Geophysical investigation of a mineral groundwater resource in Turkey

Mario Naldi – Techgea Servizi Sas – Torino e-mail info@techgea.eu

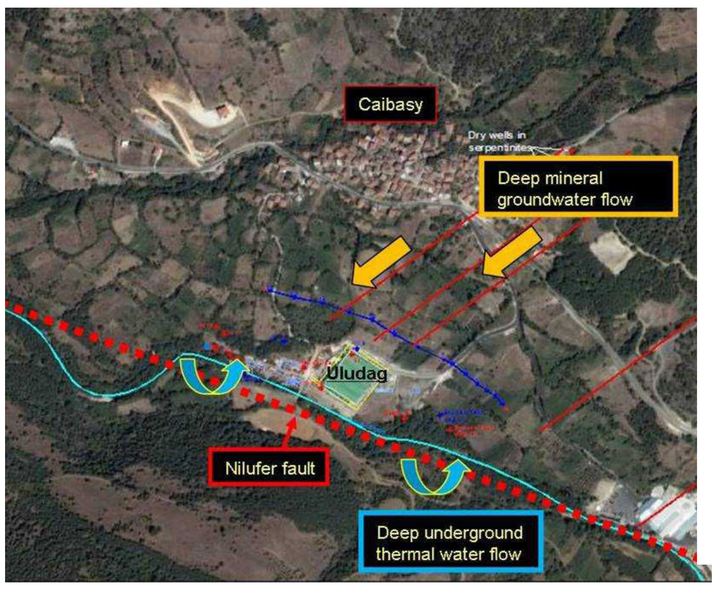
There are many mineralised groundwater resources in Turkey (high TDS, high CO_2 content and medium-high water temperature), located nearby to the main tectonic structures (fault and fractured zone). Uludag Company (the bottling company of the Uludag water, among the most popular brands of mineral water in Turkey) in 2008 planned a research program to increase mineral water production with drilling of some new water wells. According to the final use of the water (mineral water for bottling), well siting had to accomplish some requirements: a) finding of a stable (main chemical parameters) and pure (from bacterial and chemical pollution) water (in terms of chemical stability); b) considering a strong natural protection against primary or secondary source of groundwater pollution (fertlizers, pesticides, ecc.); c) avoid too much mineralised water (undesirable).

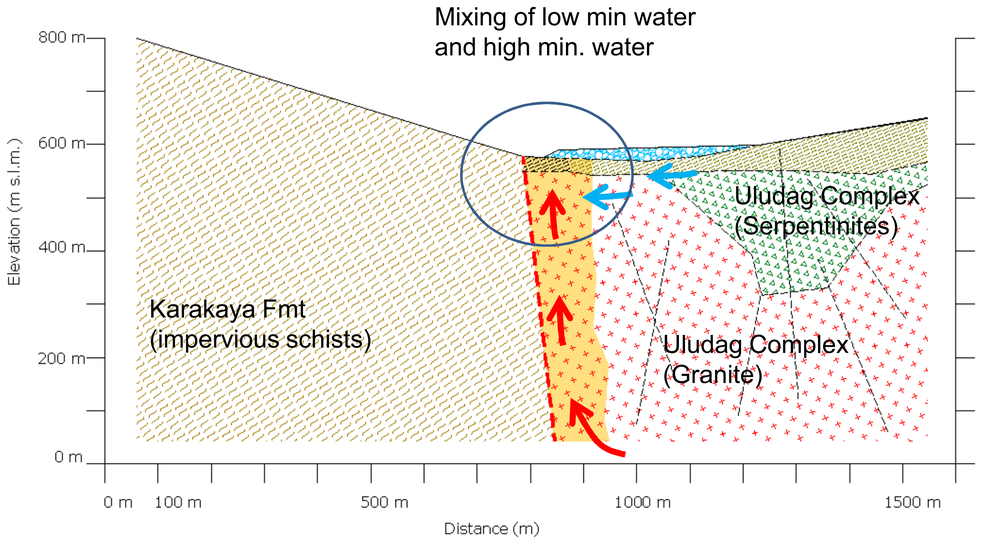
To optimize the new well location, according to the previous requirements.,we defined an investigation plan with TDEM and geoelectrical methods. Both the methods measure electrical resistivity of the underground, and, in such a case, have been choosen in order to define

1. The general hydrogeological model, according to different water types (i.e.: mixed aquifer, deep and strong mineralised aquifer, etc,)
2. Locate the low resistivity structures (water bearing fault)

Hydrogeological Model

The hydrogeological model is quite complex: deep mineral and thermal water rises from a main vertical fault which separates two lithological complexes. The highly mineralised (deep) water is naturally mixed with low mineralised water at a shallow depth, 30-40 m; the mixed mineral water is found in some surface springs and shallow wells, while the highly mineralised water is found at depth in some unused deep wells located close to the main fault. All the water points (springs and wells) are located inside a “mineral water belt” on the north side of the Nilufer River.

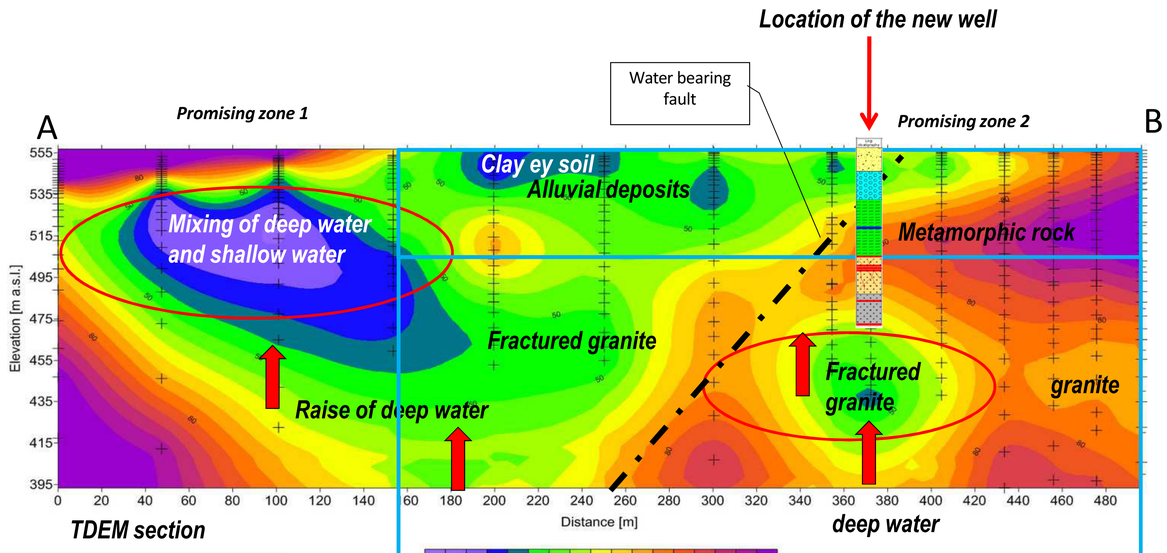




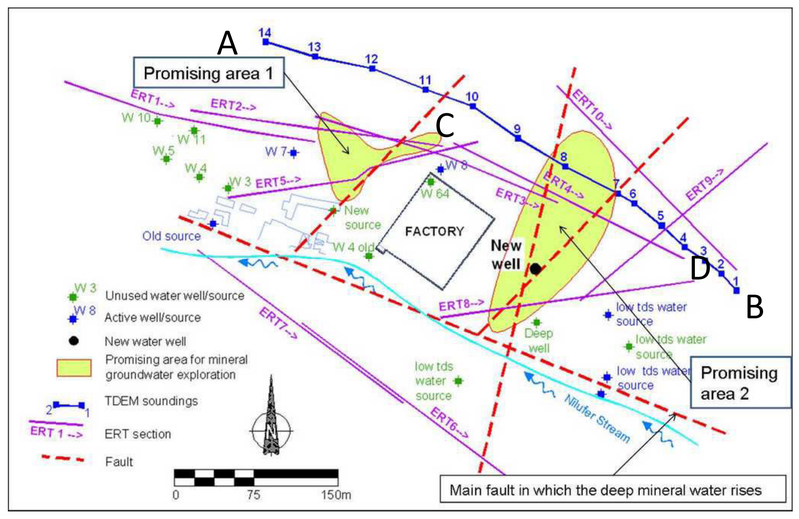
Geophysical survey

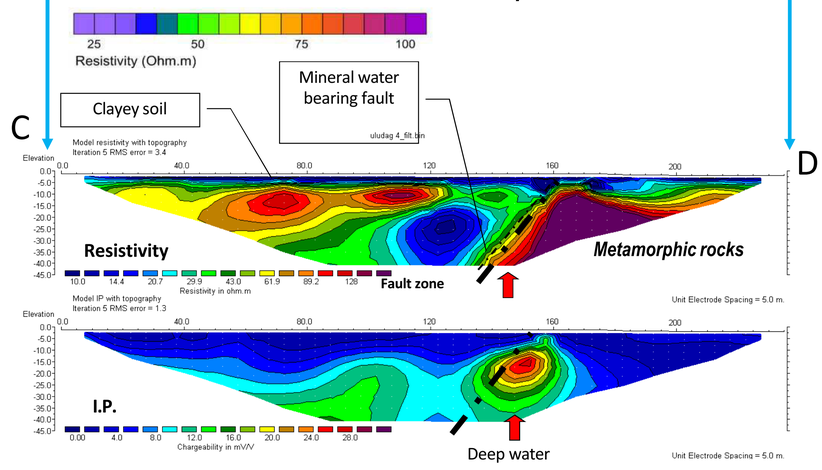
The main geophysical properties in hydrogeological prospecting of thermally active area is the electrical resistivity of the geological material. It is well known as the electrical resistivity of the geo-material is influenced by temperature, fluid contents and salinity. Therefore salt-rich water at high temperature may influence the material electrical behaviour. The TDEM and the electrical resistivity methods are well known in exploration geophysics and measure the same fundamental property, resistivity, but have different degrees of sensitivity and will not necessarily respond to the earth in the same manner. The methods are complementary in many ways: although both methods measure the electrical conductivity or resistivity of the sub-surface, they sample different volumes and have different sensitivities.

The geophysical survey confirmed the hydrogeological model and highlighted two promising zones for well siting (zones with very low electrical resistivity and high induced polarisation anomalies, corresponding to the main water bearing faults). One of the geophysical anomalies, the furthest from the exploited sources, was verified by means of a test well; the drilling results have confirmed the water mixing model.



TDEM section

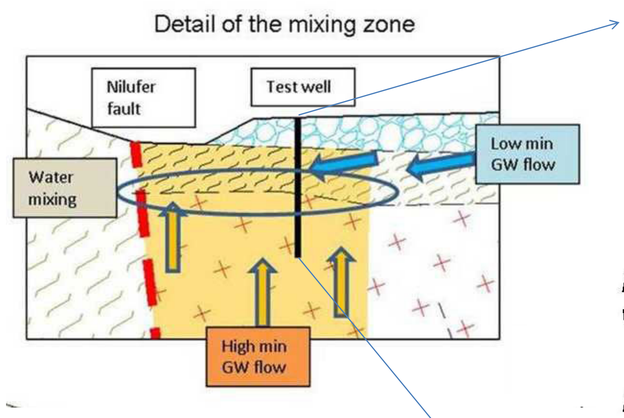


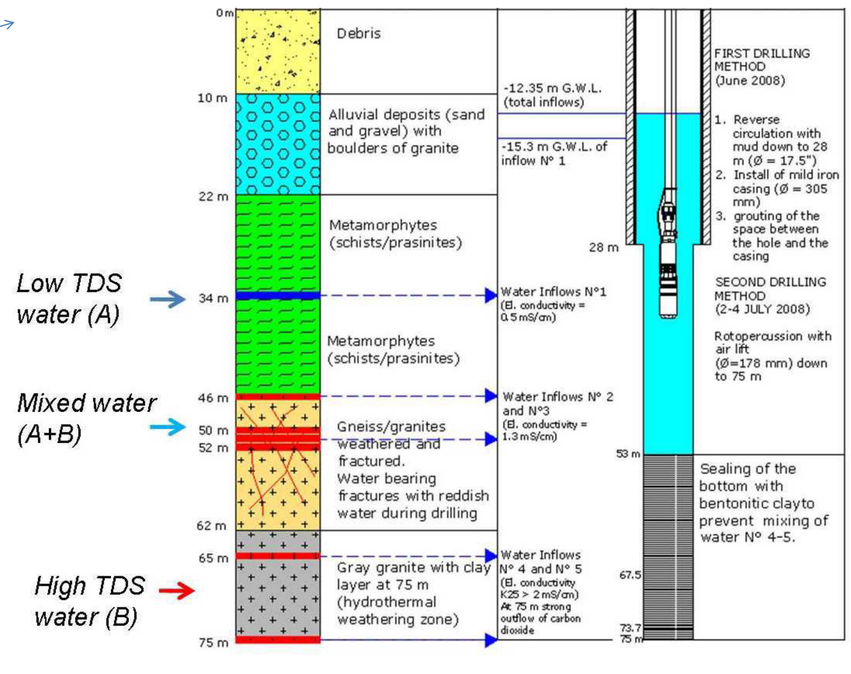


ERT section C-D

Well drilling

The well drilling in the promising zone 2 has intercepted all the three different waters, confirming the initial hydrogeological model. In the final design of the well the mixing with the highly mineralised water has been prevented with the sealing of the bottom of the hole.





Conclusions

In a complex geological area well siting could be problematic, because of the uncertainty of the water bearing structures location. In such a context the geophysical survey is the more thorough and appropriate approach for site characterization than conventional drilling. Overall cost of the geophysical survey is also usually some fraction of the final drilling cost.