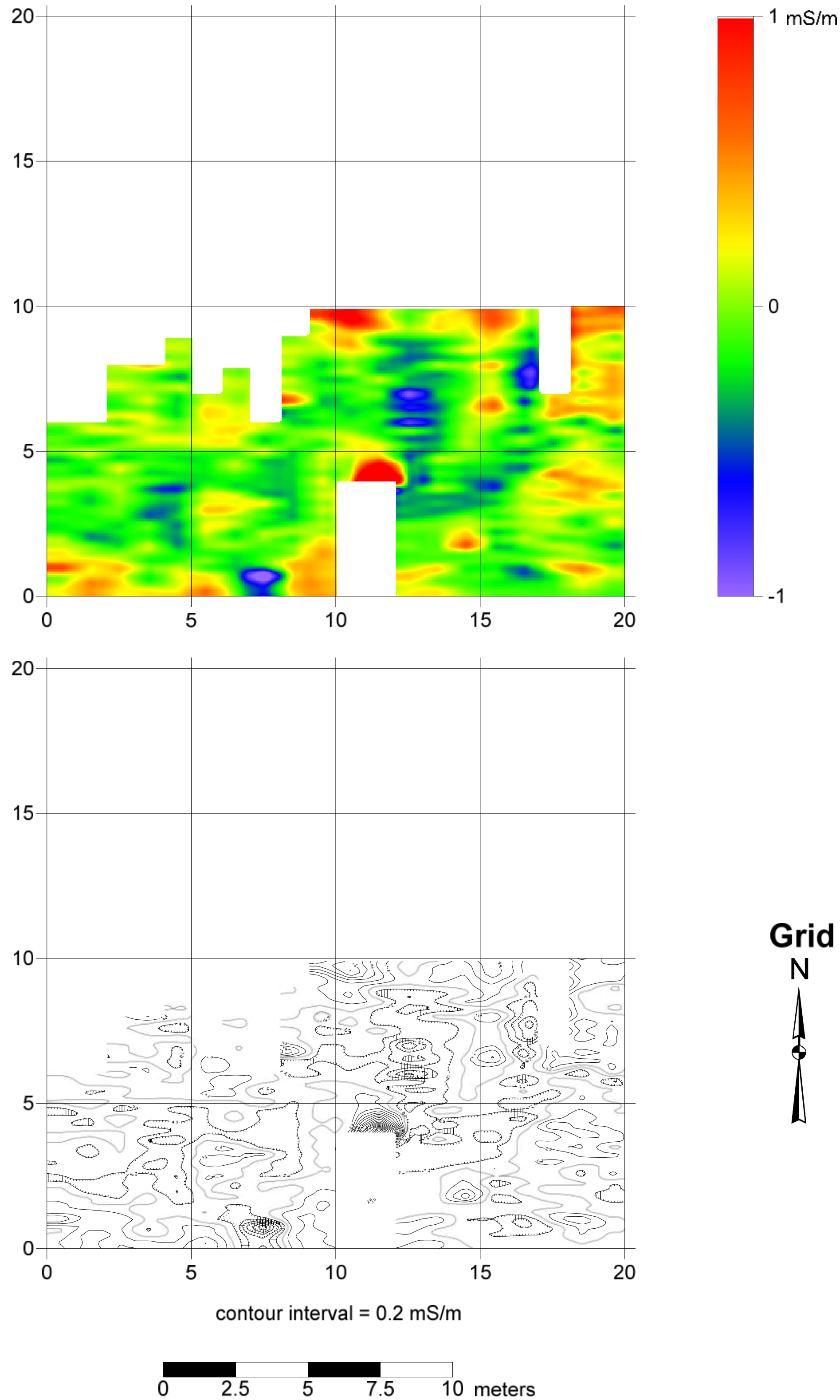


Figure 21. Image and contour plots of the conductivity data from Area C.

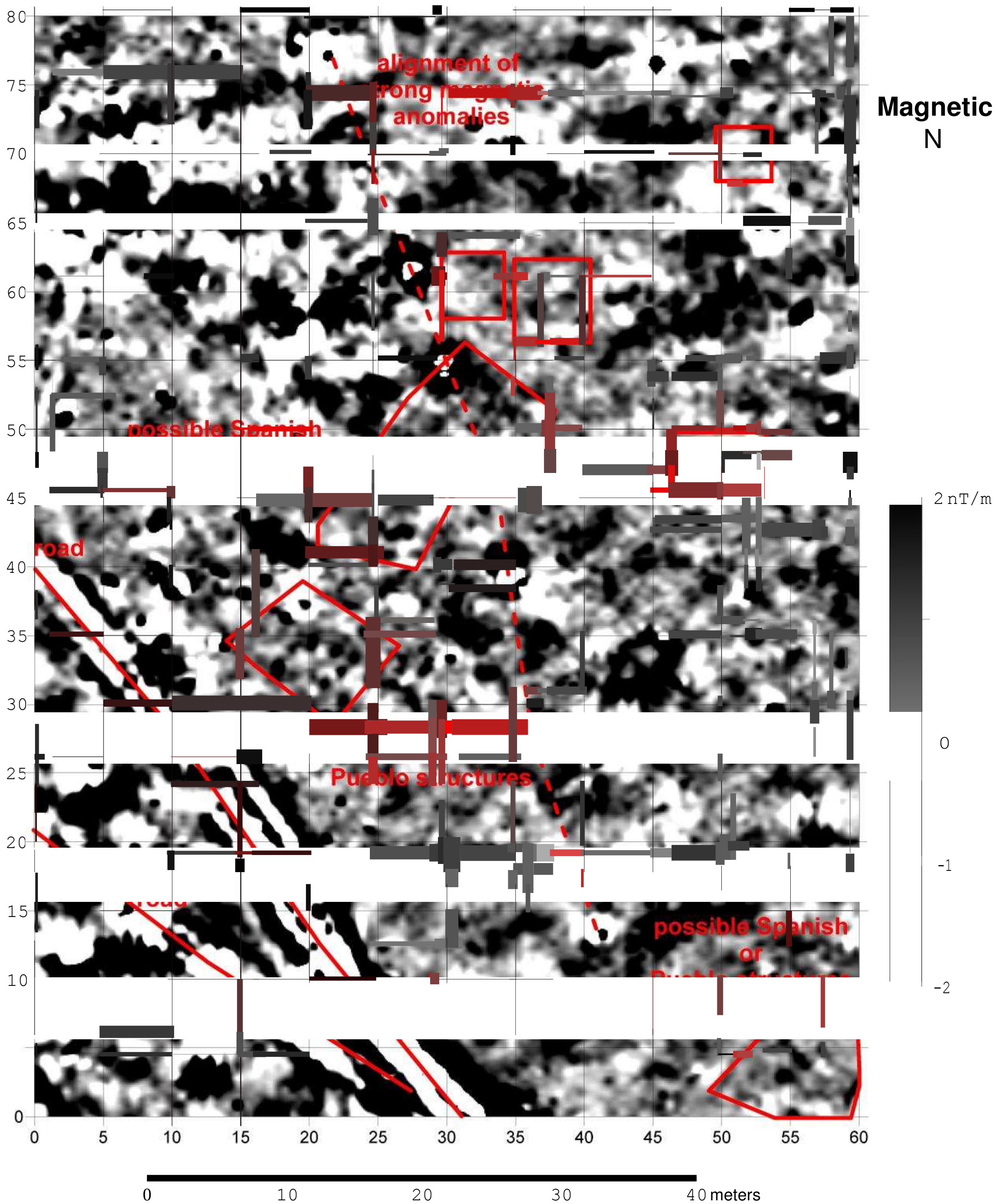


Figure 22. Interpretation of the magnetic data from Area A.

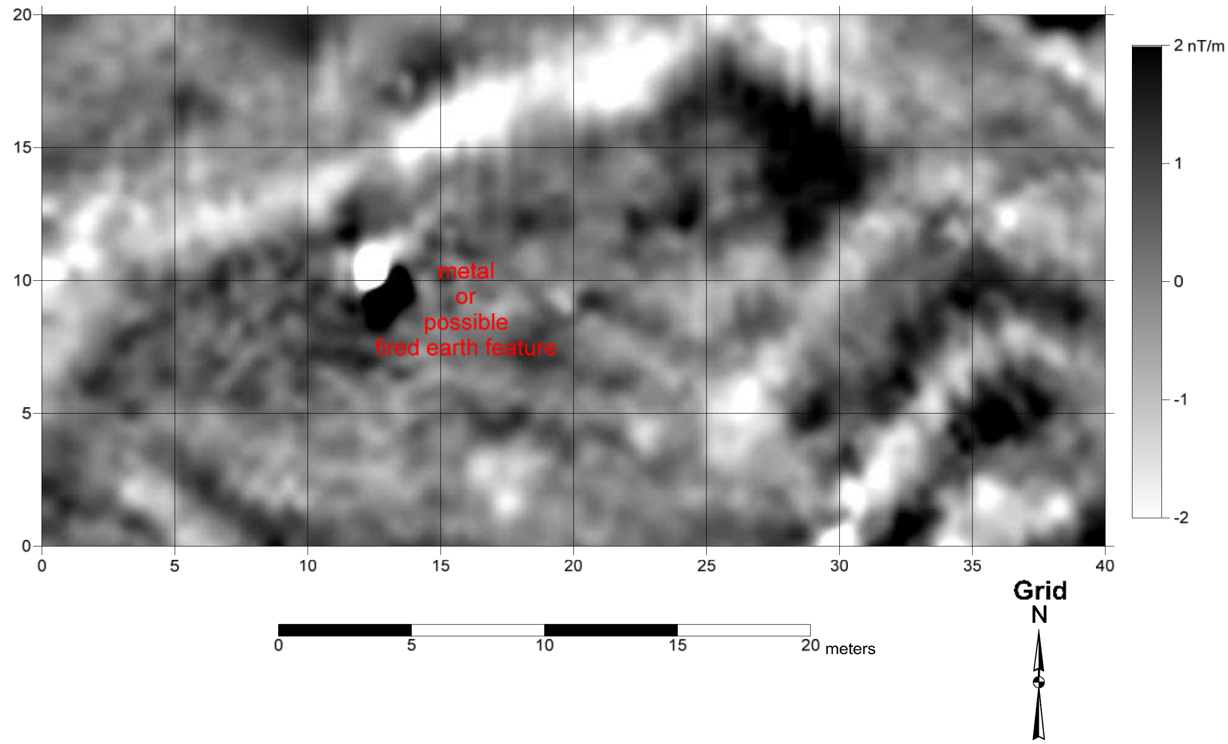
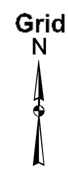


Figure 23. Interpretation of the magnetic data from Area B.



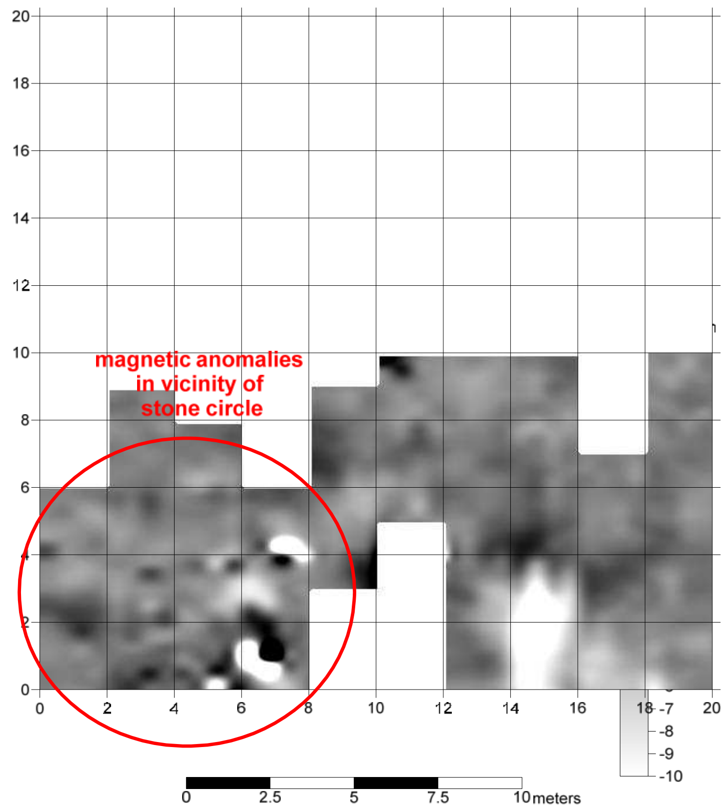


Figure 24. Interpretation of the magnetic data from Area C.

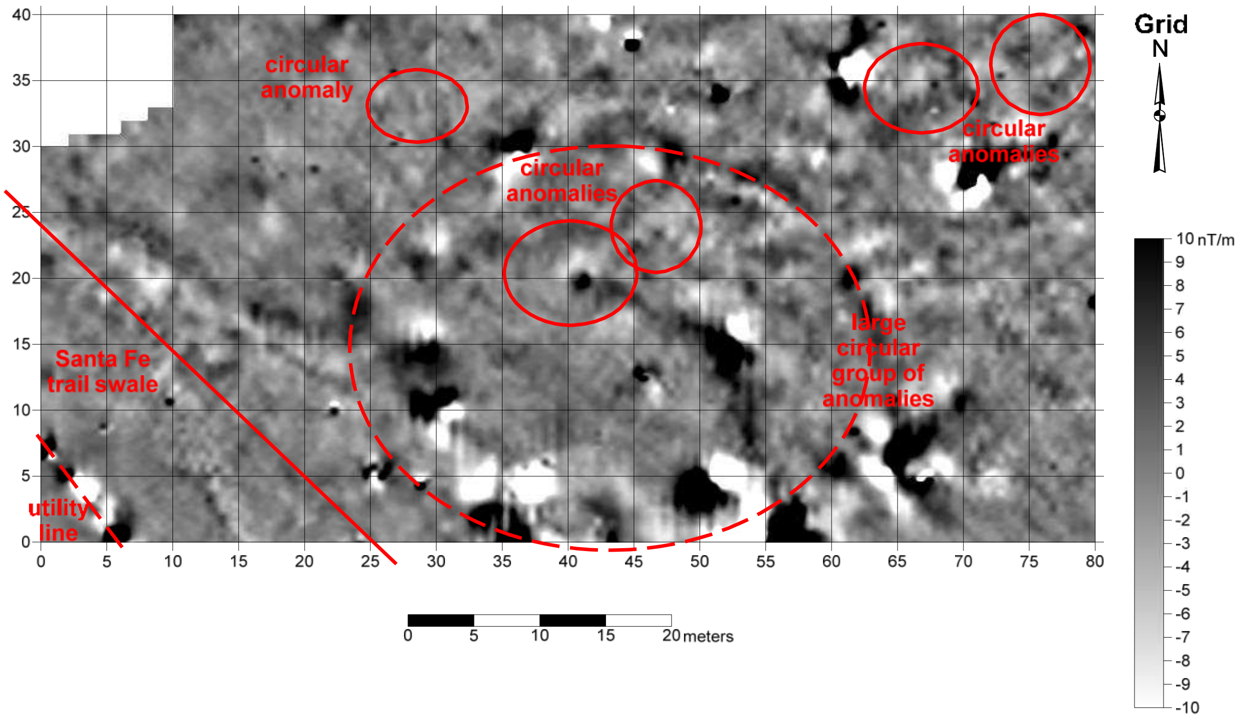


Figure 25. Interpretation of the magnetic data from Area D.

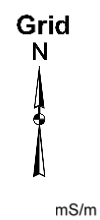
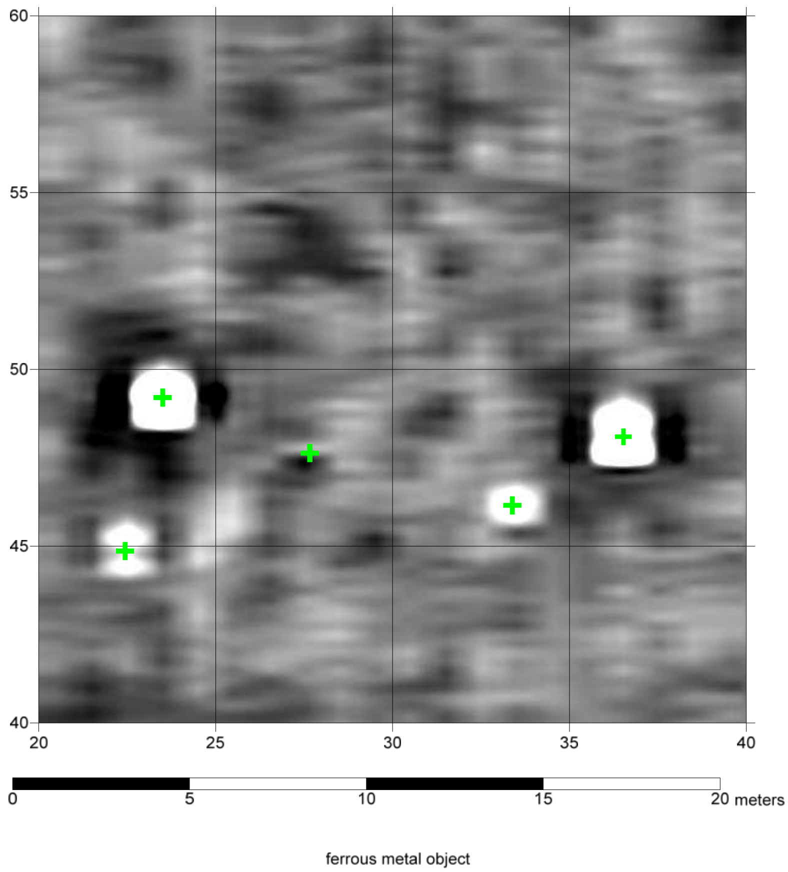


Figure 26. Interpretation of conductivity data from Grid Unit N40/E20 in Area A.



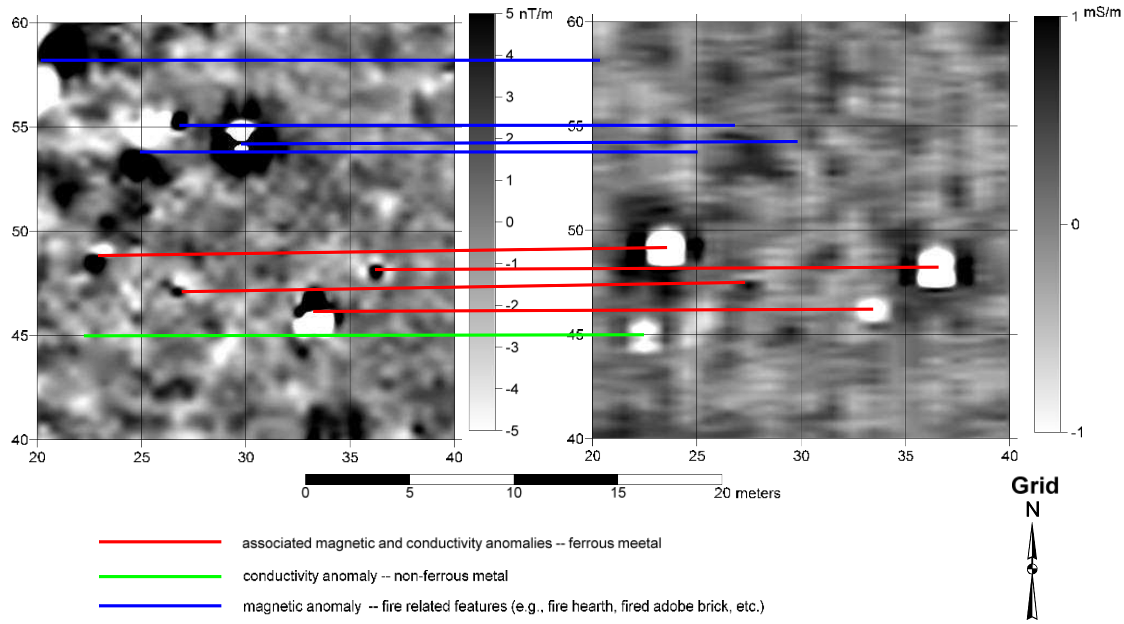


Figure 27. Comparison of magnetic and conductivity data from Grid Unit N40/E20 in Area A.

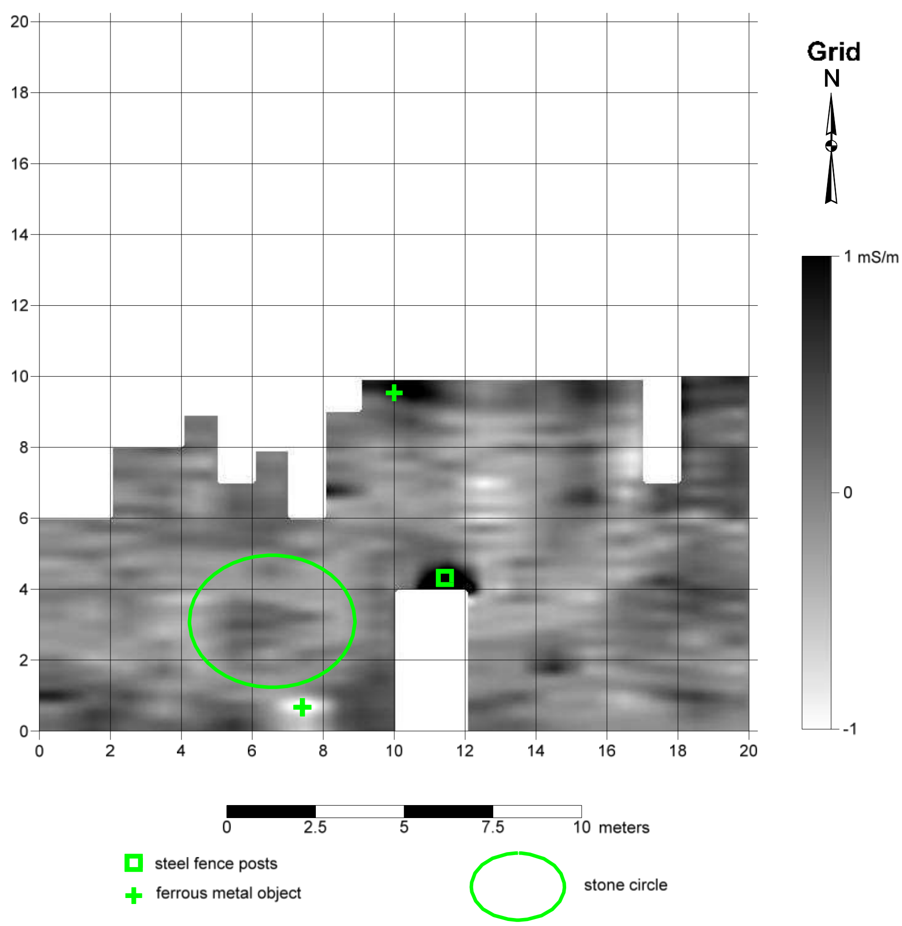


Figure 28. Interpretation of conductivity data from Area C.

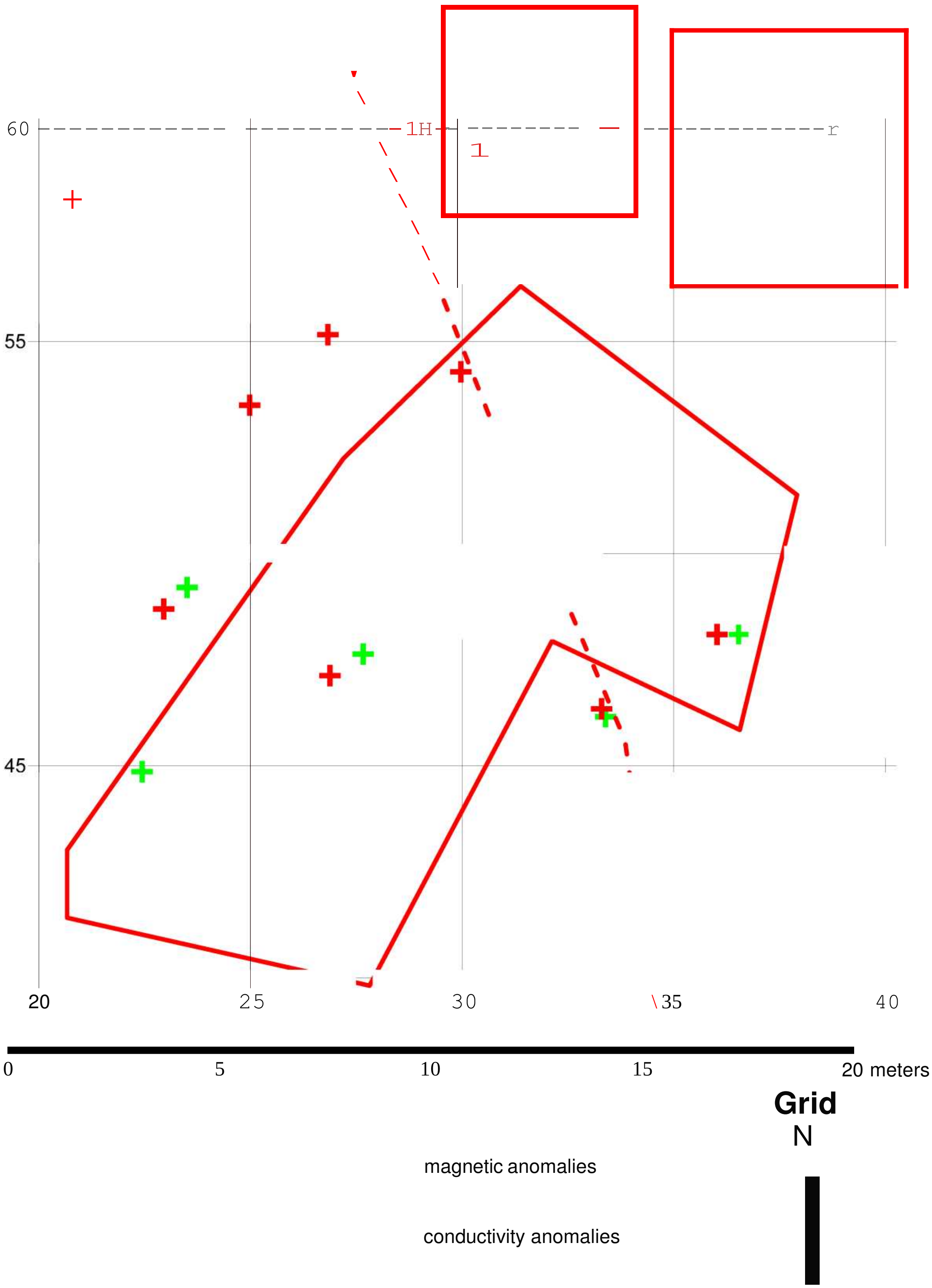


Figure 29. Combined geophysical survey data from the Grid Unit N40/E20 in Area A

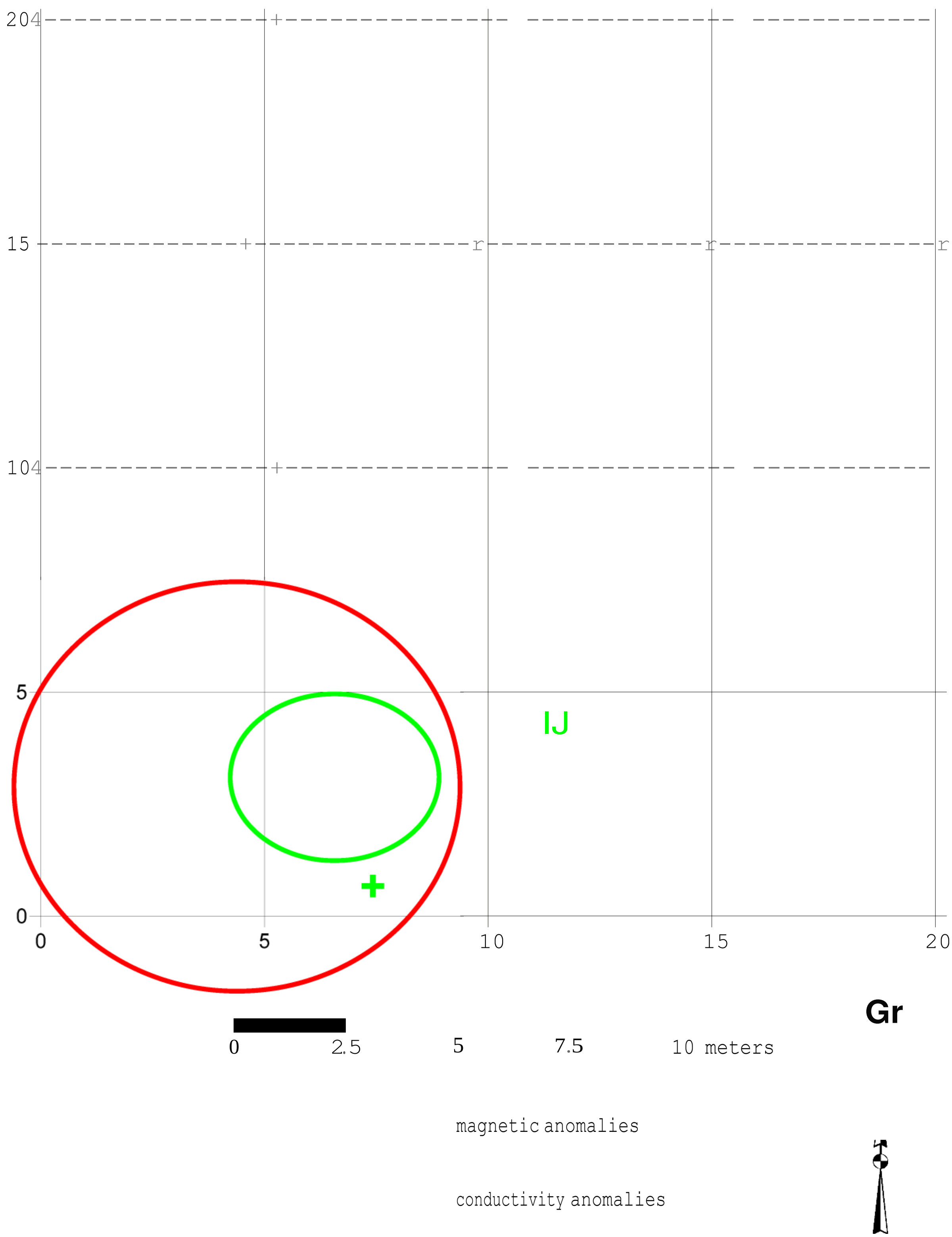

204
15
104
5
0
0
5
10
15
20
IJ
Gr
0
2.5
5
7.5
10 meters
magnetic anomalies
conductivity anomalies

Figure 30. Combined geophysical survey data from Area C.