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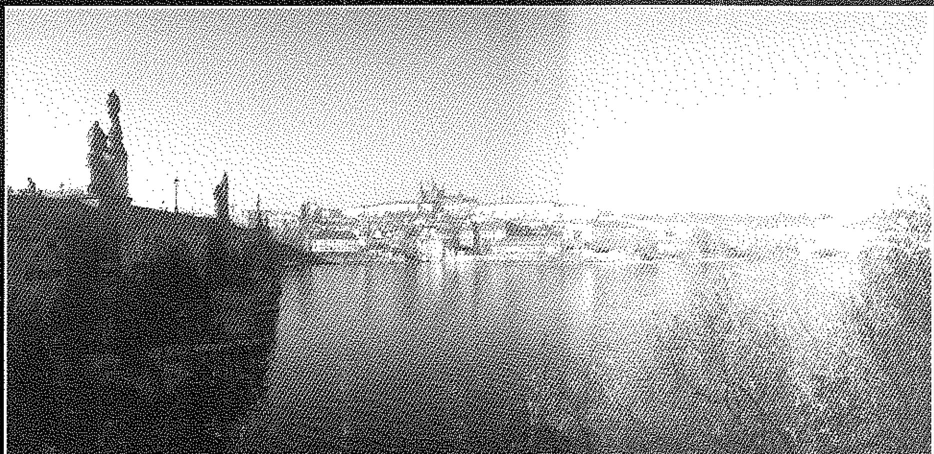

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Proceedings

This result is in good agreement with the grain size distribution of the soil (see figure 4) which contains 80 % of grains which diameter is bigger than five millimeters.
(This grain size can be interpreted as a detection limit by this method. ??)

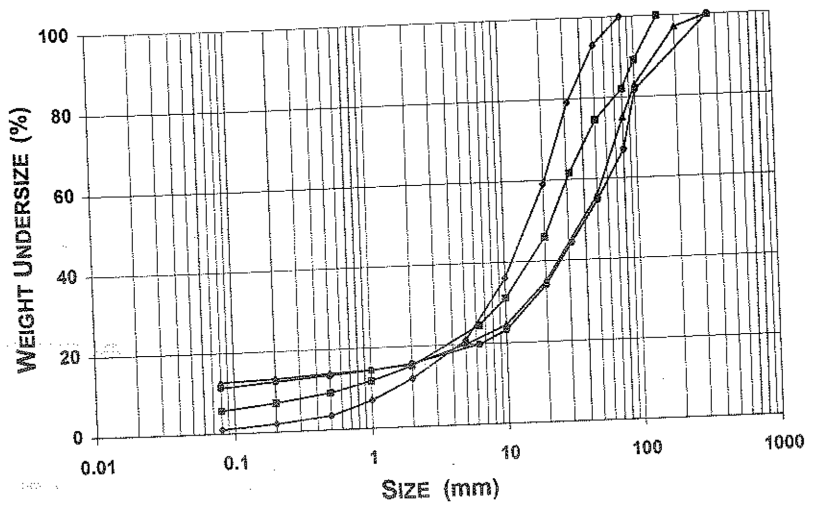

Figure 4 : Grain size distribution of the experimental soil. All samples contain 20 % of grains which size is less than 5mm.

CONCLUSIONS AND PERSPECTIVES

In this study we have found a numerical correlation between average resistivity and percentage of inclusion using two classical softwares. A good fit of the data is obtain using the Bussian's theorical differential effective model (DEM) approximation. When applicated to the alluvial cone deposits of torrent Manival, we are able to find back it's calcareous percentage with a satisfaying uncertainty.

Next we are going to test the robustness of this correlation with cylindrical and non-jointed inclusions, using the finite-element software CESAR-LCPC. It will allow us to compare predictions obtained by both electrical and seismic modelling.
Otherwise we're looking for how to quantify the size of the grains.

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POROSITY AND WATER SATURATION DEGREE FROM COMBINED RESISTIVITY AND SEISMIC SURVEYS FOR GEOTECHNICAL SITE CHARACTERIZATION.

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INTRODUCTION

Porosity and water saturation degree are some of the physical parameters that are commonly estimated in site characterization studies by laboratory tests in selected samples from geotechnical soundings. This kind of procedure gives discrete results, is time consuming and needs heavy equipment.

Some laboratorial works are being done (Carrara et al. 1999, Berryman et al., 2002) in order to improve the understanding of relationships between geophysical measurements and soil physical and hydrological properties. Based on this idea the aim of the present work was to evaluate porosity and water saturation degree, from the combination of geophysical measurements of resistivity and seismic velocity. With this approach it is possibly to have an estimation of both vertical and horizontal variation of these properties.

Some authors states that seismic methods are more suitable for determination of subsurface structure and porosity (Lines et al., 1993, Guéguen and Palciauskas, 1994 and Mathisen et al., 1995) and electrical methods are best for identifying fluids and saturation (Wilt et al., 1995 a, b). Meju et al. (2003) suggests that porosity is a connecting factor between resistivity and velocity in the near-surface.

An iterative procedure was developed using Archie's law (Archie, 1942) and a relationship between resistivity and seismic velocity derived by Carrara et al. (1999) in order to estimate porosity and water saturation degree from 2D inversion of seismic refraction and resistivity survey data. Some parameters, such as resistivity and seismic velocity for air, matrix, water and clay are imposed as a constant all along the calculation process.

FIELD PROCEDURE

Geologically the test site is a granite region (a quarry of granite is located around 500 m from the site) overlapped by sand.

The equipment used to perform the resistivity survey was an ABEM Lund Imaging System (Griffiths *et al.*, 1990; Dahlin, 1996). The array used was the dipole-dipole, with 6 m dipole spacing.

Seismic data was recorded with a Bison 9000 multi-channel seismograph. As this seismograph has only 24 channels, in order to achieve the same length as in the resistivity profile, two seismic profiles were performed in the same line of the resistivity profile, one with 24 geophones and the other with 12 geophones, both with a geophone distance of 6 m.

There was an error in the settlement of the second section of the seismic profile which gave a gap of information in the middle of the profile. This was corrected with an interpolation between the ends of each reflectors. It was used explosive as energy source with shot position at the marked places in figure 1, which generated direct and inverse shots. Seismic and resistivity profiles were apart about 0.5 m.

At this site 12 resistivity profiles were performed in six different locations using Wenner array and dipole-dipole array and four seismic profiles. At the particular location here presented the seismic profile took place while the resistivity survey was carrying on. The errors reading in resistivity profile were identical to those obtained in the other locations where the seismic survey took place after the resistivity was completed. The seismic signals were also identical from this survey to the other three. So there is no problem of conducting both surveys at the same time as it was already concluded by Scott et al. (1999). The survey took place in May and the topsoil was dry.

POROSITY AND WATER SATURATION DEGREE

Resistivity and seismic models are presented in figure 1. The first one was obtained with the Res2DInv software (Loke and Barker, 1996; Loke, 1999) while the seismic data was inverted with Gremix software (Interpex, 1990).

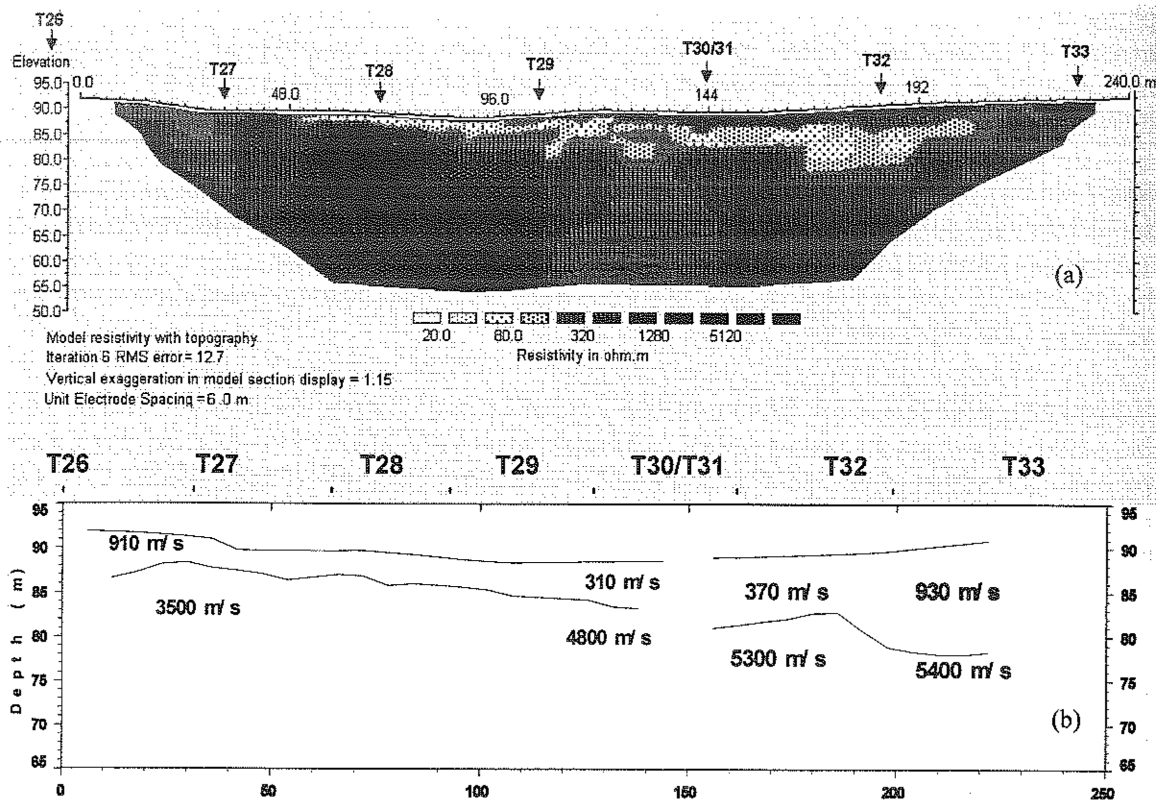

Figure 1 – Resistivity (a) and seismic velocity models (b).

The results from both inversions were conjugated using Archie's law (Archie, 1942) and a relationship between resistivity and seismic velocity derived by Carrara et al. (1999):

$$v = \frac{1}{\frac{(1-\phi)(1-P_{cl})}{v_m} + \frac{(1-\phi)P_{cl}}{v_{cl}} + \frac{S_w \phi}{v_w} + \frac{\phi(1-S_w)}{v_a}}$$

Where ϕ is porosity, S_w is water saturation degree, P_{cl}, is clay percentage and v_m, v_{cl}, v_w and v_a, are velocity for matrix, clay, water and air, respectively.

The iterative procedure developed uses a simple square root minimising calculation between the velocity model values and those derived from Carrara's relation. During the iterative process some parameters such as resistivity and seismic velocity for air, matrix, water and clay were imposed as a constant.

In figure 2 the obtained pseudo-sections of porosity and saturation degree are presented.

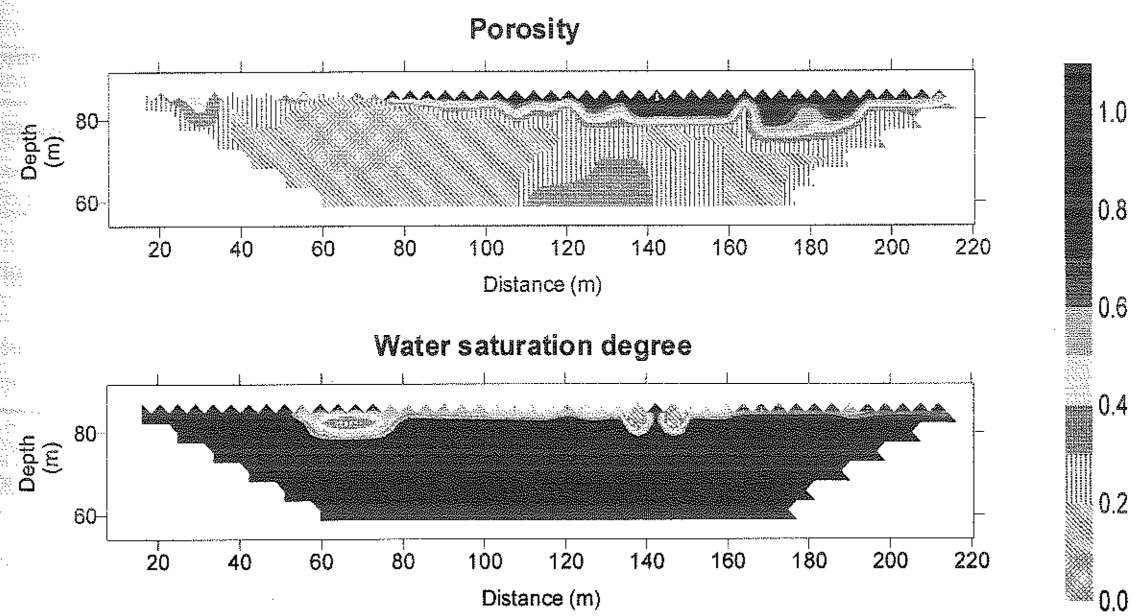

Figure 2 – Pseudo-sections of porosity and water saturation degree, for profiles presented in figure 1.

DISCUSSION

The observation of figures 1 and 2 leads to the conclusion that porosity is more influenced by resistivity than by velocity, in opposition to what is defended by Lines et al.(1993), Guéguen and Palciauskas (1994) and Mathisen et al. (1995). Further work is needed in different geological environments, to see if this conclusion is only valid for the special environment present at this test site or if it is valid for any kind of geological environment and top-soil saturation state

With the approach here presented, although it is an indirect technique that gives estimation of physical properties instead of precise values, one gets an image of the distribution of these properties instead of discrete results, as in the classical procedure.

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