Antioch Cemetery Survey

Boise State Forensic Geoscience Hub

April 2026

Ground Penetrating Radar

GPR is an electromagnetic geophysical technique that transmits radio waves into the ground to image below the surface. Changes in media such as air to rock or rock to water cause the waves to change velocity due to differences in electromagnetic properties such as the dielectric permittivity. When the radio waves come into contact with one of these boundaries part of the wave is reflected back up to the sensor.

General rock and soil has a dielectric of about 10, air has a dielectric of 1, and water has a dielectric of 80. For this survey the dielectric of the ground was about 14.

When using GPR to look for burial sites, we are mainly looking for boundaries created by a coffin such as air pockets.

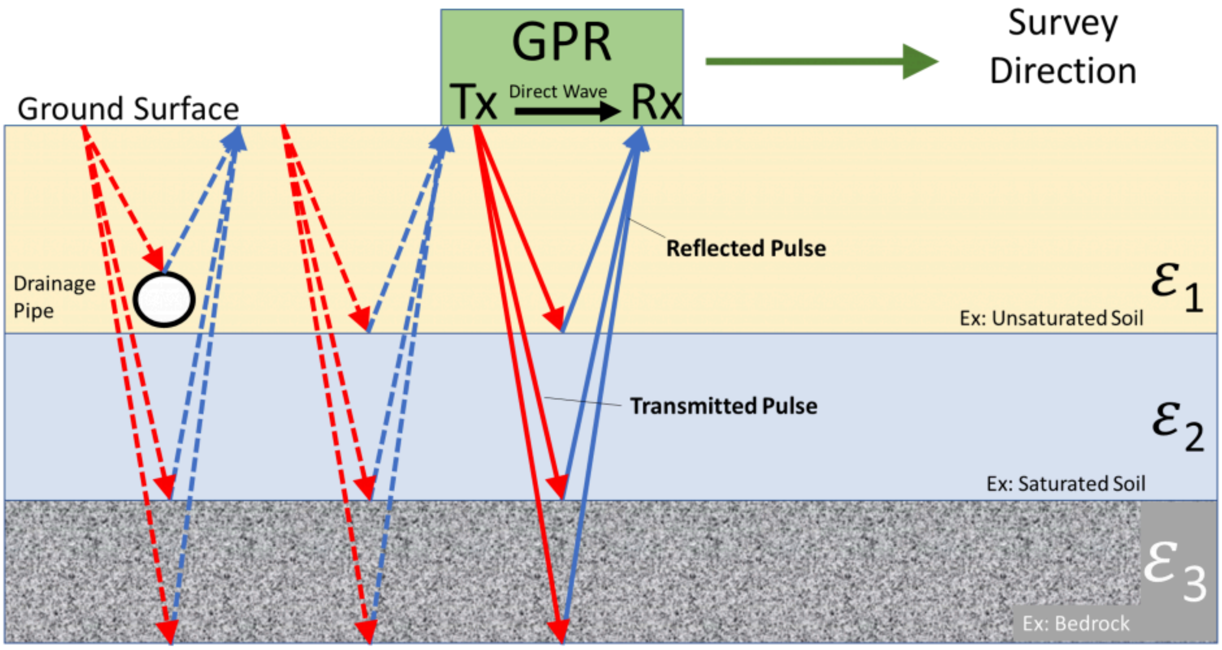

Figure 1: A diagram of a GPR survey where red lines represent transmitted radio waves and blue lines represent reflections. Epsilon (ε_n) is the dielectric permittivity; this value changes based on the material properties.

Credit: US Environmental Protection Agency- Ground Penetrating Radar (GPR)

Survey Data: Profiles

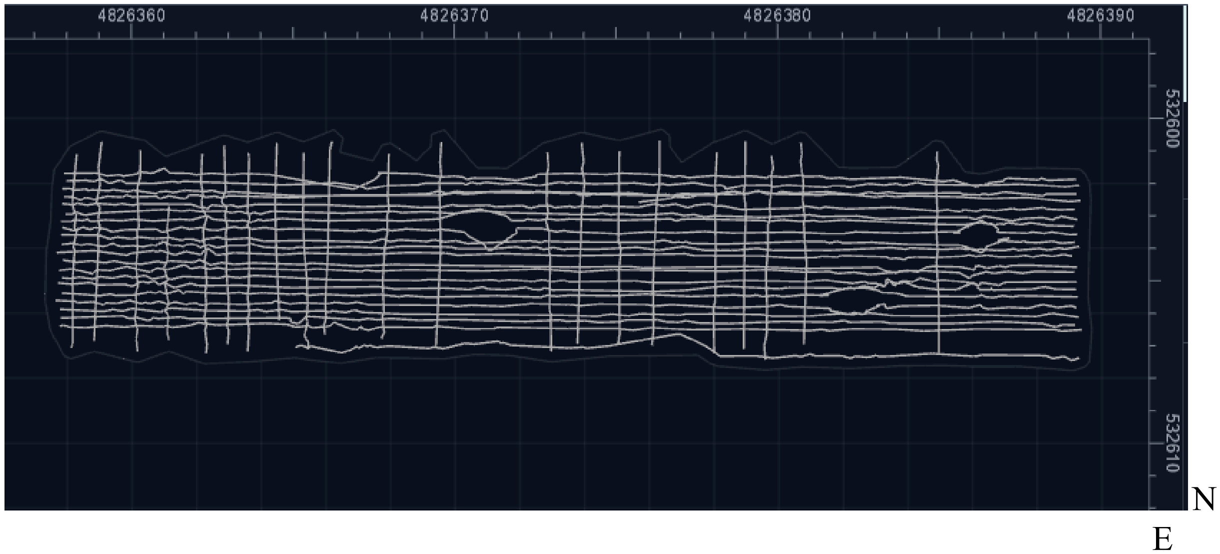

Figure 2: The survey has long North-South profiles and a few East-West profiles. The longer profiles are perpendicular to the hypothesised burial orientations and thus are most likely to exhibit reflections.

The line spacing of the survey is 0.25 meters which resulted in 19 line profiles covering the majority of the cemetery. Below is an example of the profiles. Each shows distance versus depth in meters. The bright whites and blacks are considered high amplitude reflections. Graves are traditionally between 0.5 meters and 2 meters deep. In this data there appears to be a boundary at 2 meters depth. This boundary shows up in each line.

The processing flow adds filters to the data. Among these filters are background subtraction and migration. The background subtraction is used to decrease noise such as reflections from the fence and trees. Migration is used to emphasize amplitudes.

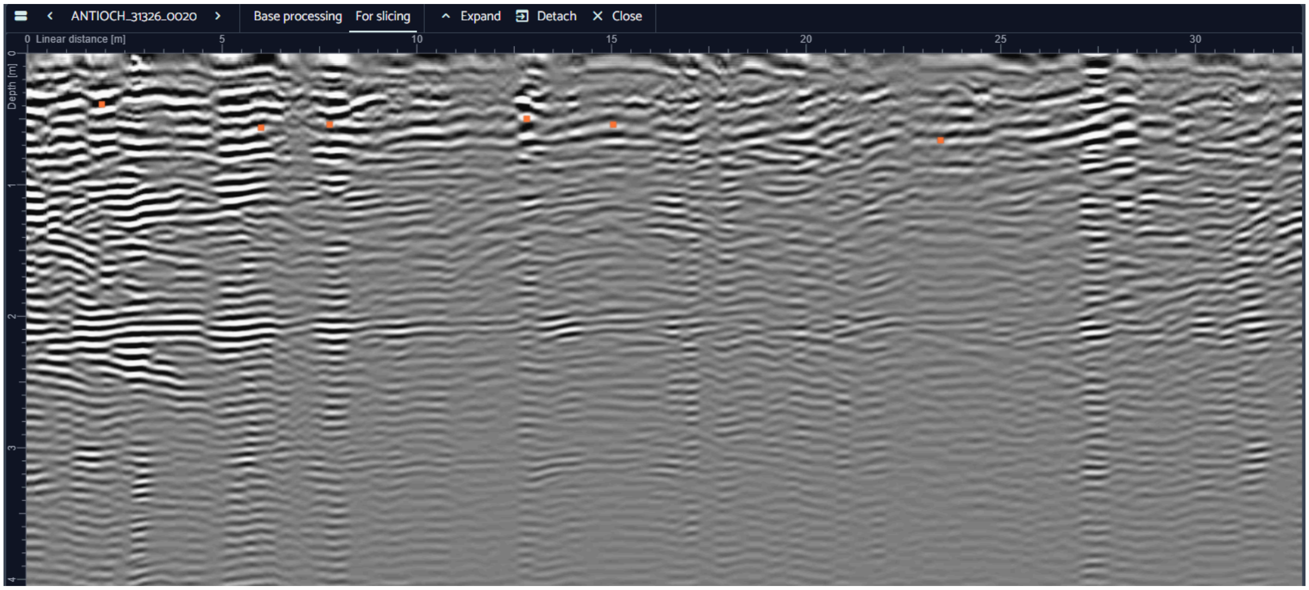

Figure 3: The top 0.2 meters of each profile is filled with noise due to direct waves as a result of ground-coupling. The orange squares are anomaly candidates which are chosen based on their high amplitudes. Also since the profiles were taken in alternating directions, every other profile is flipped from North-South to South-North.

Survey Data: Slicing

As a part of the data analysis work flow, we created slices of the data set based on depth. These slices show high amplitude areas in black and low amplitude areas in white. Each slice is averaged over its depth.

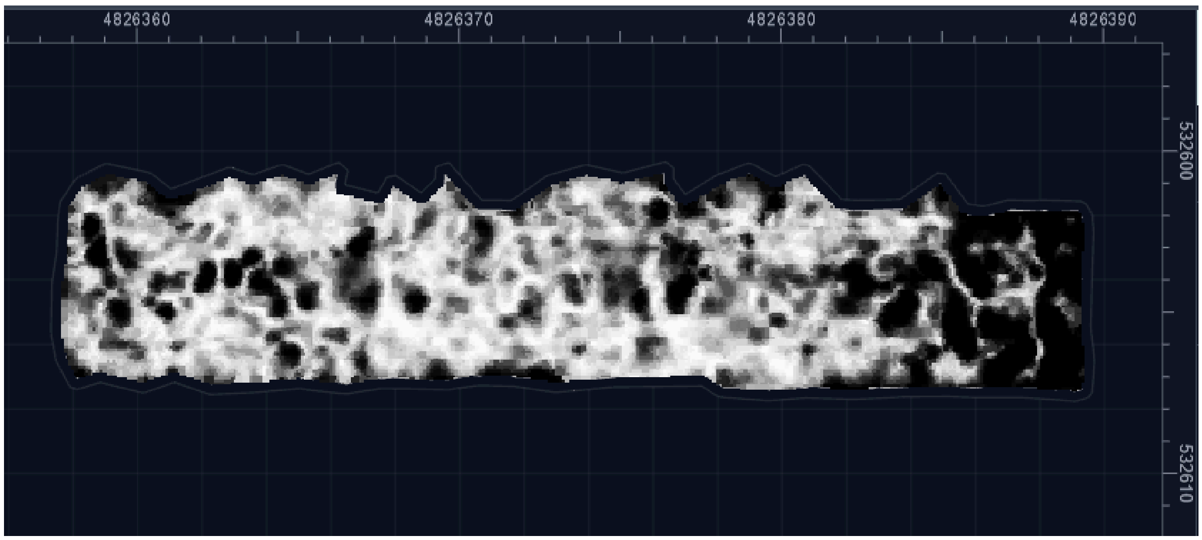

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Figure 4: The axes for this graph are in the UTM coordinate system, zone 11T, with the top of the image being West and the right of the image being North. This slice sits between 0.22 meters and 0.85 meters of depth.

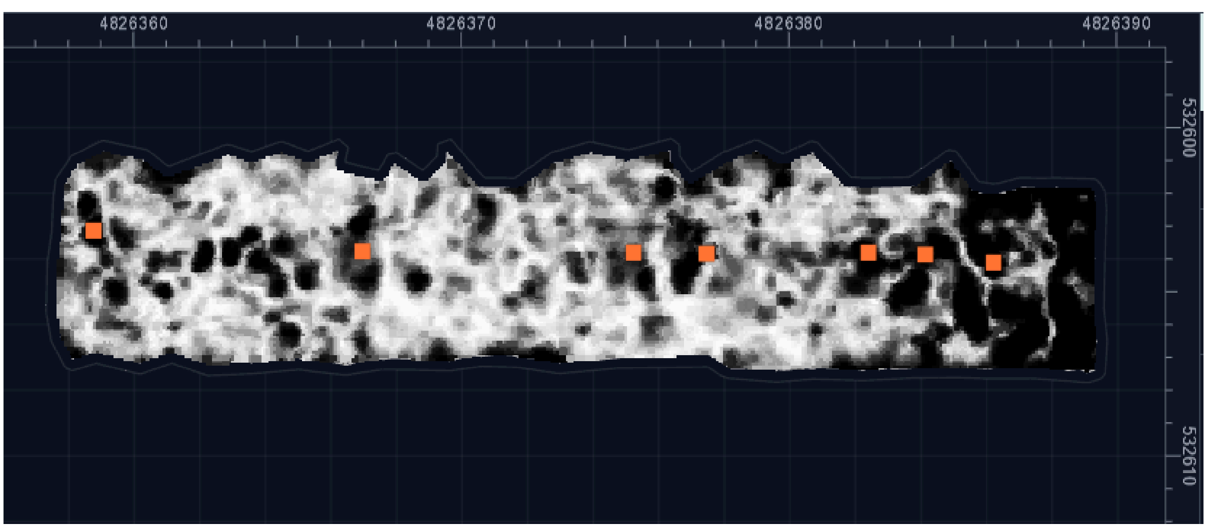

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Figure 5: The orange squares once again represent the anomaly candidates. There appear to be 7 main large anomalies. The northeast corner, while showing some potential

anomalies, was not marked due to terrain variability in that area. There were also no smaller candidates chosen due to lack of differentiation between small candidates and general noise.

Survey Data and Google Maps

Attached with this report is a .kmz file that opens with Google Earth (I recommend using the free downloaded pro version). This file gives coordinates for each marked anomaly candidate.