Geophysical Research Abstracts,
Vol. 11, EGU2009-12147, 2009
EGU General Assembly 2009

Multidisciplinary geophysical and geotechnical approach to inhomogeneous subsoil characteristics. GPR, refraction seismic, EM multi-frequency radiation, magnetometry and geomechanical approaches

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A multidisciplinary survey has been applied in a test site composed by a filled natural valley of decametric scale. The survey surface have been flattening before the survey making that the valley filling change its thickness from side to side, but also from upstream to downstream. The objectives have been to test and characterize different techniques and to analyze their limits in the same conditions. The valley developed over the Miocene substratum composed by gypsum and clays while the filling is composed by clays, gravels and located urban debris.
The applied techniques have been GPR (shielded antennas with central frequency of 100 and 250 MHz), magnetometry, EM multi-frequency radiation and refraction seismic. The survey has been aided by boreholes and dynamic penetration tests.
The change between substratum and filling represents a very clear change of the Vp, the magnetic susceptibility, apparent conductivity and attenuation of the GPR waves. The sensitivity of the located urban debris to the different techniques is maxima in the case of magnetometry (higher intensity of the magnetic field and development of dipoles over the urban debris), higher apparent conductivity and propagation velocity of the GPR waves.
The limit between the filling and the substratum is clearly identified in the gpr-profiles as a reflector (linked to a change in the wave attenuation), on the other hand the urban debris represent clusters of hyperbolic anomalies related with higher propagation velocities, higher reflectivity and the model of scattering hyperbolae show lower values of the dielectric constant.
The different results obtained from the different techniques and the different models obtained are compared with the boreholes. From both GPR devices a 3d model from the position of the substratum-filling surface, the propagation velocity and the dielectric constant (obtained from the fitting hyperbolae) and the lateral correlation between parallel gpr-profiles of the amplitude strength are compared with the EM model (apparent conductivity and susceptibility for 5 different frequencies), magnetometry (intensity of magnetic field) and model of velocity propagation of Vp waves.
The obtained conclusions show the limits and reliability of the different techniques being compared in the same settings. On the other hand, the potential application in engineering geology, comparing the geophysical methods with results from boreholes and the dynamic strength of the subsoil materials, is also analyzed.