

Geophysics Process Summary

Ground Penetrating Radar

A ground penetrating radar (GPR) survey is proposed at Nutana Pioneer Cemetery. The GPR team consists of three to four technicians, with undergraduate and graduate students working with the research team as a training and learning opportunity. For the GPR scan, a grid is laid out on the surface and the GPR machine is pushed from edge to edge in 25 cm transects. The time required varies depending on the grid size; a 10 m by 10 m grid takes approximately 1.5 hours. The GPR emits radio waves into the ground and records the reflections of the signal as they rebound off objects underground. These reflections produce a radargram, which is later analyzed and can be viewed as individual slices or as a 3D images, and further interpreted by expert data analysts during post-processing. It can take multiple months to identify areas of interest correctly.

S4 Soil Probing

The S4 soil probe is a new technological prototype that allows subsurface spectroscopy analysis. A probe, the diameter of a pencil, is pushed into the ground to a depth up to 90 cm. At set intervals, between 1 cm and 2.5 cm, light is shone through a sapphire lens at the bottom of the probe that analyzes colour spectra from the soil. These spectra are compared to known values to create a profile of subsurface material. Additionally, the S4 probe includes a pressure sensor that tracks the amount of pressure that the probe requires to push downward into the ground at each interval. For instance, a burial containing refilled soil is expected to be softer than the soil surrounding the burial. This change in pressure can indicate the boundaries of burials and has been shown to do so on burials over 100 years old.

While the S4 soil probe is an intrusive technology, it does not collect any soil or samples from below ground surface, it only pushes into the ground, shines a light to “see” the soil profile, and retracts. It also does not probe deep enough to disturb conventional burials in the cemetery or to locate decomposition residue. The probe's power to push into the ground is set at a level that it will not penetrate rock, root or bone. Upon hitting an object in the soil, the probe will stop and the operator will retract it. The software will indicate that the probe did not reach the full extent and the operator will move to the next position. Grids with the S4 probe are expected to be 2 m by 2 m and the operator follows a transect at approximately 20 cm intervals, with an average of 20 cm between each transect. This grid size will require approximately 6 hours, which can vary depending on how deep the probe can push into the ground and how dry the soil is.

S4 probing technology has been successful in locating unmarked burials with the assistance of GPR. Ground penetrating radar is used to locate subsurface anomalies first. Anomalies that meet the expected parameters for unmarked burials are then analyzed with the S4 probe. The probe can detect spectra from fatty acids caused by human decomposition. Clusters of S4 “hits” in conjunction with lower soil pressure areas and GPR anomalies are very strong indicators of the existence of a burial.