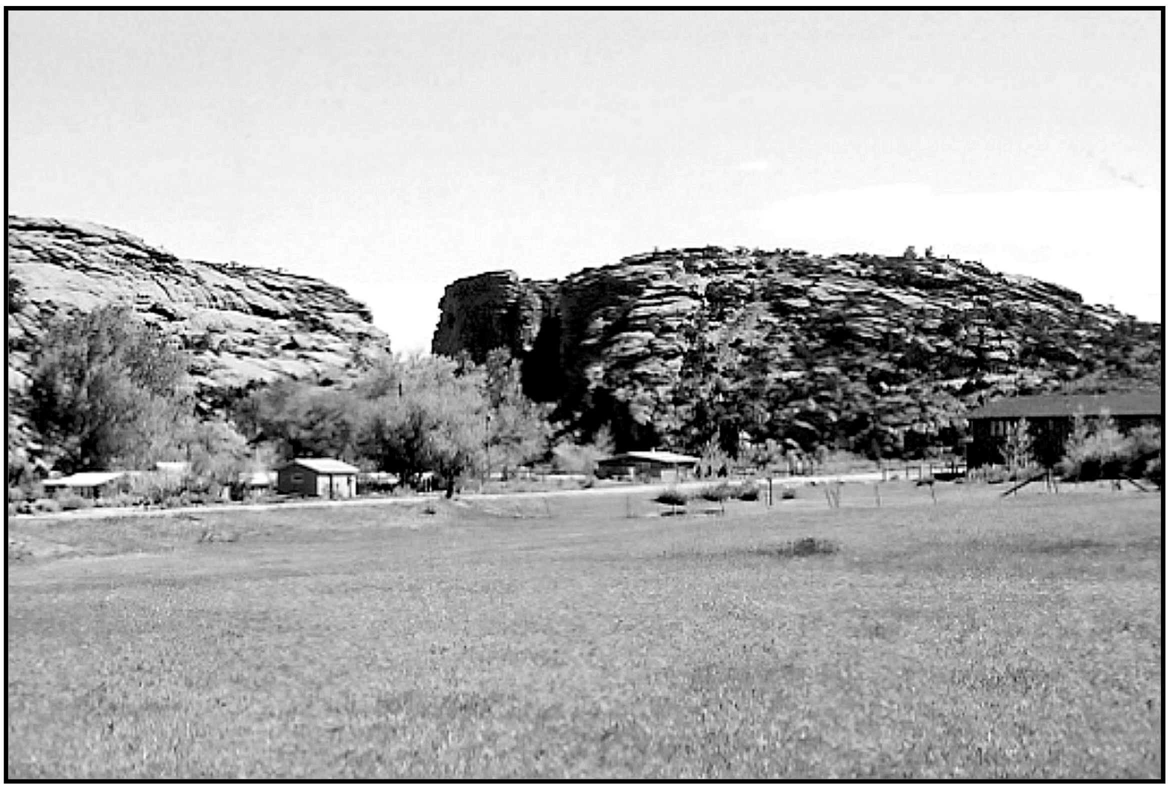
Magnetic Gradient Survey of Seminoe's Fort on the Tom Sun Ranch Along the Oregon and California National Historic Trails, Natrona County, Wyoming



National Park Service – Midwest Archeological Center

Magnetic Gradient Survey of Seminoe's Fort on the Tom Sun Ranch Along the Oregon and California National Historic Trails, Natrona County, Wyoming

By

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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 the report available meets the criteria of 43CFR Part 7, Subpart A, Section 7.18 (a) (1).

Abstract

Seminoe's Fort was a trading post along the California, Mormon Pioneer, and Oregon National Historic Trails near Devils Gate in southwestern Natrona County, Wyoming, which was used in various ways from 1852 to 1857. Over the decades since the abandonment and destruction of the fort, the exact location of the small trading post, designated 48NA288, was lost in the memory of the American people.

The National Park Service's Long Distance Trail Office in Salt Lake City requested the Midwest Archeological Center and the Wyoming State Archaeologist's Office to identify the location of the trading post using geophysical investigation techniques. Midwest Archeological Center staff conducted geophysical investigations at the Tom Sun Ranch between May 22 and May 26, 2001. Two techniques were initially identified for the investigations, including a magnetic gradient survey and a resistance or ground conductivity survey; however, due to the flooding of the project area by irrigation waters, the archeological team could only conduct the magnetic gradient survey of the project area.

An area of 14,800 m^2 was initially laid out in a hayfield on the right side of Pete Creek near the Mormon Handcart Visitor Center. The geophysical investigations covered a slightly smaller area due to the presence of Pete Creek and an irrigation ditch. The data from the magnetic gradient survey indicated the location of the trading post, a rectangular area to the southwest of the post, trash dumps associated with the trading post and with more recent ranching activities, as well as several isolated dipole anomalies. The investigations provided substantial information about the trading post's location, layout, and integrity for archeological excavations, which followed in the summer of 2001.

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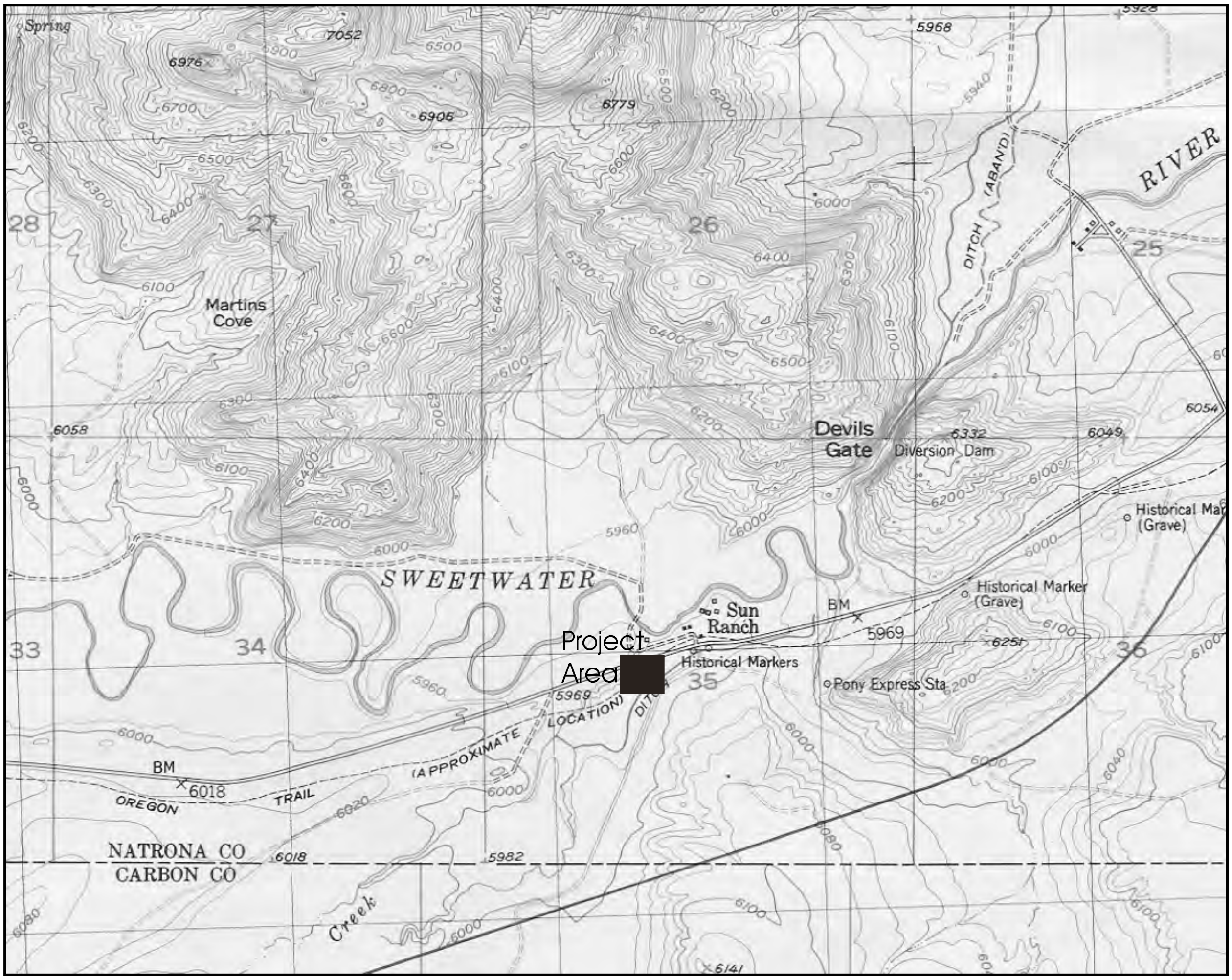

Figure 1. Seminoe’s Fort project area, 48NA288; USGS Independence Rock 7.5-minue quadrangle, photorevised in 1981.

Introduction

Geophysical investigations of Seminoe's Fort, 48NA288, which is also called Fort Seminoe (Geocities 2001), occurred between May 22 and 26, 2001. The National Park Service's Long Distance Trail Office in Salt Lake City, Utah, requested that the Midwest Archeological Center staff provide geophysical investigations of the site. The request was to assist the Wyoming State Archaeologist's staff in their archeological investigations of the trading post along the Sweetwater River near Devils Gate in southwestern Natrona County, Wyoming (Figure 1). Devils Gate (Figure 2), a 370-foot high and 1,500-foot long water gap cut through the Sweetwater Rocks by the Sweetwater River, was a common resting place along the California, Mormon Pioneer, and Oregon National Historic Trails six miles west of Independence Rock (Franzwa 1988:263–265, 1990:134–135, 1999:57; Kimball 1991:91; Stewart 1983:132, 257). The trading post provided supplies and blacksmithing services to the numerous wagon trains that passed by the site in the early to mid-1850s.

Since its destruction in September 1857, the trading post's exact location near Devils Gate was lost to the memory of the American people. However, numerous emigrant diary entries mention the trading post. Even an 1857 survey map of mail stations by Deputy Surveyor Thomas D. Brown shows its location near Devils Gate (Figure 3). The purpose of the present project was to use geophysical techniques to identify the exact site of the trading post's ruins. At the start of the project, National Park Service and the State Archaeologist staff, including Don Balley, Dave Byers, and Gavin Donnelly under the direction of Dr. Danny Walker, planned on using both magnetic and resistivity/conductivity survey techniques to identify and evaluate potential areas mentioned in the historical record. Due to the flooding of the field prior to the start of the survey, only the magnetic survey was completed across the site.

The project area is located near the Mormon Handcart Visitor Center at the Tom Sun Ranch headquarters. The project area is along the right side of Pete Creek in the eastern portion of a large hayfield (Figure 4). Approximately 2 hectares were initially identified for the initial archeological investigations. The project area is bounded on the east by the ranch headquarters boundary fence, on the north by an old blacktop highway section of Wyoming Highway 220, on the west by Pete Creek, and along the south by an irrigation ditch. The Wyoming State Archaeologist's staff planned archeological excavations for the summer of 2001 to provide the Church of Jesus Christ of Latter-Day Saints (often referred to as the Mormon Church) with architectural and archeological data on the trading post's location, layout, and use for a proposed reconstruction project.

Historical Background

Traders Charles LaJeunesse and his partner Chambeau established the trading post and stockade in 1852. LaJeunesse named the trading post Seminoe in memory of his brother Basil Cimineau LaJeunesse, who had been killed by Klamaths in May 1846. The trading post has been referred to as Seminoe's Fort, Fort Seminoe, and Chambeau and Semineaux post (Stegner 1992:293). Seminoe is the English spelling of the French Cimineau (McGreer 2001). The trading post was located near Devils Gate along the emigrant trails that are now partially preserved as the California, Mormon Pioneer, and Oregon National Historic Trails (Stewart 1983:396). The post continued in operation until 1856 when the United States military forced him to vacate the post because of increased hostilities between the American emigrants and the Native Americans (Bureau of Land Management [BLM] n.d.). Numerous emigrants mentioned the trading post at Devils Gate (Adams and Blank 1997:276; Goodell and Austin 1998:109; Mousley 1998:185; Pratt 1997:189; Read 1997:230; Taylor 1998:170; Webber 1993:46; 1994:38). The vast majority of travelers mention the trading post in passing while a few provided some insight into the physical layout, composition, and daily activities of the Devils Gate trading post. Some activities mentioned by the emigrants included trading oxen and having their horses and oxen shod. In 1853, Mary Burrell (1998:238) described the Seminoe's Fort as a "… blacksmith shop quite an establishment hewed logs & shingled with mud."

Figure 2. Devils Gate as seen from the project area; view to the northeast.

Sarah Sutton (1998:51) described the trading post in 1854 as:

> … two indian Lodges, and 7 or 8 cabins of traders … we have for years past heard of the rocky mountains but unexpectedly the time has arrived, when we can look at them for ourselves and can see that they are made of soled rock, and heaps upon heaps of rocks, and not earth as the mountains were in our homeland. In some places the pines and cedars grew large enough to build there little cabins that these french and indians reside in. these settlers do not pretend to raise a thing, not even a garden, one thing the land seems too poor to support any growth. Another one gentleman told us, it was useless to try, as there would be an hundred red indians to every ear of corn, and they would sit down by it until it got into roasting ears, and then fight who should have it. here they depend on the buffalo and bear, and what is wagond here A 1000 miles or more.

Mormon John Lyman Smith provided the most detailed description of Seminoe's Fort as he passed by the trading post on his way to his missionary post in Switzerland and Italy in 1855. In his diary, Smith (1940) provided the following account of the trading post:

> [Semino] has an excellent fort built on three sides of a square, containing ten large rooms; it is situated about three quarters of a mile [west] of the Devils Gate, and has a good horse coral on the east side; also a cattle yard, and is in decidedly the handsomest situation, and best built of any I have seen in the mountains, and is clean and neat. He has a small store containing groceries, Indian goods, and supplies for Traders and Emigrants generally. We think one reason of his prosperity is that he keeps no liquor.

Although its original owners had abandoned the trading post, it was to place a part in one of the more tragic moments in the history of the Mormon migration to the Salt Lake valley. Recruiting missions to the eastern states and to Europe brought several thousands of new converts to the Mormon faith and to the Territory of Utah in the mid-1800s. Although most traveled to Utah in wagons, a few thousand were too poor or destitute to afford the necessary provisions to outfit themselves for the harsh journey across the plains and mountains. The Mormon leadership devised a plan to use handcarts on which these poor Saints would pull their worldly possessions to the promised Zion (Hafen and Hafen 1992:28–49). By the end of

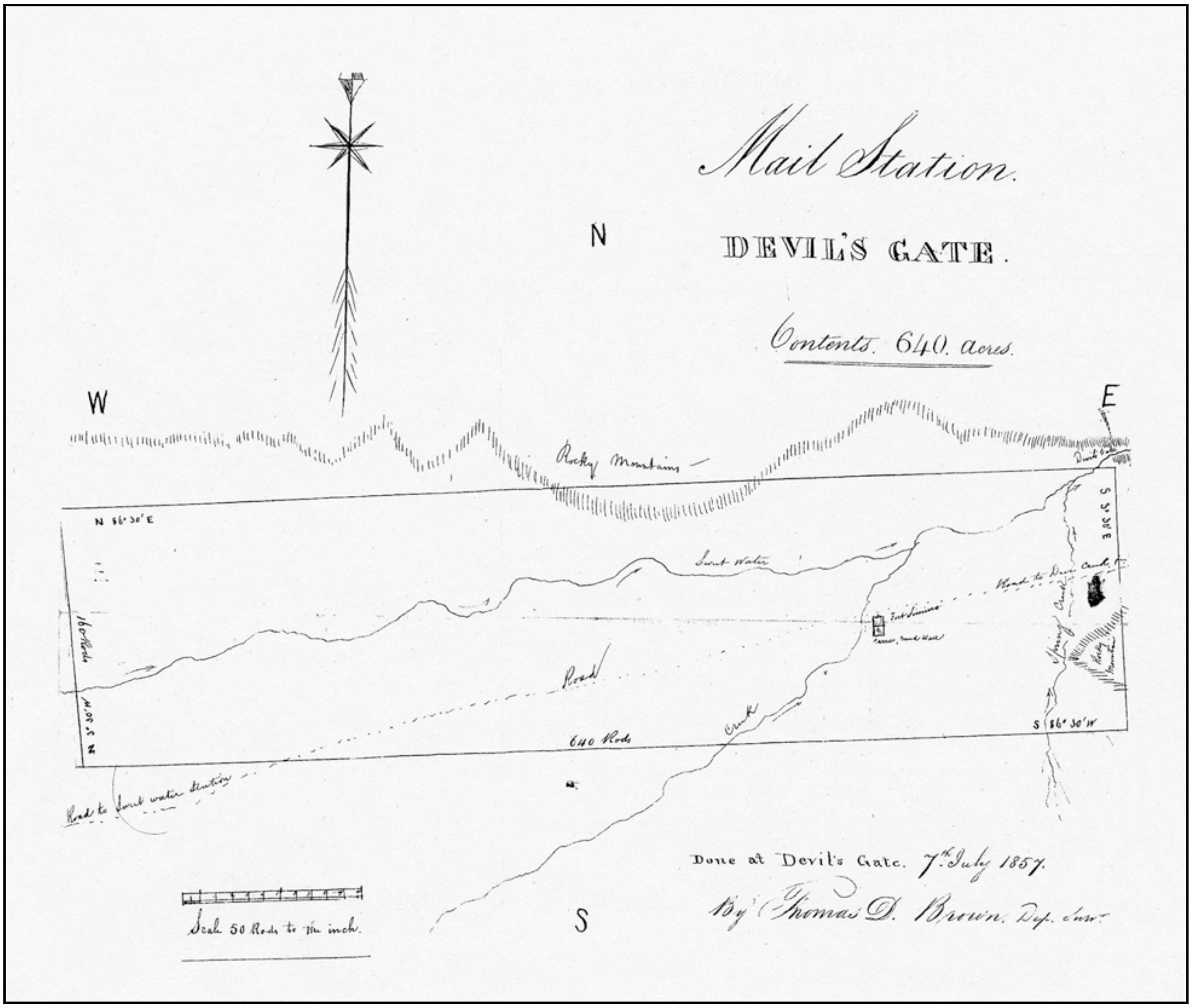

Figure 3. The 1857 survey map of mail stations by Deputy Surveyor Thomas D. Brown.

the first week of June 1856, the first two handcart companies were ready to leave Iowa City. They were under the command of Daniel McArthur and Edmund Ellsworth (Stegner 1992:227, 231). Captain Ellsworth's company left on June 9th, and Captain McArthur's company followed two days later. Although it was no easy journey to cross approximately 1,400 miles of plains and rugged mountains, both companies came out of Emigration Canyon into the Salt Lake valley on September 26, 1856. Although they had started out a couple of days apart, they arrived within a few hours of each other (Hafen and Hafen 1992:53–79; Stegner 1992:231–237). The third company, under Captain Edward Bunker, left Iowa City on June 28th. Their journey from the Missouri River took them 65 days, arriving in the Salt Lake valley in October one week behind the first two companies (Hafen and Hafen 1992:81–90; Stegner 1992:237–238).

The weather had held for these companies, however, two more companies were to leave Iowa before the summer was over. They would not be as fortunate. James Willie's company left Iowa City on July 15th (Hafen and Hafen 1992:94; Stegner 1992:239). Edward Martin's company left Iowa on July 26th (Hafen and Hafen 1992:94; Stegner 1992:239). Willie's company left Florence on the west bank of the Missouri River on August 11th (Stegner 1992:240). Martin's company followed on August 25th (Stegner 1992:240). Willie's company encountered the first snow after they had passed Independence Rock in October (Hafen and Hafen 1992:102–117). Martin company's was approximately 100 miles behind them at Last Crossing on the Platte River when the storm hit them (Stegner 1992:244–248).

Figure 4. The project area from the west side of Pete Creek; view to the northeast.

Knowing that the last two handcart companies were in the mountains, Brigham Young organized a rescue party (Hafen and Hafen 1992:119–141). On October 7th, the first contingent of the rescue party was headed towards the two handcart companies (Stegner 1992:250). On October 21st, the rescuers reached Willie's company stranded near the Sweetwater River. While half of the rescue party and supplies remained with Willie's company, the remaining rescue party under George Grant sought Martin's company in more than a foot of snow (Stegner 1992:251). They found four Mormon riders of the B.Y.X. Company, which was previously known as the Brigham Young Express Freight and Mail Company, in some of the abandoned trader's cabins at Seminoe's Fort six days later near Devils Gate (Stegner 1992:251). Grant sent a reconnaissance party consisting of three of the B.Y.X. riders and one pack mule loaded with supplies to find the Martin Handcart Company on October 27th. A day latter the riders found the Martin Handcart Company along with the Captain W. B. Hodgett Wagon Company near Red Buttes. The riders also located the Captain John A. Hunt Wagon Company. By November 2nd, the rescuers had led the Martin Handcart Company and the two wagon companies to Devils Gate. There they camped around the abandoned cabins at Seminoe's Fort (Stegner 1992:252–253). By November 30th, the last of the Martin Handcart Company was brought into the Salt Lake valley.

However, that did not end the Mormon's winter stay at Seminoe's Fort. The freight wagons of Hodgett and Hunt were left at the abandoned stockade (Franzwa 1988:265) guarded by members of the Mormon rescue party, under the leadership of Daniel W. Jones, until the following spring (Hafen and Hafen 1992:133). The guard party barely survived the harsh winter (Stegner 1992:260–274).

During the winter, spring, and summer of 1857, the Mormons continued using the abandoned trading post as a way station for B.Y.X. Company mail service between Salt Lake City and Independence, Missouri (BLM n.d; Stegner 1992:273). The station at Devils Gate was surveyed by Thomas D. Brown on July 7, 1857. While the location of the trading post is correct, identified on the map as Fort Semino, its orientation is 90° off the description left by John L. Smith. The map has the post opening to the west and the corral on the south side of the post. Smith (1940) indicated in his diary that the fort opened to the north and the corral was on the east side. Brown's handwritten notes on the map also identify the corral walls as consisting of mud.

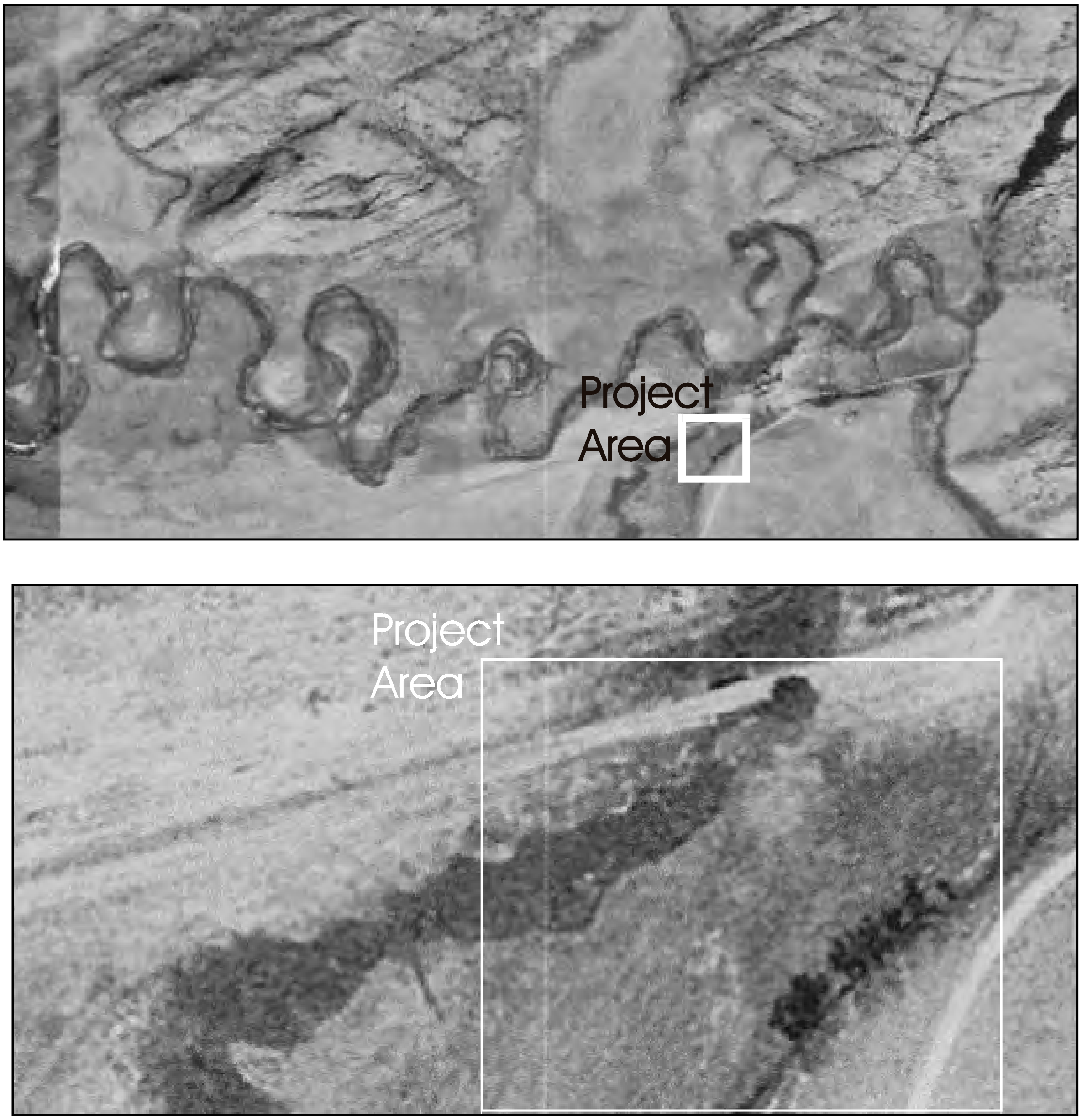

Figure 5. USGS aerial photograph, July 22, 1994, of the project area and vicinity: (a) Sweetwater River valley in the project area vicinity; (b) the project area near Tom Sun Ranch headquarters.

The facility was used as an express mail way station for a short time. Growing animosity between the Mormons and their fellow Americans was coming to a head. Many half-truths and non-truths were spread across the nation about many aspects of Mormon life (Billington 1967:548–551). In May 1857, President James Buchanan sent 2,500 troops, under Colonel Albert Sidney Johnston, to enforce federal authority in Utah. As the troops approached Utah during the summer and fall of 1857, the Mormons waged a guerrilla war against Johnston's army. Seminoe's Fort was abandoned and burnt to the ground in September 1857 so Johnston's troop would be unable to use it (BLM n.d.). With the trading post's destruction during the Utah War of 1857–1858, the native vegetation reclaimed the ruins. Buried under flood sediments of Pete Creek and vegetation, the precise location of Seminoe's Fort was lost. The area of the fort was transformed into pasture and hayfield to support cattle on the Tom Sun Ranch. Further modification to the site locality occurred with the use of the northern part of the field as borrow for the highway.

Environmental Setting

The trading post is on the floodplain along the right bank of Pete Creek less than a quarter mile above its confluence with the Sweetwater River. It lies in the NW¼ of the SW¼ of Section 35, Township 29 North, Range 87 West, in Natrona County, Wyoming (Figure 5). It lies at an elevation of 5,970 feet (1,818 m) above mean sea level. The project location is within the Wyoming Basin (Fenneman 1931:133–149).

The soils within the Sweetwater River valley belong to the Havermom-Tisworth soil association (Malnor and Arnold 1997:10–11). The soils are "very deep, and well drained or moderately well drained, nearly level or gently sloping soils on flood plains and associated terraces" (Malnor and Arnold 1997:10). The trading post site lies within the soil mapping unit "Havermom fine sandy loam, 0 to 5 percent slopes" (Malnor and Arnold 1997:95–96, 231, Sheet 99). This soil formed in an alluvium derived from various sources. The typical A horizon (0 to 4 inches) is a fine sandy loam overlying a C horizon (4 to 60 inches) consisting of loam stratified with thin layers of fine sandy loam, clay loam, and silty clay loam (Malnor and Arnold 1997:231). The A horizon is moderately alkaline, while the C horizon is commonly strongly to very strongly alkaline.

The project location also lies within the Coloradan biotic province (Dice 1943:37–39). The Coloradan province lies at high elevations with several sections being steeply mountainous. Gently rolling mountain parks cover large areas. The high plains regions of the Wyoming Basin cover a large part of the southwestern portion of the state. Several small ranges of mountains separate these high plains basins. This area is part of the transitional zone between the Plains Grasslands and the Great Basin Shrub–Grassland of the Cold Temperature Grassland (Brown et al. 1998:29, 40; Reichenbacher et al. 1998).

The native vegetation consists mainly of grasses, forbs, and shrubs (Malnor and Arnold 1997:95). Several species of sagebrush are present in the basin's grasslands. Big sagebrush forms extensive shrublands in the western parts of the Wyoming Basin. Western wheatgrass, needleandthread, blue grama, green needlegrass, needleleaf sedge, Indian ricegrass, junegrass, scarlet globemallow, fringed sagewort, phlox, milkvetch, rabbitbrush, and prickly pear cactus are also common (Roberts and Knight 2000). Greasewood occurs in low areas where standing water occurs in the spring but evaporates to form dry saltflats by mid-summer. Juniper and mountain-mahogany are common on ridges and in the foothills of the mountains. Limber pine and ponderosa pine occur in the mountains. Cottonwood trees and willow, along with a variety of shrubs, are widespread along the lowlands next to the streams and rivers such as the Sweetwater River.

The shortgrass prairie subregion of the Great Plains extends into the Wyoming Basin to the base of the Rocky Mountains (Shelford 1963:329). Large herds of pronghorn antelope once roamed the short grass region. They still form the dominant animal in the basin's grasslands. Deer are present in the timbered areas along streams and on the mountainsides. Elk are found in the mountains. Jackrabbits are common along with coyotes, badgers, mink, bobcats, and foxes. Numerous rodents inhabit the region. Numerous species of birds inhabit the grasslands, the shrublands, and wooded areas of the region (Roberts and Knight 2000). Reptiles include lizards, turtles, and snakes. Fish are found in the streams throughout the region. Insects abound with the grasshopper being one of the most abundant insect groups (Shelford 1963:344–345).

The Wyoming Basin region is subject to wide annual climatic variations due to abrupt elevation changes from the valley floors to the mountaintops (Malnor and Arnold 1997:5–6). Annual precipitation ranges from 10 to 14 inches over most of this semiarid area. Annual winter temperatures average 25°F with an average daily minimum temperature of 15°F and maximum temperature of 35°F. Annual summer temperatures average 67°F with an average daily minimum temperature of 52°F and a maximum temperature of 83°F. The average frost-free period in the county is approximately 129 days. Windy days are quite frequent during winter and early spring with strong winds generally out of the southwest. Measurable snowfall occurs between early September and late June.

Geophysical Prospection Techniques

Archeologists use several geophysical prospection techniques. These techniques record various physical properties of earth, typically in the uppermost two meters; however, deeper prospection can be achieved if necessary. Geophysical techniques are divided between passive techniques and active techniques. Passive techniques measure inherently or naturally occurring local or planetary fields created by earth related processes under study (Heimmer and De Vore 1995:7; Heimmer and De Vore 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; Heimmer and De Vore 2000:58–59; Kvamme 2001:355–356). The interaction of these signals and buried materials produces altered return signals measured by the appropriate geophysical instruments. Changes in the transmitted signal of amplitude, frequency, wavelength, and time delay properties may 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. Acoustic active techniques, including seismic, sonar, and acoustic sounding, have very limited or specific archeological applications.

A magnetic survey is a passive geophysical prospection technique used to measure the earth's total magnetic field at a point location. 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 artifacts have very strong effects on the local earth's magnetic field. Other cultural features, which affect the local earth's 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° (Milsom 1996:43; Weymouth 1986:341). The project area has a magnetic field strength of approximately 55,000 nT with an inclination of approximately 65° (Sharama 1997:72–73). 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 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 to archeological investigations have included the detection of architectural features, soil disturbances, and magnetic objects (Bevan 1991; Clark 2000:92–98; Gaffney et al 1991:6; Heimmer and DeVore 1995; Heimmer and De Vore 2000; Weymouth 1986:343).

The two modes of operation for magnetic surveys are total field survey and gradient survey. The instrument used to measure the magnetic field strength is the magnetometer (Bevan 1998:20). The total field survey uses a single magnetic sensor. Three types of magnetic sensors have been used in the magnetometer: (1) proton free precession sensors, (2) alkali vapor (cesium or rubidium) sensors, and (3) fluxgate sensors. For a detailed description of magnetometer types constructed from these sensors, refer to Clark (2000:66–71), Milsom (1996:45–47), Scollar et al. (1990:450–469), and Weymouth (1986:343–344).

The total field magnetometer measures the absolute intensity of the local magnetic field. This type of magnetometer utilizes a single sensor. Due to diurnal variation of the earth's magnetic field, the data collected with a single sensor magnetometer must be corrected to reflect these diurnal changes. One method is to return to a known point and take a reading that can be used to correct the diurnal variation. A second method is to use two magnetometers with one operated at a fixed base station collecting the diurnal variation in the magnetic field. The second magnetometer is used to collect the field data in the area of archeological interest. Common magnetometers of this types used in archeological investigations include the proton precession magnetometer, the Overhauser Effect magnetometer (a variation of the proton-precession magnetometer), and the cesium magnetometer.

A magnetic gradient survey is conducted with a gradiometer or a magnetometer with two magnetic sensors at a fixed vertical distance apart. The instrument measures the magnetic field at two separate heights. The top sensor reading is subtracted from the bottom sensor reading. The resulting difference is recorded. This provides the vertical gradient or change in the magnetic field. Diurnal variations are automatically canceled. This setup also minimizes long range trends. The gradiometer provides greater feature resolution and potentially provides better classification of the magnetic anomalies. Two commonly used gradiometers in archeological investigations are the cesium gradiometer and the fluxgate gradiometer. They are capable of yielding 8 to 10 measurements per second at less than 0.1 nT resolution (Kvamme 2001:358). Cesium gradiometers record the absolute total field values like the single sensor magnetometers. The fluxgate sensors are highly directional, measuring only the component of the field parallel to the sensor's axis (Clark 2000:69). They also require calibration (Milsom 1996:46–47). Both cesium and fluxgate gradiometers are capable of high density sampling over substantial areas at a relatively rapid rate of acquisition (Clark 2000:69–71; Milsom 1996:46–47).

The magnetic gradient survey was conducted at Seminoe's Fort with a Geoscan Research FM36 fluxgate gradiometer (Geoscan Research 1987). The gradiometer consisted of a control unit containing the electronics, power source, and memory chips. The control unit was attached to the vertical sensor tube containing the two fluxgate sensors. The sensors were set approximately 0.5 m apart from one another. In the carrying mode at the side of the body, the bottom sensor was about 0.30 m above the ground. The height of the bottom sensor above the ground is always relative to the height of the surveyor. Two readings were taken at each point along the survey traverse, one at the upper sensor and one at the lower sensor. The difference, or gradient, between the two sensors is calculated (bottom minus top) and recorded in the instrument's memory. With a built-in data logger, the gradiometer provides efficient survey data collection. Typically, data were collected in 15 minutes within a 20-m by 20-m grid unit with sampling parameters of 8 samples per meter and 1-m traverses. This amounts to 3,200 readings per survey grid.

Figure 6. Establishing the geophysical grid at Seminoe's Fort; view to the northwest.

Survey Field Procedures

Upon arrival at the site, a reference point (N1080/E1040) was established on a small rise in the middle of the hayfield where it was dry. The field had been flooded prior to the start of the survey by the ranch staff in order to provide moist soil conditions for the resistance survey; however, approximately two inches of irrigation water covered the majority of the site when the survey started. Since the ground was saturated with water, resistance and conductivity surveys were not possible. The 20-m grid corners were shot in with a transit (Figure 6) along the E1040 baseline and along the N1080 baseline and 2-inch wooden hubs were placed in the ground at 20-m intervals. The geophysical grid was aligned on magnetic north. The hubs formed the corners of each 20-m by 20-m grid unit. The transit was moved along the 20-m grid points along the E1040 baseline and additional east-west 20-m grid points were established. Thirty-seven 20-m by 20-m grids were established across the site. Due to obstacles, 9 of the 37 survey grid units covered less than the 20-m by 20-m square grid unit. Four grid units in the northwest corner of the site contained portions of the channel of Pete Creek, which formed a portion of the western boundary of the survey area. Five grid units along the southeastern portion of the site contained the irrigation ditch, which formed a portion of the southern boundary of the geophysical survey area.

Once all of the grid corners were established and wooden hubs were placed at these points, the entire survey area was mapped with a Nikon DTM-730 field station (Nikon Corporation 1993). In addition to the grid corners, topographic relief and cultural features were mapped and the data stored in the memory of the DTM-730 field station (Appendix A). The data were downloaded to a laptop computer, and the field map (Figure 7) was generated in the SURFER for Windows mapping program (Keckler 1997). Actual topographic elevation (5,969 feet above mean sea level) was obtained from a Bureau of Land Management elevation benchmark (N999.18/E741.44) west of the site. A mapping elevation for the archeological excavations was arbitrarily set at 100 m at N1040/E1080 (Figure 8). An elevation map was prepared in SURFER for Windows mapping program for the planned summer excavations.

Beginning in the southwest corner of the geophysical grid, the first 20-m by 20-m grid unit was prepared for the magnetic gradient survey. First, two 20-m-long ropes were placed between the wooden hubs along the north and south end of the grid unit. These two ropes served as guide lines for the placement of additional north-south oriented traverse ropes. The traverse ropes were placed at 1-m intervals across the grid. These 20-m lengths of rope are divided into 0.5-m increments by different colored tape. Blue is placed every 1-m point along the rope, with red tape placed at 0.5-m intervals. The use of different colored tape on the ropes provides a simple way to maintain one's position within the geophysical survey grid unit as data are being collected. The geophysical data were therefore recorded in a series of evenly spaced parallel lines with measurements taken at regular intervals along each line resulting in a matrix of recorded measurements (Kvamme 2001:356; Scollar et al. 1990:478–488).

Prior to the start of the survey and after the data in the Geoscan Research FM36 fluxgate gradiometer were downloaded, the gradiometer sensors were balanced and aligned. The operator's manual (Geoscan Research 1987:29–31) illustrates the steps involved in preparing the instrument for actual field data collection. The N1000/E1020 grid point was used as the reference point to balance and align the sensors.

Data were collected at 8 samples per meter (1 sample every 0.125 m) along each traverse and at 0.5-m traverses across each individual grid unit resulting in 16 samples per square meter. For each traverse, a total of 160 magnetic gradient measurements were recorded in the memory of the Geoscan Research FM36 fluxgate gradiometer (Figure 9). For each complete 20-m by 20-m grid unit, a total of 6,400 measurements were recorded during the magnetic gradient survey. The survey of each traverse was conducted in a zigzag fashion beginning in the southwest corner of each grid unit. The instrument was carried along the traverse rope with the control box facing magnetic north. The sample trigger on the instrument provided a series of clicks for every sample reading and a beep on every eighth sample reading. The geophysical investigator maintained a pace along the traverse in accordance with the audio beeps from the fluxgate gradiometer. This placed each eighth sample reading at the 1-m tape mark. At the end of the first traverse, the investigator moved to the next traverse and proceeded back down the line towards the starting

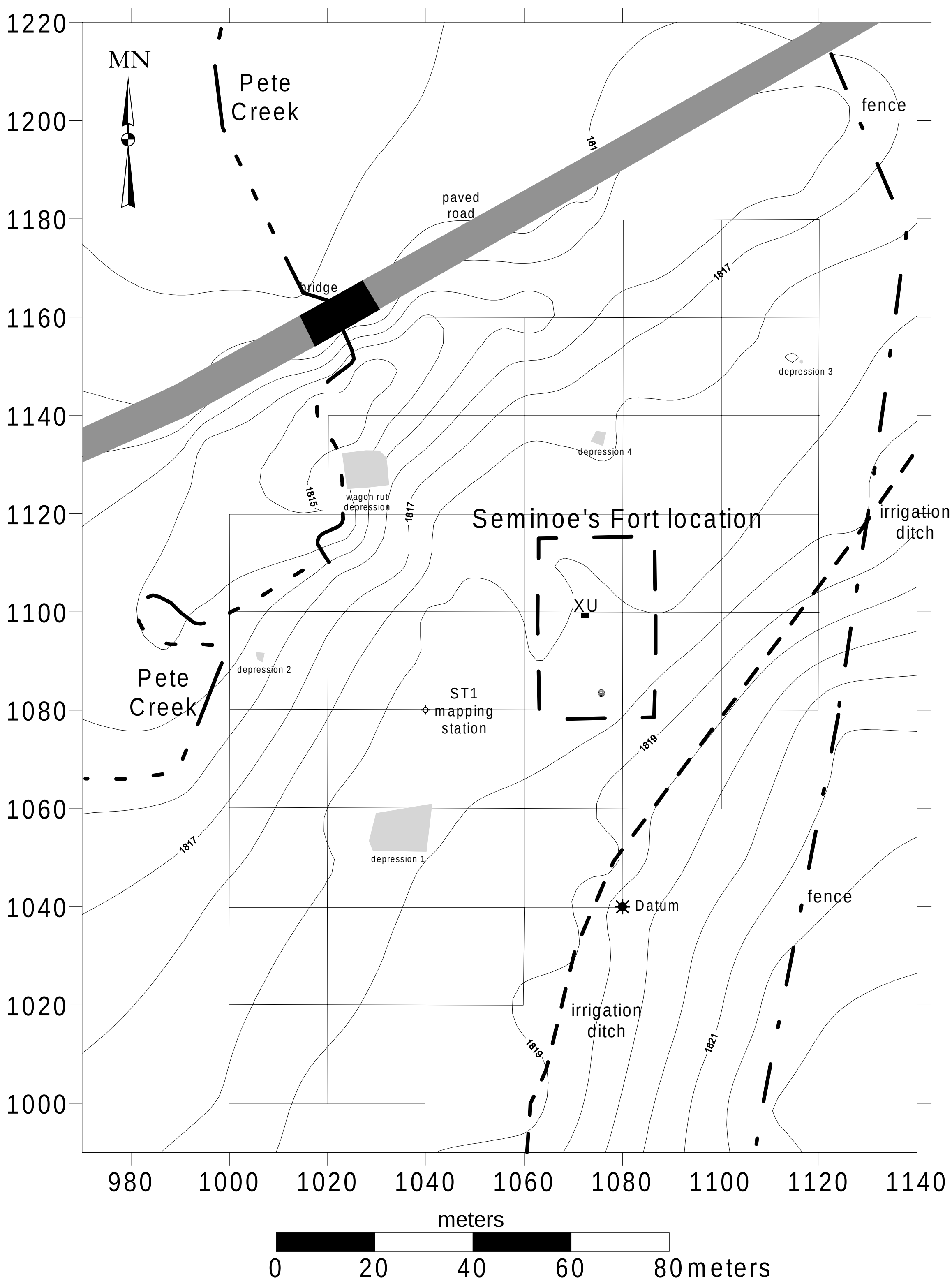

Figure 7. Topographic map of Seminoe's Fort magnetic survey project area; contour interval is 0.5 m. Measurements were taken with a Nikon DTM-730 field station, May 22–26, 2001.

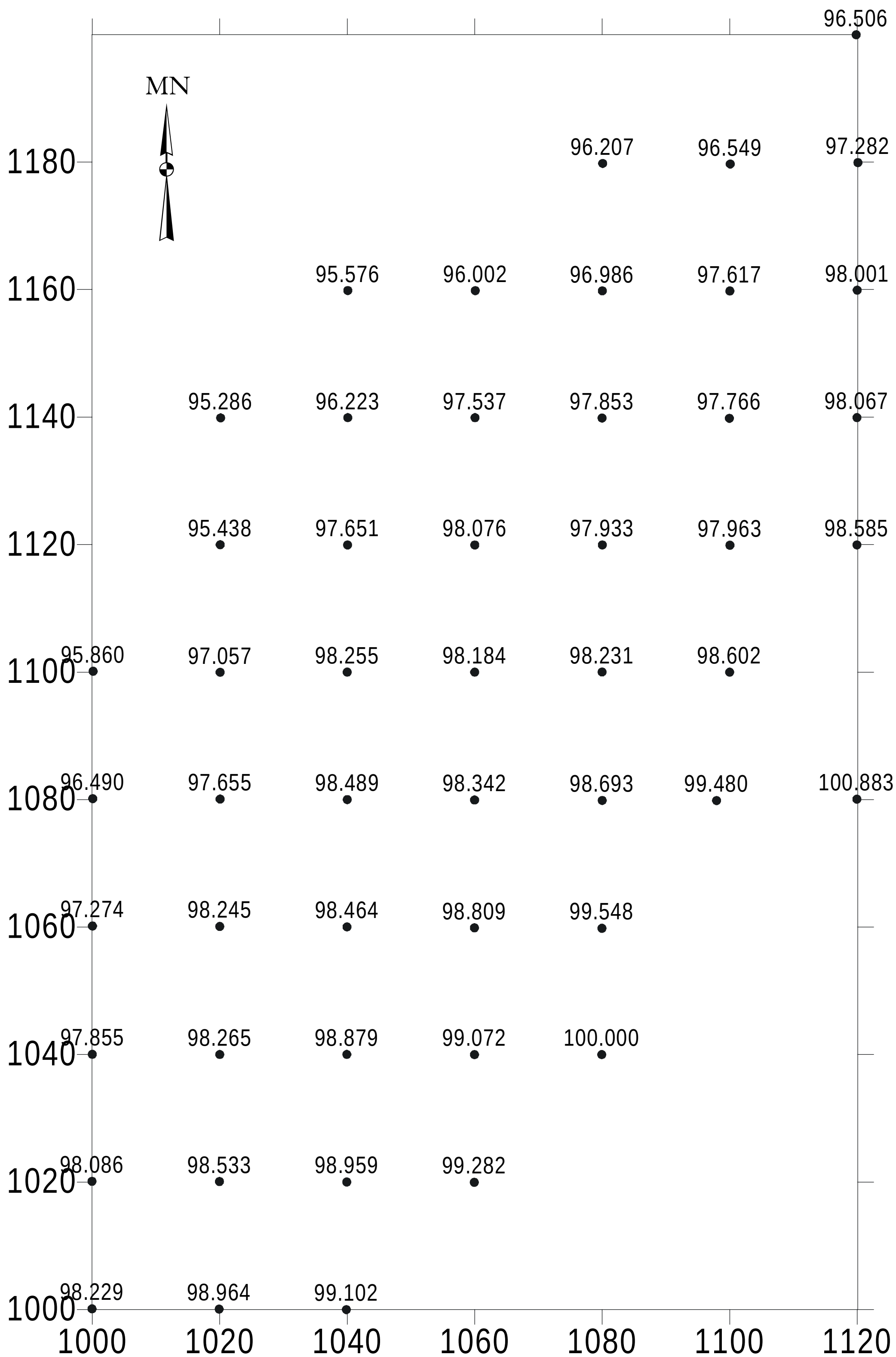

Figure 8. Arbitrary excavation mapping elevations.

edge of the grid unit. However, the instrument was held in the same orientation as in the first line with the control box facing magnetic north. The subsequent odd and even traverses were carried out in the same zigzag fashion until completion of the grid unit. The geophysical investigator then moved to the next grid unit and continued the survey until the memory of the instrument became full.

Due to the limited memory capacity of the FM36 fluxgate gradiometer, the data had to be downloaded into a laptop computer after the completion of two grid units. Grid files were created for each 20-m by 20-m grid unit and received an unique file name. The grid files were reviewed in the Geoscan Research GEOPLOT processing software (Walker and Somers 1995), and a composite file was created for further processing. While in the field, the composite file was processed with the Zero Mean Traverse Function and viewed on the laptop computer before the memory in the gradiometer was cleared and the next two grid units were surveyed. From this preliminary review of the collected data, the geophysical investigator could analyze his survey design and methodology and make appropriate survey decisions or modifications while still in the field. It took approximately half an hour to collect the data in an individual grid unit. The downloading and processing also required approximately half an hour.

Figure 9. Conducting magnetic survey with a Geoscan Research FM36 fluxgate gradiometer; view to the west-southwest.

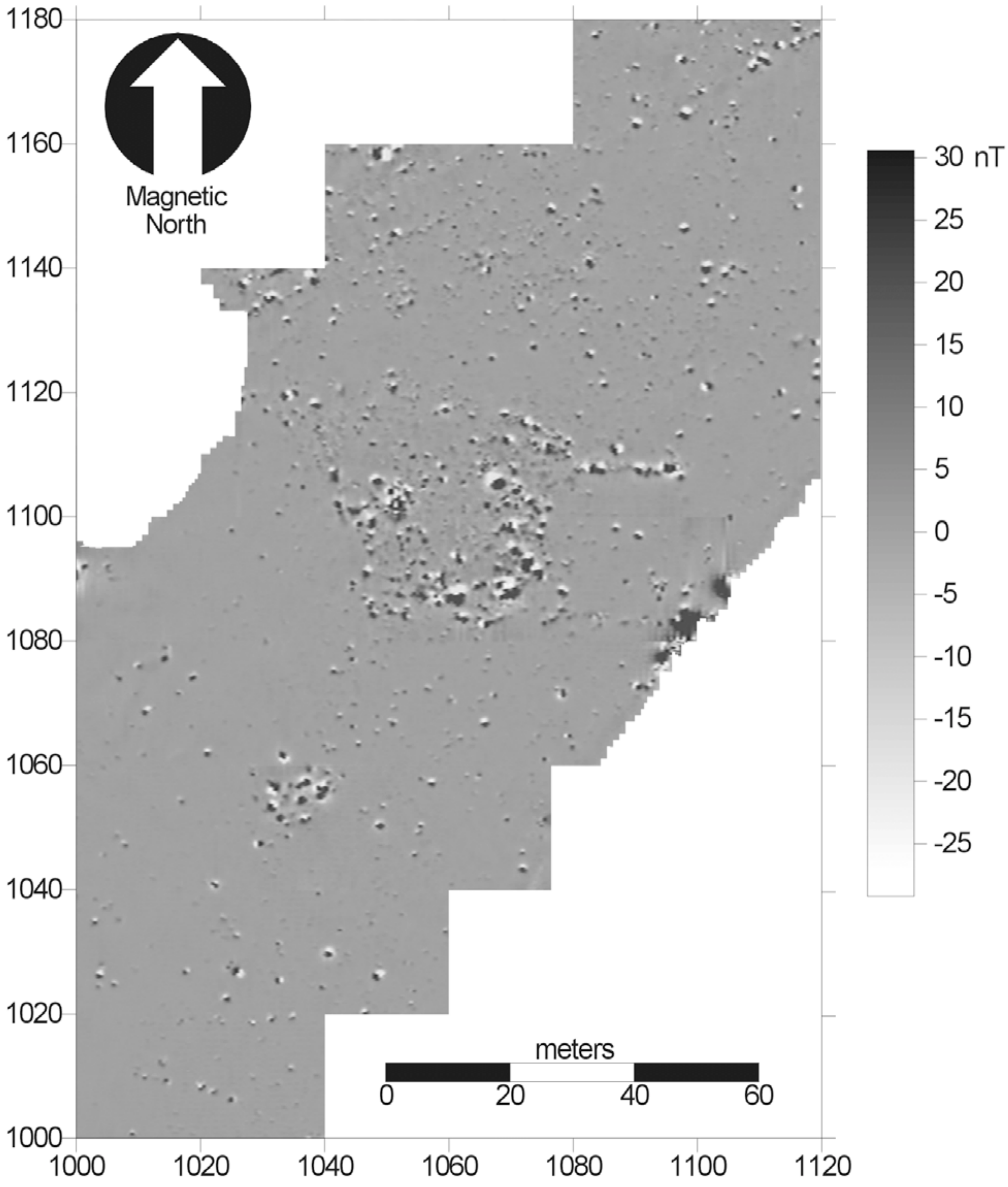

Figure 10. Image plot of magnetic gradient data.

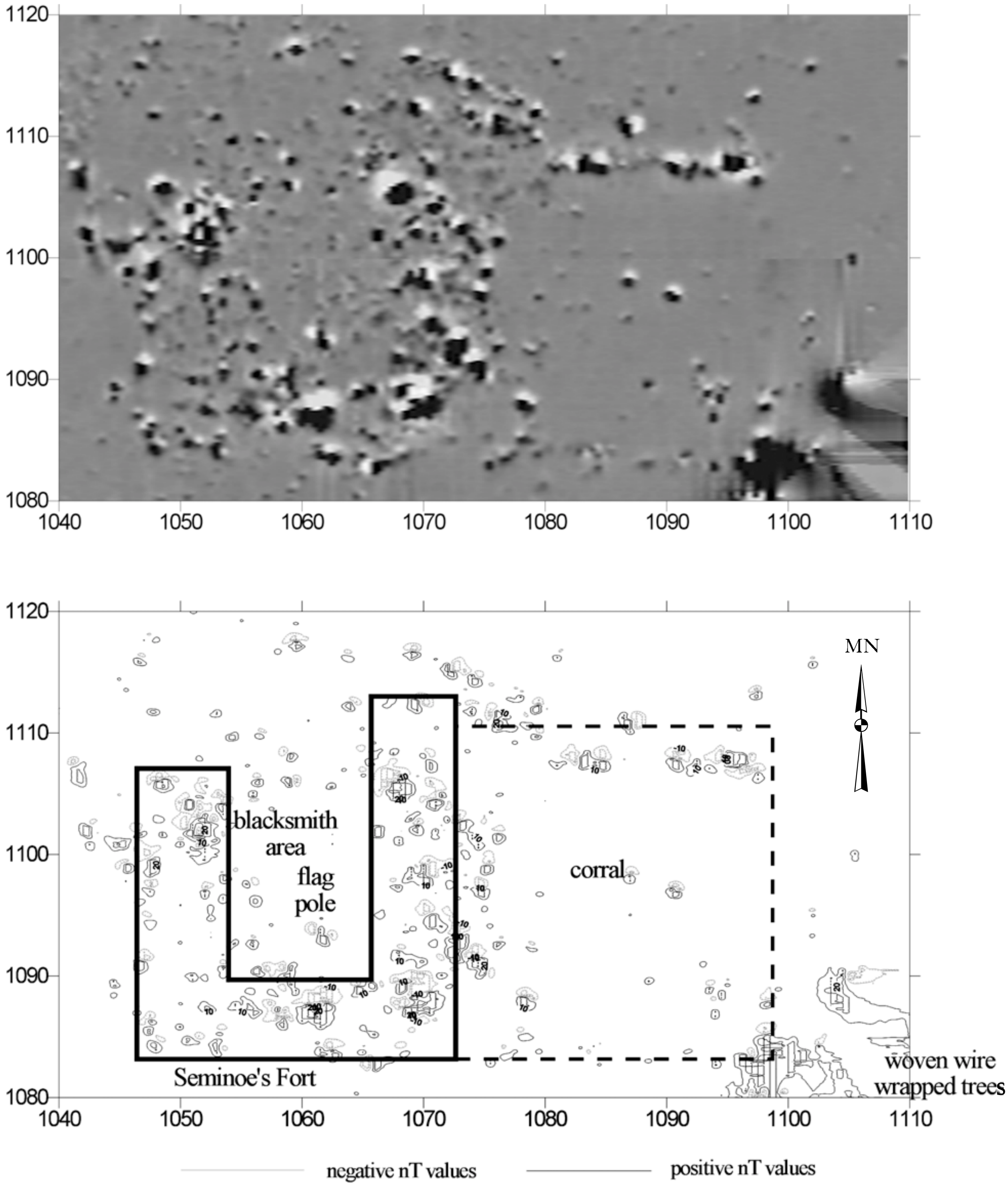

Figure 11. Image plot and contour map of magnetic gradient data in the immediate vicinity of the Seminoe’s Fort ruins.

Data Processing and Interpretation

Processing of geophysical data requires care and understanding of the various strategies and alternatives (Kvamme 2001:365; Music 1995; Neubauer et al. 1996). Walker and Somers (1995) provide strategies, alternatives, and case studies on the use of several processing routines commonly used with the Geoscan Research instruments in the GEOPLOT software manual. Kvamme (2001:365) provides a series of common steps used in computer processing of geophysical data:

(1) *Concatenation* of the data from individual survey grids into a single composite matrix;

(2) *Clipping and despiking* of extreme values (that may result, for example, from introduced pieces of iron in magnetic data);

(3) *Edge matching* of data values in adjacent grids through balancing of brightness and contrast (i.e., means and standard deviations);

(4) *Filtering* to emphasize high-frequency changes and smooth statistical noise in the data;

(5) *Contrast enhancement* through saturation of high and low values or histogram modification; and

(6) *Interpolation* to improve image continuity and interpretation.

It is also important to understand the reasons for data processing and display (Gaffney et al. 1991:11). They enhance the analyst's ability to interpret the rather large data sets collected during the geophysical survey. The type of display can help the geophysical investigator present his interpretation of the data to the archeologist who will ultimately use the information to plan excavations or determine the archeological significance of the site from the geophysical data.

Data Processing

After the completion of the magnetic gradient survey, the grid files are transferred to a personal computer in the office. The 37 grid files are combined into one large composite file for further processing in GEOPLOT. Data collection of the field magnetic gradient measurements from the 28 complete 20-m by 20-m grid units and 9 partial 20-m by 20-m grid units at the Seminoe's Fort site (48NA228) yielded a total of 38,397 magnetic gradient readings across the geophysical project area (Appendix B). The initial data processing step is to run the Zero Mean Traverse Function across the entire data set (Walker and Somers 1995:9.125). The Zero Mean Traverse Function sets the background mean of each traverse within the grid to zero. It is useful in removing the striping effects resulting from the magnetic gradient zigzag directional survey. It also removes any edge discontinuities at the same time. The function operates over the entire composite data set. The field magnetic gradient values range from -191.7467 nT to 209.2595 nT. The mean of the data is 0.3103 nT and the standard deviation is 7.9272 nT.

Depending on the required results, the Clip Function can be used to limit data to specific maximum and minimum values (Walker and Somers 1995:9.29). For historic sites, such as Seminoe's Fort, the data may be clipped to ±20 nT, but the function was not utilized on this data set. In addition, the Interpolate Function (Walker and Somers 1995:9.67) is often used to compress the magnetic gradient data count, and it gives the displayed data a smoother appearance, especially when two differently sampled composite files are combined or when producing a correlation plot of different geophysical data types. The Interpolate Function was not used on this magnetic gradient data set.

In processing magnetic gradient data, the final step is to run a low-pass filter over the entire data set. The Low-Pass Filter Function removes high-frequency, small-scale spatial detail (Walker and Somers 1995:9.71). This smoothes the data and enhances larger weak anomalies. Shade and trace maps were both generated by personal computer for display and analysis on the computer monitor screen. After the processing was completed in the Geoscan Research's GEOPLOT software, the composite data set was exported in an XYZ.dat file for further enhancement in the SURFER for Windows software (Keckler 1997).

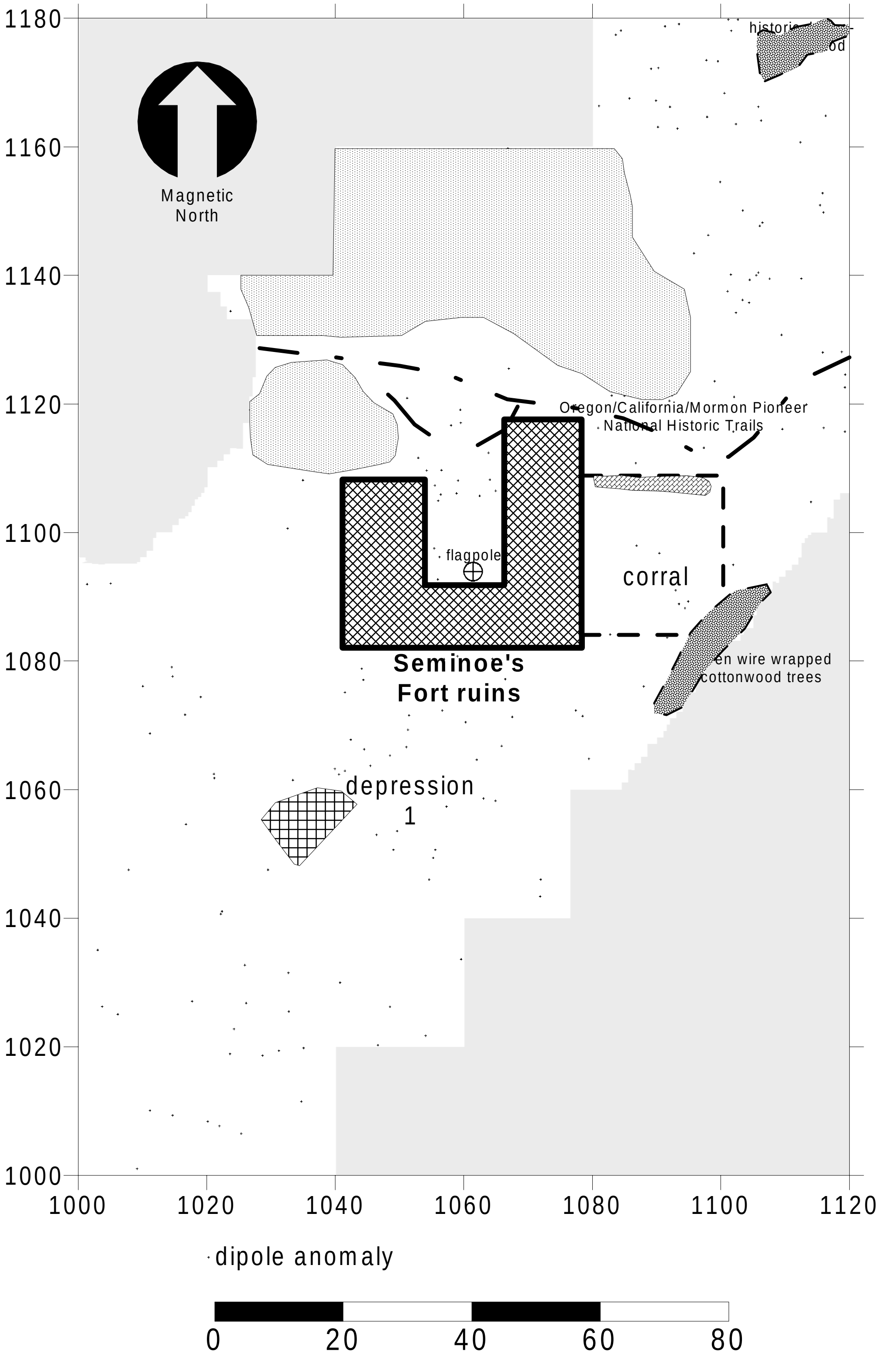

Figure 12. Archeological interpretation of magnetic gradient data.

In SURFER, the data are first imported into a worksheet (Keckler 1997). The values of the North and East coordinates are corrected to the arbitrary values used to map the site. This is required since GEO-PLOT assigns X and Y values to the data set in whole integers starting with 1. The North, or Y, values are divided by 8, which is the number of sample readings per meter, and the East, or X, values are divided by 2 since the data were collected along each 0.5-m traverse across the project area. The lowest point in the southwest corner of the project area was assigned the North coordinate of 1000 and the East coordinate of 1000. These values were also added to the X and Y values in the worksheet. A blanking file (Keckler 1997) was also created in a separate worksheet for use in the final SURFER display of the magnetic gradient data. The data file was gridded using the kriging algorithm (Keckler 1997). The resulting grid file was smoothed and the blanking file added. The final steps in the production of the magnetic gradient data plot includes the generation of an image map (Keckler 1997) and its labeling with a scale bar, North arrow, anomaly descriptions, and legend. Depending on the types of data presentations, a contour map may also be generated along with a 3-dimensional surface relief plot (Keckler 1997).

Interpretation

While numerous dipole anomalies are present across the surveyed area (Figure 10), there are two main concentrations identified during the survey: (1) a large anomalous area between N1080/E1040 and N1120/E1100 and (2) a smaller area centered at N1055/E1035. The large concentration represents the location of Seminoe's Fort (Figure 11). The concentration of magnetic anomalies is U-shaped and opens on the north side. A large concentration of magnetic anomalies on the west side of the trading post centered at N1102/E1052 may represent the blacksmith shop mentioned by Mary Burrell (1998:238). A strong anomaly, centered at N10903/E1062, is located in the trading post's open interior. It may represent the location of the post's flagpole. The corral adjacent to the trading post is identified by a linear set of anomalies along the north and south sides of the corral. A linear area in front of the trading post lacks magnetic anomalies and appears to represent the California, Mormon Pioneer, and Oregon National Historic Trails as it passes by the trading post.

To the southwest of the main concentration of magnetic anomalies is the second smaller concentration (Figure 12). This group of magnetic anomalies lies in a rectangular depression. The exact nature of this concentration of magnetic anomalies is not known. Many of the single dipole anomalies appear to be normal dipoles and may therefore represent fire hearths associated with trail activities and trading. Others are iron artifacts. Some of the smaller magnetic anomaly concentrations in the northern part of the survey area represent trash dumps or artifact discard locations. Others appear to be pieces of more recent farm machinery and implements. Linear concentration of strong magnetic anomalies along the southeast portion of the site from N1070/E1090 to N1090/E1110 represents woven wire placed around the cottonwood trees at the edge of the irrigation ditch.

Conclusions

During the course of the present geophysical project, the major portion of a 180-m by 120-m rectangular area in the eastern portion of the Tom Sun Ranch hayfield south of an old section of Wyoming Highway 220 and east of Pete Creek was investigated. A field magnetic gradient survey was conducted with the Geoscan Research FM36 fluxgate gradiometer. In the middle of the survey area, a large concentration of magnetic anomalies indicated the presence of a U-shaped structure approximating the known dimensions of Seminoe's Fort. The trading post was built in 1852 by traders Charles LaJeunesse and his partner Chambeau. Although abandoned by the traders in 1856, the post served as a mail express station until its destruction in 1857 in advance of Federal troops during the Utah War. The little trading post, 48NA288, near Devils Gate was also used by the Mormons of the ill-fated Martin Handcart Company during the blizzard of 1856.

Data recovered from the field magnetic gradient survey has provided much information on the location and layout of the trading post, as well as, the area surrounding the post. This information will be used to direct archeological excavations planned for the summer months following the geophysical investigations. The magnetic gradient data verified the diary account of John Lyman Smith made during his 1855 journey to Europe. It also provided data for the correction of the orientation of the trading post from Thomas D. Brown's 1857 survey map of the mail station at Devils Gate.

Finally, refinement of the archeological and geophysical interpretation of the survey data is dependent on the feedback of the archeological investigations following geophysical survey (David 1995:30). The archeologist is encouraged to share additional survey and excavation data with the geophysical investigator for incorporation into the investigator's accumulated experience 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 we continue to make contributions to the fields of archeology and geophysics.

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Appendix A: Topographic Survey Data

Northing	Easting	Elevation	Description	Northing	Easting	Elevation	Description
1080.00	1040.00	1820.32	ST1 N1080/E1040	1040.01	1039.92	1819.93	N1040/E1040
1099.99	1039.98	1820.56	N1100/E1040	1099.98	1059.99	1820.63	N1100/E1060
1039.99	1079.92	1818.81	Datum N1040/E1080	1060.02	1039.94	1820.35	N1060/E1040
1059.80	1079.94	1819.27	N1060/E1080	1079.93	1059.97	1820.47	N1080/E1060
1119.93	1040.04	1821.16	N1120/E1040	1059.87	1059.94	1820.00	N1060/E1060
1079.86	1079.99	1820.12	N1080/E1080	1000.05	1061.10	1819.82	Irrigation Ditch
1139.91	1040.07	1822.59	N1140/E1040	0999.84	1108.55	1816.64	Fence
1100.01	1079.97	1820.58	N1100/E1080	1006.50	1064.54	1819.63	Irrigation Ditch
1159.86	1040.07	1823.24	N1160/E1040	1017.40	1097.46	1817.79	Topo
1119.94	1080.00	1820.88	N1120/E1080	1031.34	1070.34	1819.71	Irrigation Ditch
1139.87	1020.13	1823.53	N1140/E1020	0992.84	1086.89	1817.96	Topo
1139.85	1079.96	1820.96	N1140/E1080	1049.34	1077.91	1819.77	Irrigation Ditch
1119.97	1020.06	1823.37	N1120/E1020	1024.65	1113.47	1816.89	Fence
1159.80	1080.01	1821.83	N1160/E1080	1049.59	1104.72	1818.14	Topo
1100.12	1000.12	1822.95	N1100/E1000	1116.17	1128.02	1820.15	Irrigation Ditch
1179.79	1080.06	1822.61	N1180/E1080	1079.10	1123.90	1817.68	Fence Post
1179.70	1100.08	1822.26	N1180/E1100	1131.79	1131.62	1820.09	Fence
1159.78	1100.01	1821.20	N1060/E1100	1151.08	1026.89	1823.72	Stream Bank, Right Side
1099.96	1020.05	1821.76	N1100/E1020	1177.16	1137.77	1821.12	Fence
1139.81	1099.94	1821.05	N1140/E1100	1144.22	1018.95	1823.82	Stream Bank, Right Side
1080.07	1020.05	1821.16	N1080/E1020	1139.07	1018.81	1823.84	Stream Bank, Right Side
1119.89	1100.03	1820.85	N1120/E1100	1213.48	1122.44	1821.35	Fence Post and Road
1080.14	1000.06	1822.32	N1080/E1000	1133.30	1023.46	1823.65	Stream Bank, Right Side
1060.16	1000.02	1821.54	N1060/E1000	1133.32	1027.26	1823.56	Stream Bank, Right Side
1099.98	1099.98	1820.21	N1100/E1100	1208.73	1122.43	1822.31	Base Road Fill
1060.09	1019.99	1820.57	N1060/E1020	1116.70	1024.33	1823.55	Fence
1079.85	1097.93	1819.33	N1080/E1100	1183.22	1079.52	1822.71	Base Road Fill
1040.00	1019.99	1820.55	N1040/E1020	1115.06	1019.90	1823.60	Stream Bank, Right Side
1080.06	1119.94	1817.93	N1080/E1120	1186.61	1074.37	1821.43	Road Paved
1040.03	1000.00	1820.96	N1040/E1000	1113.99	1019.34	1823.50	Stream Bank, Right Side
1119.94	1119.95	1820.23	N1120/E1120	1161.67	1030.61	1821.4	Bridge
1020.11	0999.95	1820.73	N1020/E1000	1154.26	1017.54	1821.41	Bridge
1139.91	1119.95	1820.75	N1140/E1120	1110.46	1021.36	1822.46	Stream Bank Cut
1000.10	0999.95	1820.58	N1000/E1000	1154.25	1017.55	1821.42	Bridge
1159.91	1119.99	1820.81	N1160/E1120	1094.63	1007.73	1822.37	Stream Bank Cut
1020.07	1019.94	1820.28	N1020/E1020	1147.29	1015.17	1823.07	Base Road Fill
1179.92	1120.10	1821.53	N1180/E1120	1096.89	0996.65	1823.09	Stream Bank Cut
1000.06	1019.89	1819.85	N1000/E1020	1136.20	0995.20	1823.16	Base Road Fill
1199.97	1119.84	1822.31	N1200/E1120	1102.51	0985.22	1823.18	Stream Bank, Right Side
0999.99	1039.85	1819.71	N1000/E1040	1140.16	0991.63	1821.46	Paved Road
1159.84	1060.08	1822.81	N1060/E1060	1094.56	0988.42	1823.20	Stream Bank, Right Side
1020.00	1039.91	1819.85	N1020/E1040	1096.30	0993.20	1822.95	Stream Bank, Right Side
1179.85	1060.15	1821.37	N1180/E1060	1146.16	0988.72	1821.45	Paved Road, North
1019.95	1059.92	1819.53	N1020/E1060	1093.91	0996.55	1822.95	Stream Bank, Right Side
1139.90	1060.03	1821.28	N1140/E1060	1167.59	1027.02	1821.43	Bridge, North
1039.98	1059.95	1819.74	N1040/E1060	1065.33	0989.83	1822.29	Stream Bank, Right Side
1119.93	1060.00	1820.74	N1120/E1060	1156.63	1033.68	1823.35	Base Road Fill

Northing	Easting	Elevation	Description	Northing	Easting	Elevation	Description
1064.94	0972.57	1822.26	Borrow Pit	1126.08	1034.47	1821.95	Topo
1147.77	1041.68	1823.00	Topo	1129.84	1028.31	1822.68	Stream Bank Cut
1159.00	1064.14	1822.75	Borrow Pit	1115.60	1026.02	1822.65	Stream Bank Cut
1171.42	1089.27	1822.28	Borrow Pit	1111.87	1034.86	1821.91	Topo
1053.53	1028.27	1820.55	Depression 1	1100.01	1050.13	1820.46	Fort Topo
1184.15	1116.13	1822.11	Borrow Pit	1110.25	1050.66	1820.69	Fort Topo
1051.36	1039.87	1820.14	Depression 1	1119.89	1050.79	1820.82	Fort Topo
1061.03	1041.14	1820.20	Depression 1	1112.13	1068.81	1820.55	Fort Topo
1218.29	1117.94	1821.37	Paved Road, North	1120.16	1070.46	1820.97	Fort Topo
1058.93	1029.86	1820.40	Depression 1	1109.97	1090.07	1820.82	Fort Topo
1057.60	1034.62	1820.58	Depression 1 Interior	1109.96	1100.00	1820.60	Fort Topo
1190.38	1068.14	1821.51	Road Paved, North	1099.96	1089.73	1820.63	Fort Topo
1058.64	1038.39	1820.49	Depression 1 Interior	1099.02	1072.97	1820.46	Excavation Unit (XU)
1054.74	1037.76	1820.48	Depression 1 Interior	1099.99	1073.02	1820.49	Excavation Unit (XU)
1051.81	1029.81	1820.67	Depression 1 Interior	1100.04	1071.96	1820.50	Excavation Unit (XU)
1054.12	1033.25	1820.45	Depression 1 Int. Ctr.	1099.02	1071.92	1820.47	Excavation Unit (XU)
0999.18	0741.44	1819.35	Elevation BM	1100.29	1070.33	1820.59	Fort Topo
1090.33	1005.58	1822.46	Depression 2	1100.11	1067.69	1820.75	Fort Topo
1091.88	1005.26	1822.48	Depression 2	1109.74	1059.99	1820.73	Fort Topo
1091.67	1007.20	1822.31	Depression 2	1130.14	1060.07	1820.98	Topo
1089.78	1006.73	1822.39	Depression 2	1139.81	1069.86	1821.34	Topo
1091.02	1006.05	1822.66	Depression 2 Center	1129.72	1070.02	1821.05	Topo
1150.92	1116.36	1821.14	Depression 3, 1.5 m Diam	1129.35	1080.03	1821.08	Topo
1136.62	1074.55	1821.15	Depression 4	1129.13	1089.49	1821.09	Topo
1134.70	1073.50	1821.15	Depression 4	1139.46	1089.99	1821.08	Topo
1133.80	1076.03	1821.20	Depression 4	1139.86	1068.80	1821.35	Topo
1136.51	1076.73	1821.13	Depression 4	1151.46	1071.44	1821.82	Borrow Cut
1135.52	1075.32	1821.23	Depression 4 Center	1146.70	1063.20	1821.82	Topo
1083.48	1075.75	1820.64	Cellar Depression	1147.64	1048.25	1822.45	Borrow Cut
1079.46	1070.15	1820.41	Fort Topo	1136.56	1037.13	1822.66	Borrow Cut
1079.30	1050.00	1820.45	Fort Topo	1154.18	1058.06	1822.29	Borrow Cut
1089.50	1050.38	1820.47	Fort Topo	1163.27	1077.46	1822.18	Borrow Cut
1090.34	1060.03	1820.54	Fort Topo	1173.15	1105.36	1821.50	Borrow Cut
1090.22	1061.99	1820.65	Fort Topo	1186.03	1132.26	1821.46	Borrow Cut
1089.51	1066.79	1820.55	Fort Topo	1132.93	1027.82	1823.43	Topo
1089.48	1072.05	1820.23	Fort Topo Stake	1129.90	1028.02	1822.64	Topo
1089.91	1075.87	1820.42	Fort Topo	1129.02	1028.38	1822.76	Topo
1094.94	1077.10	1820.46	Fort Topo	1126.87	1028.49	1822.73	Topo
1094.79	1073.74	1820.34	Fort Topo	1125.33	1028.45	1822.53	Topo
1094.93	1068.35	1820.54	Fort Topo	1113.73	1025.25	1822.61	Stream Bank Cut
1095.10	1065.59	1820.66	Fort Topo	1131.14	1031.97	1822.35	Topo
1095.15	1061.61	1820.68	Fort Topo	1129.92	1032.08	1822.46	Topo
1094.93	1053.88	1820.57	Fort Topo	1127.68	1032.18	1822.41	Topo
1097.57	1047.08	1820.64	Fort Topo	1125.86	1032.47	1822.15	Topo
1096.68	1034.38	1820.93	Topo	1111.71	1035.27	1821.90	Topo
1109.66	1045.81	1820.71	Topo				

Note: Northing, Easting, and Elevation values are given in meters.