Detailed 3D Subsurface Geophysical Model: Data Integration, Multi-parameter Inversion and Statistical Integrated Interpretation: The case study of the Zancara River Basin (Cuenca, Spain)

Ignacio Marzan[1], David Martí[1], Juaquina Alvarez-Marron[1], Agusti Lobo[1], Mario Ruiz[1], Montserrat Torne[1], Ramon Carbonell[1]

[1] CSIC-ICTJA Inst. Earth Sciences Jaume Almera, Barcelona, ramon.carbonell@csic.es

The main objective of this study is to improve the geophysical characterization resulting from a shallow 3D high resolution travel-time tomography survey (500 x 500 m). This survey was acquired in Villar de Cañas (Cuenca, Spain) in late 2013 and early 2014. Lithology down to 150 m depth at this site is characterized by endorheic sediments, mainly siltstone and gypsum. After processing the tomography data, the velocity model showed a good correlation with geology models and borehole data except for the siltstone-gypsum transition. The model involves two lithological limits: the "transition layer - massive gypsum layer" (well resolved by a relatively high velocity contrast) and the "siltstone layer - transition layer" (constrained only in the central part of the model by a relatively low velocity contrast). As electrical resistivity is able to characterize shale-gypsum transitions, we complemented the seismic data with results from a collection of 2D ERT surveys, for which we build a new 3D grid with 2 parameters by node: velocity and resistivity. In order to derive a geological interpretation, we applied a statistical classification method (Linear Discriminant Analysis) to the new bi-parametric grid, using reference classes from well logs. This process resulted in a final 3D lithological model with less ambiguity and thus with a better definition of the two limits under discussion. Our study shows that the integration of seismic and electric methods significantly improves geological characterization in a gypsiferous context.

Seismics, electrics and well logging have been shown as a good set for shallow subsoil exploration. However, the integration of the results of these techniques in order to derive a geological interpretation is complicated beyond a qualitative (subjective) correlation. In this study, we propose a quantitative joint interpretation of three separate geophysical datasets (a velocity model, a resistivity model and well logs) to characterize geological transitions in a shallow gypsiferous context in Villar de Cañas (Cuenca, Spain). We integrated the two models in a new 3D grid, and in order to derive a geological joint interpretation, we applied a supervised statistical classification method, LDA. The algorithm was fitted using a training set compiled from the well logs. Thus, every node is lithologically classified according to its velocity-resistivity relationship, resulting in a new 3D lithological model. This new model integrates both seismics and electrics resolution capacities, showing better agreement with geology profiles and topwells than those techniques separately. (Research supports: CGL2014-56548-P, CGL2016-81964-REDE; SIT4ME EIT-KIC-RawMaterials; 2017-SGR-1022).