

GROUND PENETRATING RADAR (GPR)

Methodology

Ground penetrating radar (GPR) is a method that provides a continuous, high resolution cross-section depicting variations in the electrical properties of the shallow subsurface. The method is particularly sensitive to variations in electrical conductivity and electrical permittivity (the ability of a material to hold a charge when an electrical field is applied).

GPR operates by repeatedly radiating an electromagnetic pulse into the subsurface from a transducer (antenna) as it is moved along a transect. Since non-metallic materials (e.g., wood, concrete, soil, and rock) are transparent to electromagnetic energy, the radar signal propagates into the subsurface. When the signal encounters a change in electrical permittivity, a portion of the energy is reflected back to the surface where it is detected by the transducer. The stronger the contrast in electrical permittivity, the more electromagnetic energy is reflected. When the signal encounters metal, all of the incident energy is reflected. The reflected signals are printed in cross-section form on a graphical recorder. The resulting records can provide information on the location, depth, and areal extent of buried objects or stratigraphic horizons.

The resolution power and depth of investigation for GPR depends, to a large extent, on the frequency of the transducer. Available frequencies range from as low as 25 megaHertz (MHz) to as high as 1200 MHz. Generally, the higher the frequency, the better the resolution. The lower the frequency, the greater the depth of investigation. Generally, electrically conductive materials, such as saturated clay, uncured or partially cured concrete, or significant amounts of rebar can reduce the penetration capability and limit radar performance.

Data Acquisition

We obtain GPR data using a Geophysical Survey Systems, Inc. SIR-3000 system equipped with either a 270, 400, 500, or 900 megahertz (MHz) antenna, depending upon the depth of investigation and level of subsurface resolution. The instrumentation is mounted on a three-wheeled cart and is moved along a traverse at a slow walking pace. As we move the cart, the detected radar signals are transmitted to the GPR console through an umbilical cable, where the data are digitized, stored in memory, and displayed on a liquid crystal display.

Data Analysis

We then examine the processed GPR records for reflection patterns typical of buried objects and disturbed strata. We then note the locations of these types of patterns relative to surface objects and the locations of other geophysical anomalous areas. The locations of significant reflection patterns are noted and mapped as necessary.