Metal Detector Use in Archaeology: An Introduction
Author(s): Melissa Connor and Douglas D. Scott
Reviewed work(s):
Source: *Historical Archaeology*, Vol. 32, No. 4 (1998), pp. 76-85
Published by: Society for Historical Archaeology
Stable URL: http://www.jstor.org/stable/25616646
Accessed: 30/03/2012 14:31

MELISSA CONNOR
DOUGLAS D. SCOTT

Metal Detector Use in Archaeology: An Introduction

ABSTRACT

Metal detectors are simple, effective, and inexpensive remote sensing tools with real value to archaeologists. The archaeologists is presented an overview of how to use a metal detector and outlines the physical principles that govern metal detectors and their limits. Examples of the use of detectors in inventory, testing, and excavation are drawn from the literature and from the authors' experience.

Introduction

Many archaeologists are familiar with "detector scat"—the small holes and divots that result when an artifact collector clandestinely digs a metal detector target. This association of metal detecting with artifact hunters has almost made the metal detector synonymous with site looting and is perhaps one of the primary reasons why metal detectors have been under-utilized by professional archaeologists. To paraphrase a popular slogan, metal detectors do not collect artifacts, people do. Metal detectors are inexpensive and effective remote sensing devices that should become part of the basic tool kit of archaeologists working at sites where metal artifacts are likely to be a part of the site assemblage. The primary difference between relic collecting and site looting, as opposed to the use of metal detectors as legitimate archaeological tools is simply the manner of application. Metal detectors find metal objects just as shovel tests or test units might be used to discover a site's content, depth, or boundary. The detector, like the shovel, is not a bad thing; it is how it is used. In archaeological applications the metal detector inventory process, coupled with precise and accurate recording techniques to be described, is very similar to the well-accepted routine shovel test field survey technique.

Today, the use of non-destructive and non-intrusive methods of archaeological investigation is ingrained in the discipline, and archaeologists have turned increasingly to methods of remote sensing for initial site investigation. This work presents a brief introduction to the metal detector as a remote sensing archaeological tool, including how it works and specific archaeological applications.

Although today's metal detectors are simple enough for children to operate, they are very effective research tools that have been used more frequently by archaeologists than published reports would suggest. One of the earliest documented examples of the use of metal detectors was by military historian Don Rickey (1958) who employed one to locate firing lines at the Little Bighorn and Big Hole Battlefields in Montana, and Rickey also assisted Smithsonian Missouri River Basin Survey Archeologist Robert Bray (1958) in using a detector to augment visual survey in mitigating the effects of construction of a blacktop path at the Reno-Benteen Defense Site of the Battle of the Little Bighorn. Two other documented cases of metal detector use on archaeological sites occurred in the 1960s and serve to illustrate the point that the metal detector is not an unknown quantity to archaeologists. In one case amateur archaeologist, Stanley Landis, located and documented features of the Revolutionary War Continental Army campsite at Valley Forge (Parrington et al. 1984:130-131). The second identified use was during archaeological investigations at the site of the Battle of San Jacinto, Texas (Frank Hole 1994, pers. comm.). In the 1970s reported uses of metal detectors include an attempt to locate the 1846 Mexican War battlefield of Palo Alto, Texas (Baxter and Killen 1976) and use by the University of Winnipeg's (Stienbring 1970; Iwacha 1979) search for prehistoric copper sites in Canada's Great Lakes region.

Reported use of detectors increased during the 1980s and 1990s, with most archaeological uses of metal detectors concentrating on historic battlefields. A major project involving detectors

Historical Archaeology, 1998, 32(4):76–85.

was completed at the Little Bighorn Battlefield, Montana in 1984 and 1985 (Scott and Fox 1987; Scott et al. 1989; Scott 1991, 1994). Detectors were also used on the 1846 Palo Alto, Texas battleground (Haecker 1994), during two separate investigations at the 1867 Wagon Box Fight Site in Wyoming (Miller et al. 1997; Reiss and Scott 1984), the K-H Butte Site in Arizona, an Apache War battle site dating from 1881 (Ludwig and Stute 1993), at the 1879 Cheyenne Outbreak site at Fort Robinson, Nebraska (McDonald et al. 1991), at the American Revolutionary War battlefield of Monmouth, New Jersey (Sivilich 1996), and at Mine Creek Civil War Battlefield in Kansas (Lees 1994), among others. Detectors were also used successfully at non-battle-related sites in the United States by Dickens and Bowen (1980) and Lees (1984), in England (Gregory and Rogerson 1984), in Canada (McLeod 1985), and recently on Romanian and Russian Bronze and Iron Age sites (Hap Hendrickson 1996, pers. comm.).

Recently Dobison and Denison (1995) conducted a comprehensive assessment of metal detecting and archaeology in the United Kingdom. They found that literally tens of thousands of new finds are made by detectors each year in England. They concluded that metal detectors can be used for good or ill, but with proper controls their value far outweighs the negatives associated with their use in archaeological sites. One result of their study was the passage of a new Treasure Act Code of Practice in 1996 that establishes guidelines on reporting finds, seeking the advice of archaeologists and museum personnel, and defines general government policy relating to the hobby of metal detecting.

Hardesty (1997) successfully used conventional visual inventory and testing techniques coupled with metal detector sweeps to locate and study one of the sites of the 1846 winter camp of the famed Donner Party. These and other archaeological investigations utilizing metal detectors have demonstrated that when coupled with traditional visual survey methods, shovel probes, and test excavations, metal detectors are valuable tools. They can aid in establishing the metallic debris distribution at a site which may assist the archaeologist in establishing site boundaries, locating buried trash deposits, and locating buried structural remains.

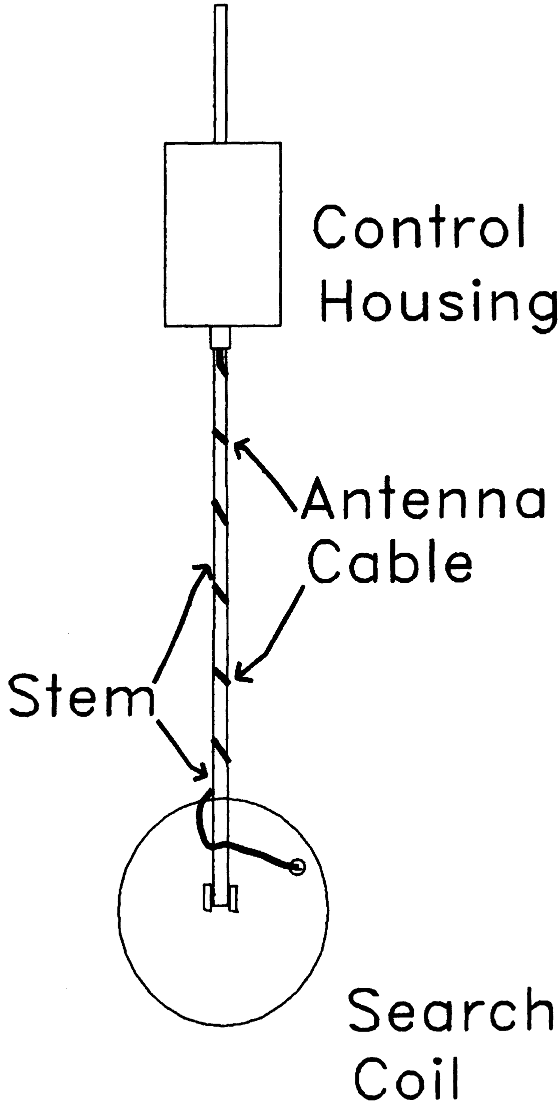
Recently several metal detector projects, utilizing volunteers, were conducted under the auspices of the U. S. Forest Service to assist in identifying the location of historic trails. In one case, portions of General Alfred Sully's 1863 movement through the Dakota badlands and General George Custer's trail through the same area in 1874 were investigated using metal detectors (Richard Fox and William Kurtz 1994, pers. comm.). Segments of the Santa Fe Trail on the Comanche National Grasslands in Colorado have also been surveyed using metal detectors (U. S. Forest Service 1993) and they were used as part of National Historic Preservation Act compliance activities related to the construction of a new local headquarters facility on the site of a Civil War camp in Missouri (Clark 1995). Previous investigations at this Union campsite, including shovel testing, failed to recover Civil War era artifacts that were subsequently found with systematic metal detecting of the impact area. Most recently, one of the Texas campsites of the 1540 Spanish entrada on to the Great Plains led by Coronado, has been found and confirmed by metal detecting (Donald Blakeslee 1997, pers. comm.).

These and other examples of investigations employing metal detectors as archaeological tools demonstrate the investigation of virtually any archaeological site containing metal artifacts can benefit from the use of metal detectors. Metal detectors can be used to identify sites even when no surface evidence exists (Scott et al. 1989; Adams 1991; Dowdy 1992). They can help determine site boundaries by establishing the extent of metallic debris associated with an occupation. When used in a systematic manner they can be used to find artifacts that may be easily missed using systematic shovel testing programs, and metal detectors can be used to study metallic artifact distribution patterns across a site without resorting to expensive and time consuming formal excavation units. Metal detectors can aid in planning testing and excavation strategies, because they can locate buried individual metallic artifacts or concentrations of metallic artifacts thus providing information to supplement inventory data and documentary evidence that are regularly used in planning excavations.

A good example of the value of metal detectors is our work at the site of the Battle of the Little Bighorn, Montana (Scott et al. 1989). The surface of the nearly 800 acre (320 hectare) National Park and some 400 acres (160 hectares) of Crow tribal and private lands were intensively inventoried using standard transects and visual techniques. Less than 10 metal artifacts were seen on the ground surface even though a wild fire had literally consumed the vegetation and exposed the ground surface. Intensive systematic metal detecting recovered over 5000 artifacts. To cover the same area using a 10 m (32 ft.) shovel testing interval would require 45,500 shovel test units, and at a 5 m (16 ft.) interval 91,000 units would need to be dug. Applying this hypothetical computerized array of shovel test units spaced at 5 and 10 m intervals over the map of the metal detected finds demonstrates that less than 1% of the recovered metal targets would have been found using conventional shovel testing techniques. Had systematic shovel testing been employed the 10 weeks of field work required for the metal detecting inventory would have been wholly inadequate to complete the work and would have yielded less than 50 artifacts.

Geophysical Principles

A metal detector is one of the least expensive geophysical instruments. Working on the same principles as the magnetometer, the detector reacts to the electrical conductivity of objects (Garrett 1985; Heimmer 1992). All metal detectors work on the same general principle and the basic configuration includes a handle, search coil, cable, and a metal box that houses the battery and tuning apparatus (control housing) (Figure 1).



1. A schematic of a metal detector with its principal elements identified.

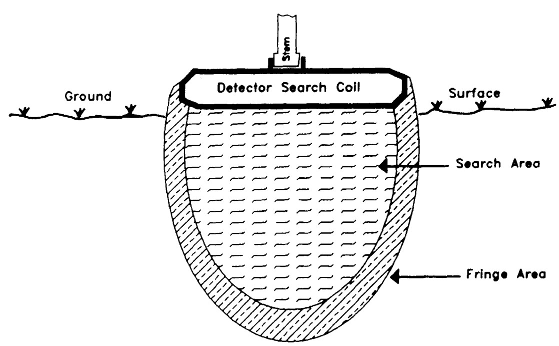
The search coil contains a flat, circular coil of wire (antenna) that generates an electromagnetic field. When metallic objects are near this coil, an electrical eddy current is created which is detected by the unit and converted to a visual digital or analog representation, and/or emitted as an audible signal. Search coils come in a variety of sizes. The electromagnetic field produced by the search coil, held at ground surface, penetrates the earth in a cone shape emanating downward from the coil (Figure 2). In effect, the larger the coil, the greater the electromagnetic field, and the deeper buried artifacts can be detected. The coil must be swung over the ground surface in a back-and-forth motion with each pass slightly overlapping the previous pass to achieve maximum coverage due to the cone effect of the electromagnetic field (Figure 3). Smaller coils are light weight and easier to use, but penetrate less deeply. The 8 in. (20 cm) and 10 in. (25 cm) coils are popular compromises between the desire for depth and practicality. These coils will reliably detect to a depth of 12 to 14 inches (30 to 36 cm). Smaller coils are useful for precisely locating artifacts (pinpointing), and are most efficient in detecting metallic debris at shallower depths, to about 8 in. (20 cm), than the larger coils. On most machines, coils are interchangeable, and multiple coils can be purchased and used for different purposes such as deep searches or pinpointing targets. For very deep detecting, special two coil (double box) detectors are also available. Their capabilities are limited to finding larger targets or concentrations of metal items at depths around 3 ft. (1 m).

Most search coils can be immersed in fresh water, allowing the metal detector to be used underwater as long as the control housing is not submerged. Artifact retrieval in water is often difficult, as is pinpointing the location of the artifact after it is detected. Specialized detectors that work completely under water are also available and are important tools in underwater archaeology (Koski-Karell 1994). Detectors used in saltwater environments use a pulse-induction technology, as mineralized environments or those with high salt content, such as seawater, foil the operation of conventional conductivity metal detectors.

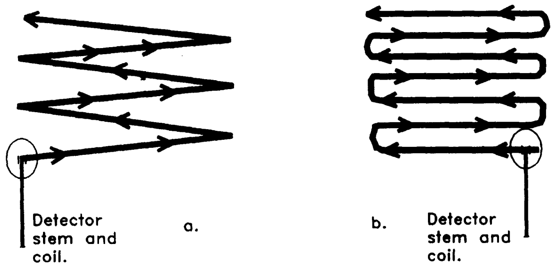
Returning to the detector, the search coil is usually mounted on a metal handle, or stem, which allows the operator to stand upright while swinging the search coil along the ground surface. The handle is adjustable and can be altered to conform to the height of the operator. An electrical cable connects the antenna in the search coil to the control housing and is wound around the stem. It is important to keep the cable wound tightly and securely so that the inductance and capacitance of the cable do not change during use, thereby altering the tuning of the detector.

The control housing contains electronic components and can be carried or worn in a variety of ways depending on the personal comfort of the operator. Most housings attach to the stem of the detector, but during periods of extended use the operator may find it more comfortable to strap the housing around the waist or carry it over the shoulder.

The components within the control housing separate the basic, less expensive machines from the more expensive models, which have more elaborate functions and displays, and exhibit a greater range of discrimination as well as sensitivity to certain types of metallic artifacts. The electromagnetic field that detectors create cause eddy currents to circulate around materials which conduct electricity. Metals differ in their electri-



2. Electromagnetic fields generated by the metal detector.



3. Incorrect (*a*) versus correct (*b*) methods of making a metal detector sweep. The overlapping method allows for the most ground coverage and is the most time and energy efficient technique.

cal conductivity and, in principle, it is possible for a sophisticated detector to determine which buried metal is being sensed. This discrimination function is not always reliable because the shape, size, and orientation of the metallic objects also affect the detector readings. Many detectors can reliably distinguish iron objects from all other metals, however, because iron objects are magnetic as well as good conductors. Some detectors have an electronic display, or an electronic voice, which identifies the type of metal detected, while others can be set to tune to, or to tune out, discriminate, specific metals. Many popular detectors have a "pull-tab" discriminator, that is tuned so that the machine does not respond to aluminum. In most archaeological contexts, the discriminating mode should ***not*** be used since the metal detector will be used to locate all types of metallic debris associated with past events. The presence of pull-tabs can demonstrate modern use of the site and, more importantly, aluminum is near the conductivity range of several other metals so that if instrument tuning is not precise, signals generated by the near-conductive aluminum range metals might be overlooked. It is best to use the metal detector in the all-metal or non-discriminate mode during archaeological site investigations.

Like other remote sensing devices, metal detectors respond to changes in the moisture and metallic content of soils. When a detector is first used in an area, it needs to be tuned (ground-balanced), to the general background level of moisture and metal in the soil. This is usually done by manipulating the tuning knob until a steady, low hum is achieved. Even with proper tuning, false signals may occasionally be generated by mineralized rocks, pockets of metallic or other mineralized soils, or even areas of high moisture, all of which conduct electricity beyond the ground-balanced threshold of the machine. Most detectors manufactured today are self-tuning or ground balanced so that simply turning the machine on while holding the coil at waist level for a few seconds, then placing the coil on the ground surface, will achieve a ground-balance.

Detectors using the same electronic frequency respond to one another by distorting and disrupting each others' signal. Since a single brand of metal detectors often operates on the same electronic frequency, it is necessary to adjust the operating frequency or keep those machines physically separated from one another to eliminate signal distortion. Different detector brands operate on different frequencies, thus alternating brands on a multiple machine transect line will usually eliminate signal overlap problems. This practice is particularly useful in the case of multiple detectors working adjacent to one another along survey transects, for example.

Operation of a metal detector can be learned quickly and easily. As with any tool, the more experienced and skilled the operator, the more efficient the work and the better the results. Since the skill of the operator is one of the most important variables, many successful projects have relied on experienced volunteer detector operators. The volunteers are frequently metal detecting hobbyists who provide their own machines, thus the project benefits from both knowledgeable volunteers and a cost savings. From an altruistic viewpoint, the inclusion of metal detector hobbyists achieves many of the same goals of working with other amateur and avocational archaeologists. The same pitfalls also apply, but the gains in goodwill and public education are considerable.

Metal Detectors in the Field

A successful archaeological metal detector project will require careful planning and adaptation of the methods and techniques to the specific site context. When developing a metal detector survey strategy, operator experience, soil conductivity, and the purpose of the work must be considered. One effective method, but by no means the only useful one, was developed at the Little Bighorn National Battlefield (Scott et al. 1989), and was subsequently improved at Big Hole National Battlefield (Scott 1994) and at the Civil War battlefield of Monroe's Crossroads, North Carolina (Scott and Hunt 1998). This method of survey consists of three sequential operations: metal detecting, artifact recovery, and provienence recording. During metal detecting, metal targets are located and marked. A recovery crew follows and carefully uncovers the objects, leaving them in place. The recording team then plots individual artifact locations, assigns field specimen numbers, and collects the specimens.

Visual inspection of the surface, using traditional survey techniques, can be carried out concurrently with the metal detector survey. A metal detector crew may consist of a crew chief, metal-detector operators, and visual inspectors who also flag the targets found by the detectors.

Detector operators should walk abreast, following transects across the area to be inspected. Maintaining the same crew chiefs for the duration of the project helps to maintain continuity. While walking, the operators use a sweeping motion over the ground making sure their sweeps overlap the preceding one. Coils should be held as close to and as level with the ground as possible to provide maximum vertical and horizontal coverage. Each operator can normally cover an area of roughly 5-6.5 ft. (1.5-2.0 m) with each sweep, depending on the individual's height and technique. The transects can also be varied in width to meet the needs of different sampling approaches, ranging from a random sample to a stratified random sampling (Haecker 1994). The 5-6.5 (1.5-2.0 m) sweep with a 16 ft. (5.0 m) interval between detector operators obtains approximately a 35% sample of a study area (Scott et al. 1989). If necessary, the metal detector operator can cover a site in a series of more closely spaced units in order to cover up to 100% of the site.

Transect orientation can be based on any reasonable parameter, such as grid orientation or cardinal direction, as long as a systematic approach is maintained to achieve the desired coverage. Parallel transects and radial transects worked from a central point are two other methods that have proven successful and effective in meeting different site sampling needs. Crew chiefs or supervisors need to help the operators maintain transect orientation and individual operator interval spacing. A crew of five to eight operators is optimal for rapid areal coverage and supervision purposes, but investigations can be satisfactorily accomplished with only one detector and operator.

Once an operator locates a target the target should be marked for further investigation or mapping. The detector operator will find it difficult to pinpoint a target exactly while burdened with a handful of surveyor's pinflags or other target-marking devices. Using other crew members, flaggers, walking behind the operators and marking the targets as they are found is one means around this issue. The flaggers can also visually examine the ground for surface artifacts, allowing the detector operators to concentrate on their machines. Leaving the target unexcavated or uninvestigated may be the most frustrating part of the operation for the hobbyist detector operator, but if each operator stopped to dig every target, the transect lines quickly lose any semblance of order. Occasionally, however, a location may need to be excavated immediately by the operator so that the operator can properly interpret the sophisticated nuances of machine functions such as depth readings, metallic and object type-discrimination, object size, and accuracy in pinpointing subsurface objects. The usual procedure, however, should be to mark the location and leave it for excavation by the recovery crew.

In dense concentrations of metallic debris it may be necessary to recover the targets located and then re-sweep the area multiple times to recover all the artifacts. The signal from larger metal objects may obscure the signal from other smaller or less dense targets unless the larger targets are removed from the detector field. Metal shafts of surveyor's pinflags can also obscure nearby buried targets, so that a dense field of surveyor's pinflags will affect the number of targets found. Pinflags with fiberglass shafts are available and can be used to eliminate the masking problem found with metal shaft surveyor's pinflags. Fiberglass shaft pinflags, however, are relatively expensive and repeated use tends to abrade and fray the shafts, resulting in a limited lifespan for them. The metal pinflag, despite is drawbacks, is inexpensive and has a long use life.

Recovery crews are constituted to pinpoint and excavate the artifact locations marked by the detector team. The usual procedure is to trowel earth away to expose the artifact using traditional hand tools. No formal excavation unit is necessary, especially at sites, like battlefields, where stratigraphic relationships often do not exist. Traditional excavation techniques can be employed when site stratigraphy, time, and project design require it. Uncovering the flagged target with minimal disturbance is usually adequate for inventory and other levels of initial site investigation. During investigations at the Little Bighorn Battlefield and other sites, nonmetallic objects including leather boots, and animal and human bone were occasionally found in association with metal artifacts. Non-metallic objects likely to be located in association with the metal for any given site should be anticipated before the survey, and plans developed for dealing with them before the situation arises.

The recovery team should also include a metal detector to pinpoint the buried target. A metal detector using a small, 3 to 4 in. (7.5 to 10 cm) diameter coil that allows precise location of the object while still in the ground works best for this task. While some experienced detector operators can predict the object type and depth from the audible signal given out by a machine fitted with a larger coil, excavation time and areal disturbance can usually be saved by using a small coil for pinpointing the artifact. Be aware that wire, nails, bolts, and other elongated objects are notorious for giving ambiguous locational signals.

As with any archaeological investigation, it is essential to record provenience data to allow for later interpretation of artifact patterns. The recording crew may include a transit operator, a rod holder, and personnel to assign field-specimen numbers and bag the finds. The recording crew also backfills the excavated holes. The projects completed by the authors used total stations (combined transits and electronic distance meters) and electronic data collectors to record location and attribute data. Field point provenience data, topographic points, and other relevant data were entered into a Sokkia SDR33 data collector, although a handwritten field catalogue was also kept by a member of the recording crew as a backup. The electronic catalogue was transferred from the SDR33 to a laptop computer on a daily basis. The Sokkia MAP program and Autodesk AutoCad programs were used for displaying the mapping data. This procedure can be adapted to individual projects.

Conclusion

Metal detectors can aid in the recovery of archaeological information from almost any site containing metal. Without excavation, by simply detecting a site and flagging "targets," the archaeologist can easily examine the distribution and varying density of metal artifacts within a site. This can aid in identifying intra-site spatial patterning and in establishing site boundaries. In shallow, unstratified historic sites, which are common in the western United States, the targets can be excavated and a sample of temporally and functionally diagnostic material quickly and inexpensively obtained. This can also be done within a structure or where structural remains are present, the detector can be used to quickly obtain information on age and function.

The primary values of metal detector use on sites where metal artifacts may be present are: 1.) metal detectors are a relatively inexpensive remote sensing tool; 2.) they are most useful for locating shallowly buried (10-12 in. [25-30 cm]) metal objects; 3.) they can be used in a relatively non-intrusive manner; 4.) they are easy to learn to use and operate, although using experienced hobbyists is usually preferable when they are available; and 5.) they are very cost efficient relative to the high cost of shovel testing or digging test units. The metal detector can be used to determine site boundaries as long as they are used in a systematic manner. Systematically employed, the detector can be used to provide a variety of information on metallic density across a site that may be useful for assessing potential structure locations and concentrations that may represent trash deposits. Metallic density distributions may be useful in assessing a site's potential to yield information for legal compliance with Section 110 or Section 106 of the National Historic Preservation Act. Detectors may also be useful in planning larger scale excavations for both research and cultural resource management-related activities.

Metal detectors are tools that have real value to archaeologists. Used in a supervised, systematic, and controlled manner, metal detectors can aid the professional archaeologist in achieving site documentation, research and cultural resource management goals, and identifying metallic artifact patterns and associations. The detector should become a regular part of the tool kit of any archaeologist who investigates historical sites.

ACKNOWLEDGEMENT

Irwin and Riva Lee are responsible for opening our eyes to the archaeological potential of metal detectors and generously sharing their knowledge of the machines with us. We also thank William Lees, William Adams, Steven Potter, Robert Sonderman, Clark Davenport, Charles Haecker, and other colleagues, who shared their experiences in using detectors and offered suggestions for improving the technique. Comments by Bruce Bevan, Judy Tordoff, SHA Associate Editor, and three anonymous *Historical Archaeology* reviewers significantly aided us in strengthening our information and presentation.

REFERENCES

ADAMS, WILLIAM HAMPTON, AND KEITH GARNETT
1991 The Historical Geography of Fort Yamhill. In *Fort Yamhill: Preliminary Historical Archaeological Research Concerning the 1856-1866 Military Post*, edited by William Hampton Adams, pp 35-58. University of Oregon, Corvallis.

BAXTER, EDWARD P., AND KAY L. KILLEN
1976 *A Study of the Palo Alto Battleground Cameron County, Texas*. Anthropology Laboratory Report 33, Texas A&M University, College Station.

BRAY, ROBERT
1958 A Report of Archaeological Investigations at the Reno-Benteen Site, Custer Battlefield National Monument, June 2 to July 1. Manuscript, Midwest Archeological Center, Lincoln, NE.

CLARK, CAVEN P.
1995 Archeological Investigations at Camp Lincoln (23CT355), Carter County, Missouri. Report, Ozark National Scenic Riverways, National Park Service, Van Buren, MO.

DICKENS, ROY S., AND WILLIAM R. BOWEN
1980 Problems and Promise of Urban Historical Archaeology: The Marta Project. *Historical Archaeology* 14:42-57.

DOBISON, COLIN, AND SIMON DENISON
1995 Metal Detecting and Archaeology in England. English Heritage and Council for British Archaeology, London and Walmgate, York, England.

DOWDY, WILLIAM P.
1992 A Spatial Distribution Study in the Fort Jefferson Research Area, with an Assessment of the Utility of a Metal Detector as a Research Tool. Honors Thesis, Murray State University, Murray, KY.

GARRETT, CHARLES L.
1985 *The Advanced Handbook on Modern Metal Detector,* first edition. Ram Books, Dallas, TX.

GREGORY, T., AND J. G. ROGERSON
1984 Metal-detection in Archaeological Excavation, *Antiquity* 58(224):179-184.

HAECKER, CHARLES
1994 A Thunder of Canon: Archeology of the Mexican-American War Battlefield of Palo Alto. *Southwest Cultural Resources Center Professional Papers* No. 52. Division of Anthropology and History, Southwest Regional Office, National Park Service, Santa Fe, NM.

HARDESTY, DONALD L.
1997 *The Archaeology of the Donner Party.* University of Nevada Press, Reno.

HEIMMER, DON H.
1992 Near-Surface High Resolution Geophysical Methods for Cultural Resource. *Management and Archaeological Investigations.* National Park Service, Denver, CO.

IWACHA, HENRY
1979 The Use of Metal Detectors in Archaeology. *Manitoba Archaeological Quarterly* 3(2):13-16.

KOSKI-KARELL, DANIEL
1994 Discoveries and Site Evaluations: Underwater Archaeological Investigations of Three Bridge Project Areas from the Delaware Route 1 Corridor, Kent County, Delaware. *Delaware Department of Transportation Archaeology Series* No. 112. Dover.

LEES, WILLIAM B.
1984 *Results of an Archaeological Evaluation of a Proposed Maintenance Building Location, Fort Larned National Historic Site, Pawnee County, Kansas.* Office of Archaeological Research, Museum of Anthropology, University of Kansas, Lawrence.
1994 When the Shooting Stopped the War Began. In *Look to the Earth Historical Archaeology and the American Civil War,* edited by Clarence R. Geier, Jr. and Susan E. Winter, pp 39-59. University of Tennessee Press, Knoxville.

LUDWIG, LARRY L., AND JAMES L. STUTE
1993 *The Battle at K-H Butte: Apache Outbreak-1881: Arizona Territory.* Western Lore Press, Tucson.

MCDONALD, J. DOUGLAS, LARRY J. ZIMMERMAN, A. L. MCDONALD, WILLIAM TALL BULL, AND TED RISING SUN
1991 The Northern Cheyenne Outbreak of 1879: Using Oral History and Archaeology as Tools of Resistance. In *The Archaeology of Inequality,* edited by Randall H. McGuire and Robert Paynter, pp 64-78. Blackwell, Cambridge, England.

MCLEOD, K. DAVID
1985 Metal Detecting and Archaeology: An Example from EbLf-12. *Manitoba Archaeological Quarterly* 9(2):20-31.

MILLER, MARK E., JEFFERY HAUFF, AND DANNY N. WALKER
1997 Historical Archaeology at the Wagon Box Battlefield (48SH129) Sheridan and Johnson Counties, Wyoming. Office of the Wyoming State Archaeologist, Division of Cultural Resources, Division of State Parks and Historic Sites, Wyoming Department of Commerce, Laramie.

PARRINGTON, MICHAEL, HELEN SCHENCK, AND JACQUELINE THIBAUT
1984 The Material World of the Revolutionary War Soldier at Valley Forge. In *The Scope of Historical Archaeology, Essays in honor of John L. Cotter,* edited by David Orr and Daniel G. Crozier, pp 125-162, Occasional Publications of the Department of Anthropology, Temple University, Philadelphia, PA.

REISS, DAVID, AND SKYLAR S. SCOTT
1984 Archaeological and Historical Investigations at the Wagon Box Fight, Sheridan County, Wyoming. *Wyoming Archaeologist* 27(3-4):57-78.

RICKEY, DON
1958 Administrative History of Custer Battlefield National Monument, Crow Agency, Montana. Manuscript, Little Bighorn National Monument, Crow Agency, MT.

SCOTT, DOUGLAS D.
1991 Archaeological Investigations at the Reno-Benteen Equipment Disposal Site. In Papers on Little Bighorn Battlefield Archaeology. *Reprints in Anthropology,* 42:1-183. J & L Reprint Co., Lincoln, NE.
1994 A Sharp Little Affair: The Archaeology of Big Hole Battlefield. *Reprints in Anthropology,* 45. J & L Reprint Co., Lincoln, NE.

Scott, Douglas D. and Richard A. Fox, Jr.
1987 *Archaeological Insights into the Custer Battle*. University of Oklahoma Press, Norman.

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.

Scott, Douglas D., and William J. Hunt
1998 *The Archeology of the Monroe's Crossroads Battle, Fort Bragg, North Carolina*. Southeast Archeological Center, National Park Service, Tallahassee, FL.

Sivilich, Daniel M.
1996 Analyzing Musket Balls to Interpret a Revolutionary War Site. *Historical Archaeology* 30(2):101-109.

Steinbring, Jack
1970 Evidences of Old Copper in a Northern Transition Zone. In *Ten Thousand Years, Archaeology in Manitoba*, edited by Walter M. Hadly, pp 47-45. Manitoba Archaeological Society, Winnipeg.

U. S. Forest Service
1993 Windows on the Past: Accomplishment Report, Rocky Mountain Region Heritage Team 1993. Rocky Mountain Region, U. S. Forest Service, Denver, CO.

Melissa Connor
Douglas D. Scott
Midwest Archeological Center
National Park Service
Federal Building, Room 474
100 Centennial Mall North
Lincoln, NE 68508