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Passive geophysical methods for geothermal exploration in the External Crystalline Argentera Massif of the Western Italian Alps: Gravity and Magnetotelluric

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In the Argentera Massif in the Western Italian Alps, two thermal sites are exploited for spa utilization at Bagni di Vinadio and Terme di Valdieri
The Argentera Massif is the southernmost of the External Crystalline Massifs of the Western Alps and can be divided into two main complexes: the Malinvern-Argentera Complex mainly constituted by migmatitic gneisses and intruded my granitic formations and the Tinée Complex constituted by anatectic gneisses. These two complexes are separated by a 3km wide fault zone trending NW-SE named the Bersezio Fault Zone. Moreover the Malinvern-Argentera Complex is crossed, in the southern part, by a East-West Shear Zone named the Fremamorta Shear Zone wich dips towards North.
The studied thermal springs reach a temperature up to 72˚C at Bagni di Vinadio and 65˚C at Terme di Valdieri. The geochemical composition of these waters provides information about the origin, the circulation paths and the depth reached by these hot fluids. Meteoric water infiltrates through the Massif and interacts with the hosting rocks , getting a NaCl composition for the waters of Vinadio and NaSO4 for the ones at Valdieri. The reservoir temperature has been estimated to be 130˚C for the waters of Vinadio and 110˚C for the ones at Valdieri. Thermal waters therefore cool down during their upflow towards the surface, especially in the last few tens of meters where they mix with cold NaSO4 groundwaters. The observed Na-Cl-SO4 composition of these waters derive from a mixing process between two end members at Vinadio and a pure NaSO4 composition at Valdieri.
The aim of this part of the study is the identification of the geological structures related to the thermal water circulation. To reach this goal two passive geophysical methods were chosen: gravity and magnetotelluric. Gravity method aims to identify the gravity anomalies within an area which are related to the density distribution at depth. Magnetotelluric methods investigate the fluctuations of the natural electric and magnetic fields to obtain the electrical resistivity anomalies at depth. It has been shown in the past that these two methods are appropriate to investigate thermal waters circulation paths and thus geothermal reservoirs at depth.
During the summer 2010 two campaigns were carried out. The gravimetric survey involved the measures of gravity data along profiles. The 384 measures were then elaborated and corrected (instrumental drift, tides, free air correction, Bouguer and topography corrections). The obtained Bouguer anomaly map was in a first step used to identify areas of anomaly to plan the further investigations.
From magnetotelluric surveys the electric resistivity as function of frequency was determined to investigate different depth. The high frequency band allow to investigate a depth up to 2km with a good resolution of the data, the low frequency band reached about 10km of depth. Data were elaborated by 1D and 2D inversion. Four behaviors and corresponding site groups have been identified in respect to the distribution of the resistivity at depth: decreasing resistivity, increasing resistivity, constant resistivity with depth, high shallow resistivity and strong lateral discontinuity effect at depth.
The goal of the project is to elaborate more deeply the data and to integrate them together to a 3D geological model that has been elaborated and figure out which structures are responsible for thermal water circulation and therefore identify areas suitable for drilling and exploitation of the geothermal resource.