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DATA INTEGRATION IN SITE CHARACTERIZATION

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Summary. Geophysical tests are widely used in site characterization for geotechnical and geo-environmental applications. A wide range of methods is available to reconstruct geometrical features of the subsoil and to determine physical and mechanical parameters. Data integration is very often performed only at the final stage in the construction of the subsoil model, when the results of different tests are combined, leading to possible inconsistencies and difficulties in obtaining coherent parameters. Integration at an earlier stage, during the interpretation of experimental data may provide more consistent and robust models. Moreover, additional information from borehole logs and laboratory testing can be introduced. The procedure may benefit from the adoption of unifying theoretical frameworks that allow different phenomena to be considered simultaneously. Examples of combined interpretation of different seismic and electrical datasets will be illustrated to discuss the potential benefit of data integration. Similar approaches could be devised in the interpretation of other tests currently adopted for site characterization.

1 INTRODUCTION

In situ testing is a fundamental step in site characterization as geomaterials can be investigated in their natural state at the scale that is relevant for most applications. In particular, geophysical methods provide valuable information as they are based on non-invasive measurements of the subsoil response to a variety of external excitations.

Geophysical methods typically require the solution of an inverse problem, which on the basis of recorded experimental data aims at estimating model parameters for the subsoil. Several sources of uncertainties may affect the outcome of such an inverse problem [1]:

- experimental uncertainties on the measurements (repeatability, systematic errors, etc);
- model uncertainties associated to the assumption of a specific subsoil model (i.e. horizontally stratified model in surface wave testing) or from a-priori assumptions on the values of the parameters (e.g. regularization in seismic or electrical tomography);
- solution non-uniqueness (i.e. different sets of model parameters can honor equally well the available experimental data also accounting for the their associated uncertainty).

Integration between different methods and different datasets can provide a more reliable site characterization, reducing the uncertainties associated to a single measurement. Moreover, each method explores a specific volume of the subsoil. Integration of different methods can provide high local resolution while characterizing large extents of the site. Different levels of integration can be implemented between datasets [1]:

- very often different methods are applied at the same site to verify the accuracy of the results [2]. In such applications it is important to recall the differences in investigated volume between different methods;
- combined interpretation of results from different geophysical surveys is often use for the development of an overall model of the site;
- information from a dataset can be used to impose constrains or to set a-priori values in the solutions of the inverse problem of a second dataset [3];
- the highest level of integration is represented by joint inversion approaches in which different datasets are fully coupled to improve robustness and reliability of the results [4].

Within this framework, information from laboratory tests provide additional valuable information.

2. INTEGRATION OF SEISMIC AND ELECTRICAL DATA

Seismic and electrical measurements can be profitably combined to get consistent soil models using approaches with different levels of integration. The basic level is based on sharing the geometry of the geophysical models in methods which assume horizontal layering [1]. In this case, a more consistent solution is obtained as the number of unknowns is reduced. A further improvement is achieved as fundamental relationships are introduced to include a physical coupling between geophysical parameters. In particular, porosity can be used to link the seismic model and the electrical one within the framework of porous media theory [4]. An example of integrated seismo-electrical model for unsaturated materials and its application for the characterization at the laboratory scale is reported in [5].

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