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Subsurface multidisciplinary research results at ICTJA-CSIC downhole lab and test site

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Two scientific boreholes, Almera-1 and Almera-2 were drilled in the Barcelona University campus area in 2011. The main purpose for this drilling was to create a new geophysical logging and downhole monitoring research facility and infrastructure. We present results obtained in the frame of multidisciplinary studies and experiments carried out since 2011 at the ICTJA "Borehole Geophysical Logging Lab - Scientific Boreholes Almera" downhole lab facilities. First results obtained from the scientific drilling, coring and logging allowed us to characterize the urban subsurface geology and hydrology adjacent to the Institute of Earth Sciences Jaume Almera (ICTJA-CSIC) in Barcelona. The subsurface geology and structural picture has been completed with recent geophysical studies and monitoring results. The upper section of Almera-1 214m deep hole was cased with PVC after drilling and after the logging operations. An open hole interval was left from 112m to TD (Paleozoic section). Almera-2 drilling reached 46m and was cased also with PVC to 44m. Since completion of the drilling in 2011, both Almera-1 and Almera-2 have been extensively used for research purposes, tests, training, hydrological and geophysical monitoring.

A complete set of geophysical logging measurements and borehole oriented images were acquired in open hole mode of the entire Almera-1 section. Open hole measurements included acoustic and optical imaging, spectral natural gamma ray, full wave acoustic logging, magnetic susceptibility, hydrochemical-temperature logs and fluid sampling. Through casing (PVC casing) measurements included spectral gamma ray logging, full wave sonic and acoustic televiewer. A Quaternary to Paleozoic section was characterized based on the geophysical logging and borehole images interpretation and also on the complete set of (wireline) cores of the entire section. Sample availability was intended for geological macro and micro-facies detailed characterization, mineralogical and petrophysical tests and analyses.

The interpretation of the geophysical logging data and borehole oriented images, and core data allowed us to define the stratigraphy, structures and petrophysical properties in the subsurface. Quaternary sediments overlie unconformably weathered, deformed and partially metamorphosed Paleozoic rocks. A gap of the Tertiary rocks at the drillsite was detected. Structures at intensely fractured and faulted sections were measured and have yielded valuable data to understand the subsurface geology, hydrology and geological evolution in that area.

Logging, borehole imaging and monitoring carried out in the scientific boreholes Almera-1 and Almera-2 has allowed also to identify three preferential groundwater flow paths in the subsurface. Geophysical logging data combined with groundwater monitoring allowed us to identify three zones of high permeability in the subsurface. Logging data combined with core analysis were used to characterize the aquifers lithology and their respective petrophysical properties. We also analyzed the aquifer dynamics and potential relationships between the variations in groundwater levels and the rainfalls by comparing the groundwater monitoring results and the rainfall.

A seismic survey was carried out to outline the geological structures beyond Almera-1 borehole, a vertical reverse pseudo-3D (2.5D) seismic tomography experiment. The results allowed us to define the geological structure beyond the borehole wall and also a correlation between the different geological units in the borehole and their geometry and spatial geophysical and seismic image.