



## **A principal component analysis to interpret the spectral electrical behaviour of sediments**

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Spectral Induced Polarization (SIP) measurements provide the opportunity to evaluate both conduction and polarization processes occurring in a porous medium. Conduction properties are related to the pore volume (for coarse grained materials) and also to the pore surface (for fine grained materials), whereas polarization properties are mainly controlled by the pore surface. Thus, SIP is a valuable survey method and its applicability ranges from aquifer characterization to organic and inorganic contaminant detection. However, the high number of factors affecting the spectral electrical behaviour still prevents an easy and unambiguous interpretation of SIP measurements. Controlled laboratory experiments by different research groups have shown that the resistivity phase depends on pore/grain size distribution, clay percentage, specific surface area, water saturation/conductivity and packing, among other factors. In the analysis of natural samples, all these variables are often simultaneously unknown and the direct application of the laboratory-derived empirical relationships between geophysical and sedimentological properties is not trivial.

In this framework, we performed SIP laboratory measurements on unconsolidated alluvial samples of the Po river and Lambro river depositional units (Northern Italy). These samples were fully saturated with NaCl solutions with increasing electrical conductivity. SIP measurements were analysed using a Debye Decomposition technique and by fitting two Cole-Cole-type models (i.e. the Cole-Cole and the Generalized Cole-Cole). A principal component analysis was then applied separately on the three different subsets of model parameters. The main aims of this analysis were: i) to cluster the samples according to their spectral properties; ii) to evaluate differences and similarities of the fitting models in terms of the most significant combinations of parameters able to describe the overall variability within the dataset; iii) to analyse litho-textural (granulometric class weight percentage, characteristic diameters, non-uniformity coefficients, porosity, mineralogical phases in the finest granulometric fraction, organic matter content) and chemical (electrical conductivity of the saturation fluid) properties of each cluster in order to link sedimentological and geophysical properties.

Preliminary results show that this analysis is effective to identify samples that share comparable amplitude and phase spectra but have different properties of the solid and fluid components. Such a proper samples classification prevented the derivation of distorted empirical relationships between electrical and sedimentological parameters. On the other hand, the proposed approach highlights spectral similarities which are not apparent in available sedimentological data, thus indicating the need to consider additional variables in the explanation of the bulk complex electrical response (e.g. the spatial distribution of the fine granulometric fraction).