Ground Penetrating Radar

Principle: Ground Penetrating Radar (GPR) is a geophysical method that consists in emitting short electromagnetic (em) pulses from the radio spectrum (UHF and VHF frequencies, tens of MHz up to several GHz) and detecting the reflected signals from subsurface structures. The pulse (a few tens of nanoseconds long) propagates in a shape of a cone. The technique is based on the determination of the difference of speed of light in different type of materials. The principles involved are similar to reflection seismology, except that electromagnetic energy is used instead of acoustic energy, and reflections appear at boundaries with different dielectric constants instead of acoustic impedances.

Basic features: The instrumentation is based by an emitting antenna, a receiving antenna, a control unit and a process unit - that also can act as a visualization tool. Control and processing units are powered by a battery pack, with an autonomy of several hours, depending the ambient temperature.

Resolution and penetration: The depth range of GPR is limited by the electrical conductivity of the ground, the transmitted center frequency and the radiated power. As conductivity increases, the penetration depth decreases. Lower frequencies can reach depths up to tens of meters (e.g. 100 MHz can travel up to 20 meters) with a resolution of tens of centimeters, while higher frequencies can give a resolution of centimeters but up to depths of several meters.

Exploration and application: GPR does not function well in water with a salinity above a few ppm, or in sediments containing clay layers. However it operates well in some fresh water environments, and can also be used in coastal areas where the ground water is fresh and with a low salinity.

Advantages:

- high speed repetition acquisition, up to 100kHz
- high speed recording, the machine were the radar system is mounted may travel with speed up to tens of km/h
- non destructive and non coring method

Disadvantages:

- cannot be used in water with a salinity above a few ppm
- low penetration in high conductivity environments, e.g. clay
- high concentration of water in the ground gives noisy radargram

Literature:

O'Neal, M.L. & Dunn, R.K. 2003. GPR investigation of multiple stage-5 sea-level fluctuations on a siliciclastic estuarine shoreline, Delaware Bay, southern New Jersey, USA. Geological Society, London, Special Publications January 1, 211, 67-77.

Huisman, J. A., Hubbard, S. S., Redman, J. D. & Annan, A. P. 2003. Measuring Soil Water Content with Ground Penetrating Radar: A Review. Vadose Zone Journal, November, 2(4), 476-491.

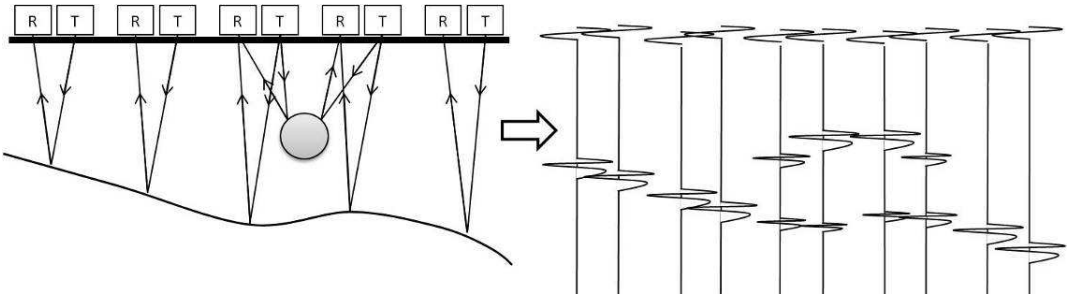

Fig. 1 Illustration of how a radargram is generated.

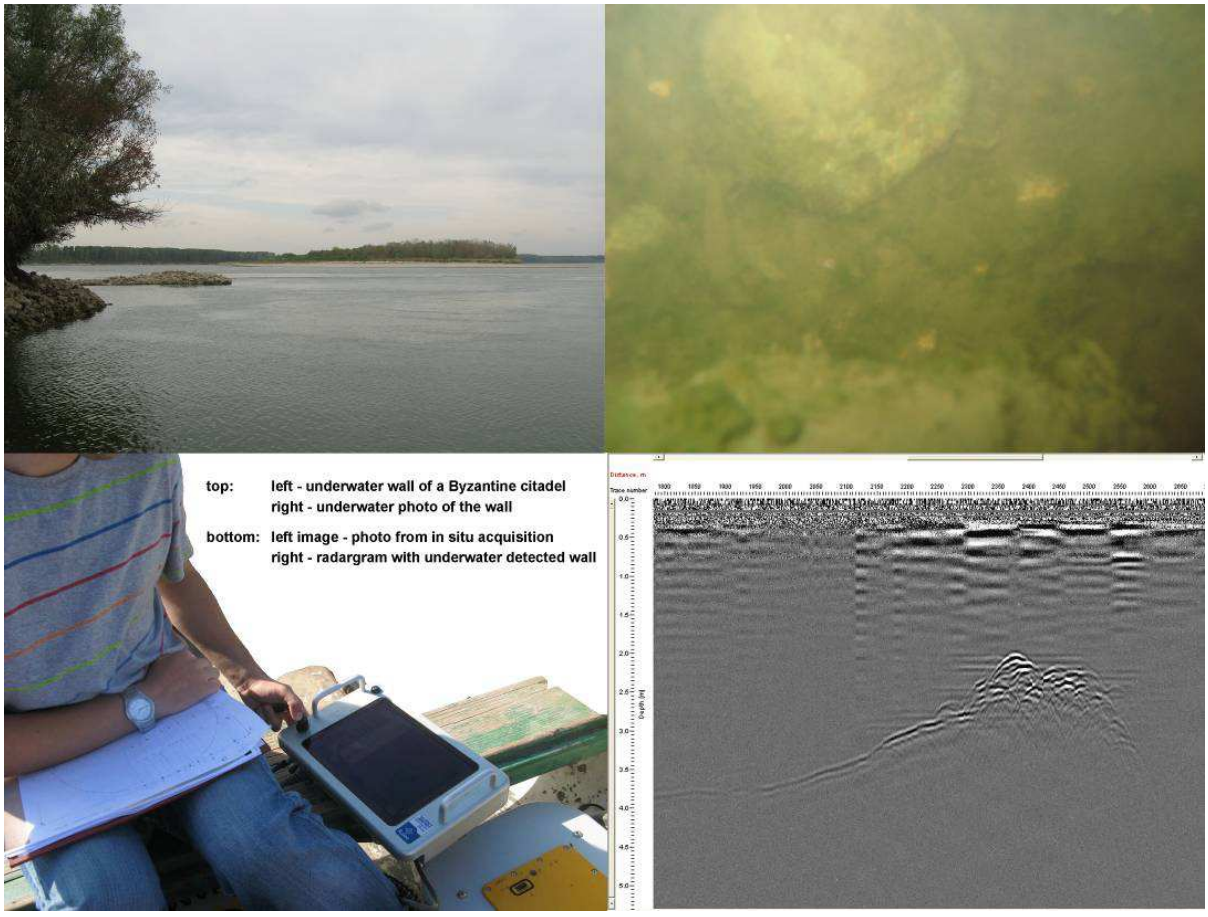

Fig. 2 Example of radargram obtained on a underwater site (Danube river).