



An integrated deep electrical resistivity model of the Larderello geothermal field (Italy)

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A new deep electrical resistivity acquisition was carried out in Larderello geothermal area (Tuscany Region, Italy) by 3D Deep Electrical Resistivity Tomography (3D-DERT) and Magnetotelluric (M) acquisition. The investigated area is located close the Venelle2 well in the southern part of Larderello site, where there is the oldest field in the world under exploitation for power production (actual installed capacity is about 795 MWe). A vapour-dominated system is exploited to depth over 3500 m, with temperatures exceeding 350°C, from two different reservoirs. The Larderello area has been investigated by many geological and geophysical data of previous exploration projects but nowadays several critical issues on deep features of the field are still matter of debate, e.g., permeability distribution in the hydrothermal reservoir and the presence of fluids at supercritical condition at depth.

The 3D-DERT system was designed by Surface-Surface and Surface-Hole electrode distributions in the area around Venelle2 well covering an area around 16km². The well (kindly provided by Enel GP) was accessible down to 1.6 km with a temperature up to 250°C and a metallic casing down to 1 km. The in-hole thermal cable is characterized by n.12 flexible metallic electrodes with an electrodes space of 50m covering the open-hole portion (1050m-1600m). The surface electrodes are located around the Venelle2 hole on n.23 different positions connected to automatic datalogger to acquire the drop of potential and to transmitter device to inject the current (5-10A). The crucial task was the data processing, considering the large distance between the Tx and Rx systems that strongly reduces the signal to-noise ratio. To overcome this drawback, for each quadripole position the corresponding voltage signal was filtered, stored and processed with advanced statistical packages.

The new 22 station were installed in the studied area and the data were carried out taking in account a permanent remote station in the Capraia Island. A Zonge International Inc multi-channel 32-bit receivers able to record broadband time-series from 0.0001 to 1 kHz, was used. For each site, we recorded at least 17 hours using the sampling rate of 256 Hz and one hour with a sampling rate of 4096 and 1024 Hz.

The integration of MT model and experimental DC resistivity measurements improved the knowledge on the deep structures of the Larderello field. The interpretation took advantage also of a detailed and integrated 3D modelling of many geological and geophysical data available in the area.

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