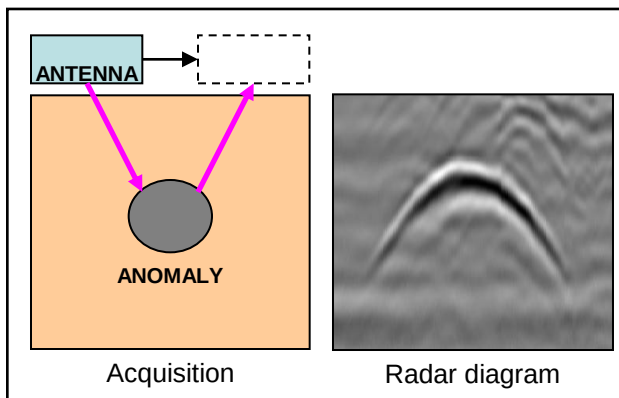
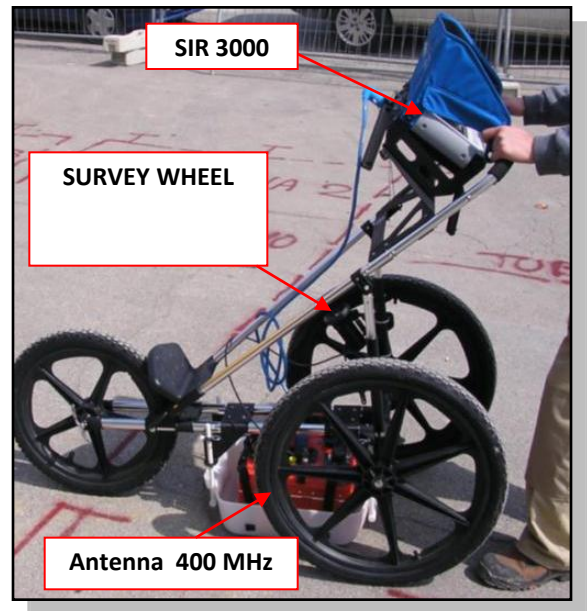


GPR SURVEY METHOD

The ground penetrating radar (GPR - Ground Probing Radar) is a geophysical method used to investigate the near surface underground. Thanks to its high degree of resolution, the GPR is the most effective method for locating cavities, underground tanks or utilities, and buried artifacts, archaeological remains and structures in general. In addition, the GPR can be used to identify geologic contacts, substrates and surface geological features of various kinds (fractures, groundwater levels, etc..).

The GPR (Ground Penetrating Radar) is based on the response of an electromagnetic signal of impulsive high-frequency (20 to 2000 MHz) from a transmitting antenna. The electromagnetic signal generated by the antenna propagates in the subsoil: the difference of electromagnetic properties of the material causes reflection of electromagnetic waves with a energy incident on the discontinuity.



The reflection can be generated by geological contact, soil-rock interface, groundwater levels, different kinds of artifacts and other objects characterized by different dielectric properties). The resolution degree is typically of few centimeters, while the depth of investigation is usually the order of 3-4 m from ground level

GPR equipment (SIR3000 GSSI - USA, represented in the figure in the typical configuration of 400MHz antenna cart) can use different frequency antenna. The choice of the antenna frequency is a function of depth and size of the target object:

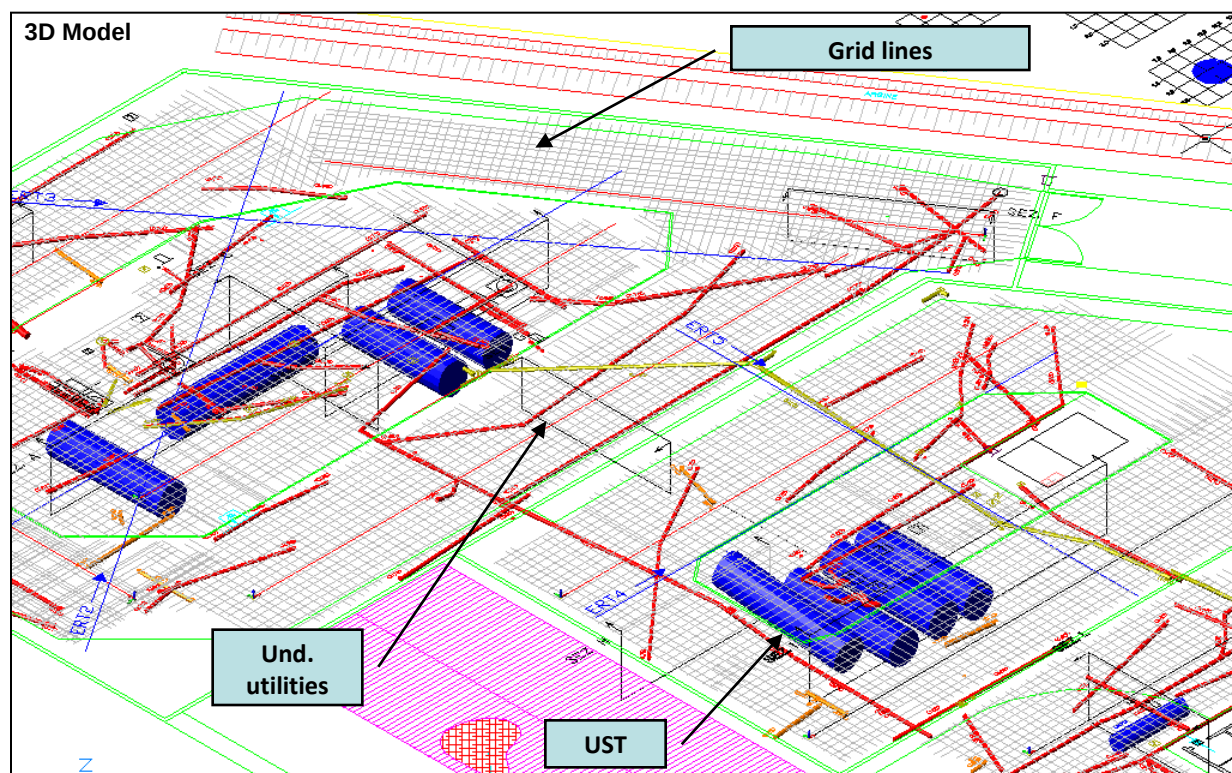
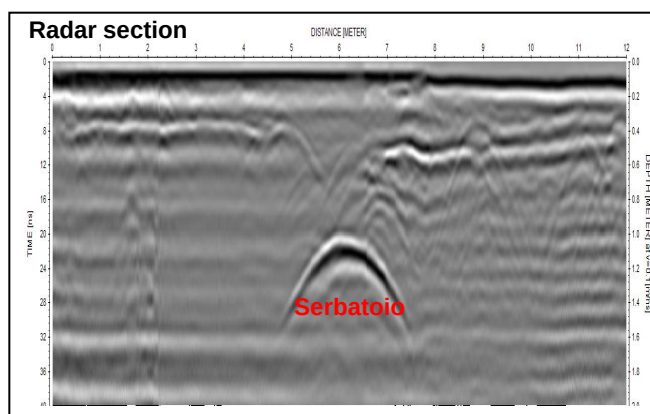
- 1) high frequencies (with a wavelength very small and very high resolution). This is 1.5-2 GHz antennas, for high detailed investigation of concrete structure (rebar location, etc). Depth of penetration < 50 cm
- 2) intermediate frequencies, 250-500 MHz antennas are used in most applications (underground utilities location, archeology, etc..) ; they represent the best compromise between the degree of detail and depth of investigation;
- 3) low frequencies, ie 100-200 MHz antennas, characterized by longer wavelength and lower resolution capabilities. They can reach 10 m depth, but can only identify big structures of minimum dimensions of some decimeters

UNDERGROUND UTILITIES AND STORAGE TANKS DETECTION

For any kind of work involving excavation of the ground, the exact knowledge of the location of underground structures is a key element for proper execution of the work. In this perspective, the use of GPR is an excellent tool to obtain all the information needed to perform the actions provided for in an effective way, safe and without damage to the infrastructure

Thanks to its features (high resolution, speed of execution) the GPR method is one of the most used diagnostic method to detect subsurface structures, with a significant expansion of the possibilities of application.

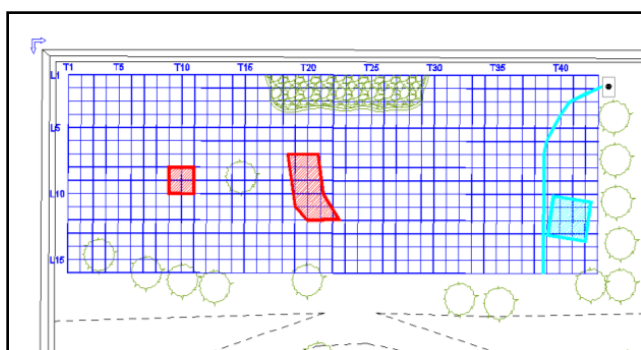
The GPR method can detect underground storage tanks and pipes, underground utilities of any type (metal, plastic and concrete). A typical GPR survey requires the acquisition of a series of lines arranged in a regular grid, in order to investigate the entire site. When a radar profile crosses a cylindrical shape (pipe or tank) across its axis, the electromagnetic signal undergoes a reflection effect that results in a typical hyperbolic shape .



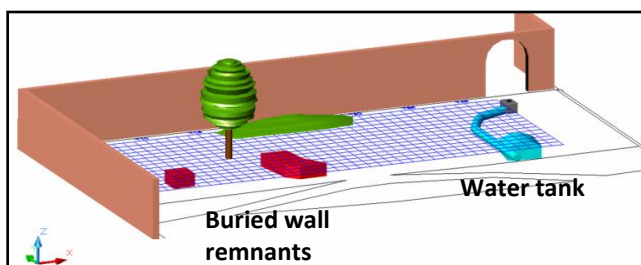
GPR FOR ARCHAEOLOGY

In order to detect the presence of archaeological structures, GPR survey acquisition is arranged in regular mesh of lines (with a spacing generally between 0.5 and 2 m). This type of survey allows the reconstruction of a 3D model with "time-slice" at different depths (maps of the amplitude of the electromagnetic signal at different time of reflection)

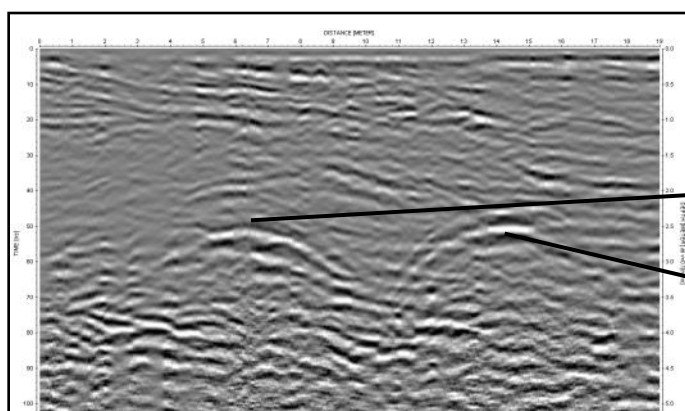
Map with the grid lines



3D model: recognition of the archeological remnants



Radar 2D section



Low frequency antenna (270 MHz)

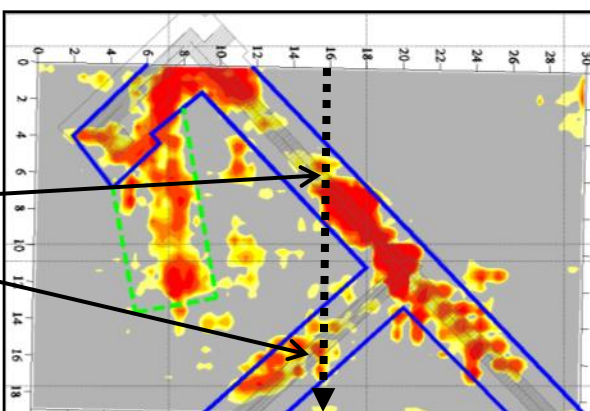


Medium frequency antenna (400 MHz)



Time slice at -2.5 m from the ground surface

Map location of ancient galleries



GPR FOR DIAGNOSTIC OF CONCRETE STRUCTURES

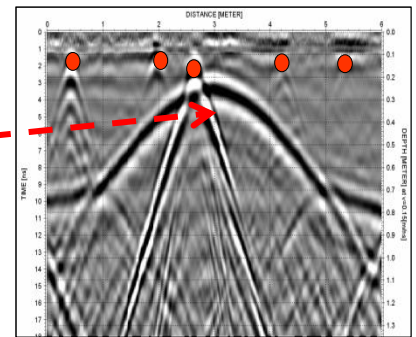
The GPR technology has been improved to meet the requirements needed for radar investigations on building elements. New high frequency shielded antennas ensure very high resolution images.

GPR reconstructions are particularly useful for the diagnostic investigation of historic buildings (to find details or inclusions inside a structural element, like wall, pillar, roof or floor, and the detection of voids, metal or timber elements), inspection of tunnel lining (concrete lining thickness and the variation in thickness, location of defective zones in the concrete lining, e.g. cavities, water leakage, fractured zones, location of steel supports like rock bolts and steel ribs and their omission), inspection of building foundation or any concrete structure.

Studio di ponti



Diagnostic of a hystorical building



Tunnel lining diagnostic

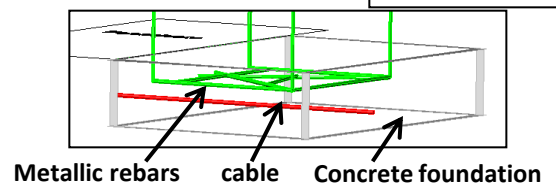


Detection of the reinforcing rebars of the foundation of a utility pole

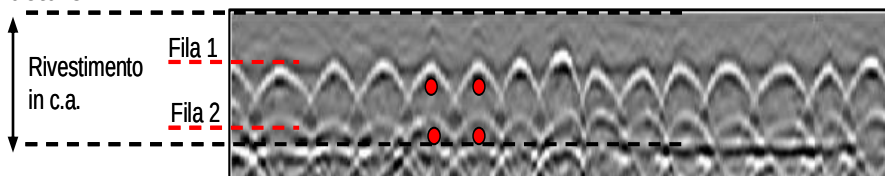
Outside



View in the ground



Reinforce rebars in a concrete structure



BOREHOLE GPR

The Borehole Radar method is mainly used for the determination of unknown bridge foundations (1). An omni-directional borehole radar system with a monostatic (zero-offset) antenna is used in 4-in. diameter, PVC-cased boreholes. For the Borehole Radar (BHR) test the reflection from the soil/foundation boundary (the abutment) is of interest. Frequency of the antenna is usually 300 MHz, which allows a penetration depth of 3-4 m (i.e.: the borehole must be drilled at 1 or maximum 2 meters from the bridge foundations).

Another application of BHR is the evaluation of dams concrete (2). To avoid difficult survey on the dam wall with conventional survey radar, BHR can easily identify defects or voids inside the concrete dam.

