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Analysis of the applicability of geophysical methods and computer modelling in determining groundwater level

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The paper presents analysis of the possibilities of application geophysical methods to investigation groundwater conditions. In this paper groundwater is defined as liquid water flowing through shallow aquifers. Groundwater conditions are described through the distribution of permeable layers (like sand, gravel, fractured rock) and impermeable or low-permeable layers (like clay, till, solid rock) in the subsurface.

GPR (Ground Penetrating Radar), ERT(Electrical Resistivity Tomography), VES (Vertical Electric Soundings) and seismic reflection, refraction and MASW (Multichannel Analysis of Surface Waves) belong to non – invasive, surface, geophysical methods.
Due to differences in physical parameters like dielectric constant, resistivity, density and elastic properties for saturated and saturated zones it is possible to use geophysical techniques for groundwater investigations.
Few programmes for GPR, ERT, VES and seismic modelling were applied in order to verify and compare results. Models differ in values of physical parameters such as dielectric constant, electrical conductivity, P and S-wave velocity and the density, layers thickness and the depth of occurrence of the groundwater level. Obtained results for computer modelling for GPR and seismic methods and interpretation of test field measurements are presented.
In all of this methods vertical resolution is the most important issue in groundwater investigations. This require proper measurement methodology e.g. antennas with frequencies high enough, Wenner array in electrical surveys, proper geometry for seismic studies.
Seismic velocities of unconsolidated rocks like sand and gravel are strongly influenced by porosity and water saturation. No influence of water saturation degree on seismic velocities is observed below a value of about 90% water saturation. A further saturation increase leads to a strong increase of P-wave velocity and a slight decrease of S-wave velocity. But in case of few models only the relationship between differences in density and P–wave and S-wave velocity were observed. This is probably due to the way the modelling program calculates the wave field.
Trace by trace should be analyzed during GPR interpretation, especially changes in signal amplitude. High permittivity of water results in higher permittivity of material and high reflection coefficient of electromagnetic wave.
In case of electrical studies groundwater mineralization has the highest influence. When the layer thickness is small VES gives much better results than ERT.