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Geophysical Survey of Wisconsin Burial Site BOU-0017
Freedom Moravian Cemetery

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Introduction

Lawrence University was asked by members of the Freedom Moravian Church, Freedom, Wisconsin, to conduct a geophysical survey of their cemetery, which is catalogued as Wisconsin Burial Site BOU-0017 and with the name “Township Cemetery” (Figure 1). The purpose of the survey was to determine the location of open plots and possible unmarked interments. The Church had found that cemetery records were not complete, particularly for the late 19th century (the earliest interment is 1857), and it was hoped that the geophysical survey might help fill in some of the missing information.

Methods

Initial geomagnetic survey of the Freedom Moravian Cemetery took place on April 11, 2015. Peregrine and three Lawrence University students collected geomagnetic data from four 30 meter by 30 meter grid units covering the southern two-thirds of the cemetery. From initial processing of the data, it became clear that because many of the interments contained large amounts of metal (casket lining and hardware, for example), it was impossible to identify unused plots because the size of the magnetic anomalies from neighboring interments concealed them (see Figure 2).

The data themselves were collected using a Geoscan FM256 differential gradiometer. This instrument consists of two magnetometers arranged one atop the other with a 0.5 meter separation. Each magnetometer measures the earth’s magnetic field and the difference between the two readings, which is equivalent to the vertical gradient of the earth’s magnetic field, is recorded. The instrument is sensitive enough to measure tiny variations in the earth’s magnetic field, variations that might be caused by subtle soil changes or the presence of buried materials. For this application sensitivity of the FM256 was set at 1.0 nanotesla, or about 1/25,000th of the earth’s total magnetic field. Data were collected at 0.5 meter intervals along 0.5 meter spaced parallel north-south lines. Complete 30 meter by 30 meter grid units were each collected at a single time, without interruption. Zero logging was conducted before and after every grid to correct for diurnal variation in the earth’s magnetic field.

The raw magnetic data were downloaded from the FM256 into the Geoplot 3.0 software package. Analyses conducted on the data involved (in the following order) (1) “clipping” to remove high and low data points more than one standard deviation from the mean; (2) “zero
mean traverse” to balance the data values across the separate grids: (3) “despiking” to remove highs and lows more than two standard deviations from the mean, and (4) “interpolation” conducted twice in both the X and Y directions to improve the resolution of the data. The image resulting from this processing is presented as Figure 2. Magnetic highs appear here as darker grays; magnetic lows as lighter grays.

Peregrine and his three students returned to the cemetery on April 18, 2015, to test if soil resistivity surveying might be able to identify interments and unused plots, as this method would not be as sensitive to the presence of metal. Soil resistivity surveying employs two sets of dipoles to measure the resistance to a current run through the ground. Differing soils have differing resistivity (largely due to water content), as do objects such as stone, concrete, and, in this case, caskets. One of the major drawbacks to soil resistivity surveying is that it is a much slower process than geomagnetic surveying, taking roughly five times as long to cover the same area. For this reason, only the oldest part of the cemetery, the southeast, was surveyed using this method.

A Duoyi DY4300 soil resistivity meter was used for this survey, employing a twin electrode array (one stationary pair of electrodes, one mobile). Readings were taken at one meter intervals along parallel lines spaced one meter apart. It was planned that a full 30 meter by 30 meter grid would be collected in this way, but difficulties with the unit setup and other delays forced a restriction of data collection to a 30 meter by 25 meter area, leaving out the easternmost five meters of the planned collection area.

Resistivity data were written into a log-book then transferred to an Excel file. This was then ported into Geoplot 3.0 for analysis. The data were clipped and interpolated to create the base image in Figure 3. The resistivity data were also ported into Quickgrid 5.3 to create a contour plot, which is superimposed upon the Geoplot image in Figure 3. The resistivity contour plot is also superimposed upon the geomagnetic image for the southeastern 30 meter by 30 meter grid in Figure 4, and it is superimposed on an aerial photograph of the cemetery in Figure 5.

Results

The results from the geomagnetic and resistivity surveys were difficult to interpret. Areas with strong magnetic anomalies, likely due to casket construction and hardware, were obvious using both methods. But other interments for which headstones are present showed up weakly, if at all. This is not surprising, given the intensity of the interments with strong magnetic and resistivity signatures, as these overwhelmed the more subtle anomalies of interments that may lack them. However, three areas did stand out as resembling locations of known interments with weak signals, and these are marked with yellow circles on Figure 5. These three areas are interpreted as being unmarked interments (and it is interesting that there are two gravestones leaning against the tree adjacent to all three). There is also a strong magnetic anomaly at the far eastern end of the southern road that runs through the cemetery, near the current location of a burn barrel. It is not clear what this anomaly represents, as it is very near the edge of the cemetery, but it could represent a fourth unmarked interment.
Figure 1. Location of Wisconsin Burial Site BOU-0017
Figure 2: Gradiometer data for entire 60 meter by 60 meter survey area. Blue areas are unsurveyed and mark the locations of headstones and trees.
Figure 3: Resistivity data for the southwest quadrant of BOU-0017, with contour plot and dates of headstones. The blue area was not surveyed.
Figure 4: Gradiometer data for the southwest quadrant of BOU-0017, with superimposed resistivity contour plot and dates of headstones.
Figure 5: Aerial image of the southwest quadrant of BOU-0017 with superimposed resistivity contours, showing the locations of suspected unmarked interments.