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Imaging Industrial Pollution Using Electric Resistivity Tomography (ERT). Preliminary Results from Thessaloniki Tanneries (Greece)

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Introduction

Pollution from organic and inorganic pollutants is very frequent in places with industrial activity. The existence of pollution plumes in shallow or even in deeper aquifers is inevitable. Pollution can be due to raw materials that are used during treatment of industrial products, during the storage of intermediary products and from the remains (wastes). The cost of risk assessment for the polluted regions, with the existing geochemical environmental techniques, is judged expensive, time-consuming and does not provide results for the entire region.

Imaging of the pollution of waters in rural regions, recording the pollution in places of industrial wastes deposition, imaging of salination of underground water regions, imaging of the water-bearings stratum pollution from petroleum products and other environmental problems have been identified using lot of geophysical techniques. The fast cover with dense network of measurements in the entire region that offers the possibility of extension is one of the main advantages of the geophysical methods. In opposition, the geochemical techniques cover parts of the polluted area with specific samplings and chemical analyses.

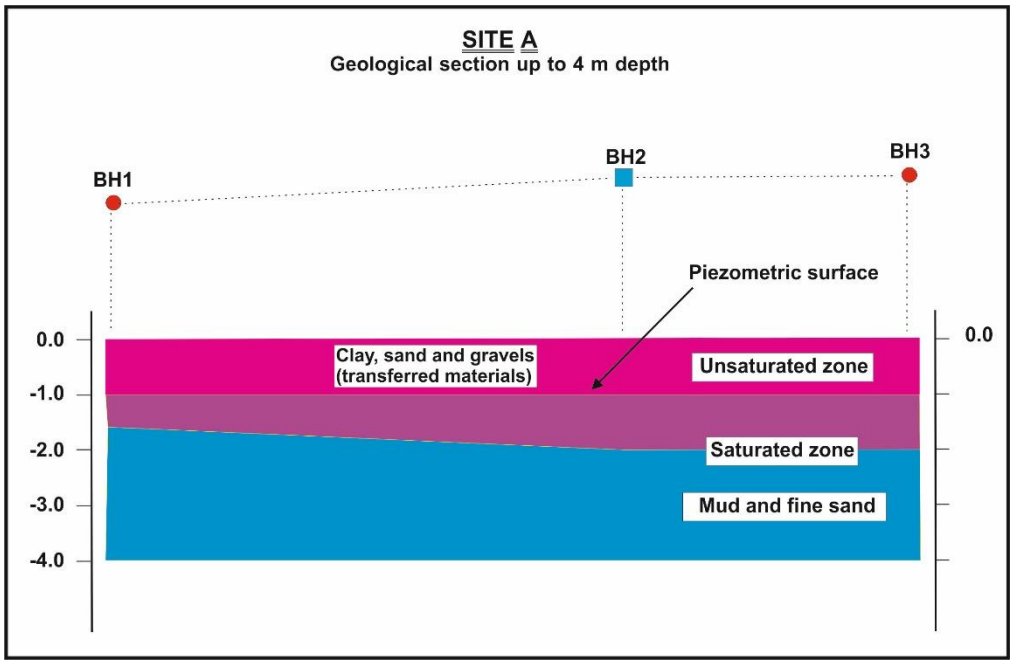

Figure 1. Geological section of site A according to boreholes BH1, BH2 and BH3.

Geological and hydrogeological setting

The tanneries of Thessaloniki established in 1970. Then they were developed arbitrarily. Surface channels with polluted liquids, storage of dangerous chemical substances without particular precautions etc. had resulted the pollution of subsoil and underground waters and the progressive demission of the environment.

The geophysical research was realized in 3 selected places A, B and C. The geological and hydrogeological conditions in region A, as these were recorded the shallow drillings (BH1, BH2 and BH3) are as follow: Unconsolidated geological formations (sediments) up to 5 m in depth, consisting of sands, fluvial and torrential deposits, red clays with limestone conglomerates (figure 1). Underground water measurements showed that the pH values are normal and the electric conductivity values are between 3,41 and 6,95 mS / cm. Low concentration values (0,5 - 6,8 mg/l) of free oxygen prove the existence of organic pollutants.

The chromium (Cr^{+3}), the zinc (Zn) and the arsenic (As) are the inorganic pollutants in the soil and the dichloromethane and the acetone are main organic.

The chromium (Cr^{+3}) is also observed in the underground water while the petroleum products (TPH) are main organic pollutants (Atzemoglou et al. 2003).

Geophysical research and results

We applied the electric resistivity tomography (ERT) at the region of tanneries of Thessaloniki (Greece), aiming at the investigation of subsoil and underground water in-depth up to 5 meters. The research was realized with the LUND system of ABEM that supports many electrode configurations and 42 electrodes (max.). Data were initially plotted in pseudosections and bad quality data points were rejected. Subsequently the data were processed using a non-linear 2-D inversion scheme and the results of the region A are showed in figure 2.

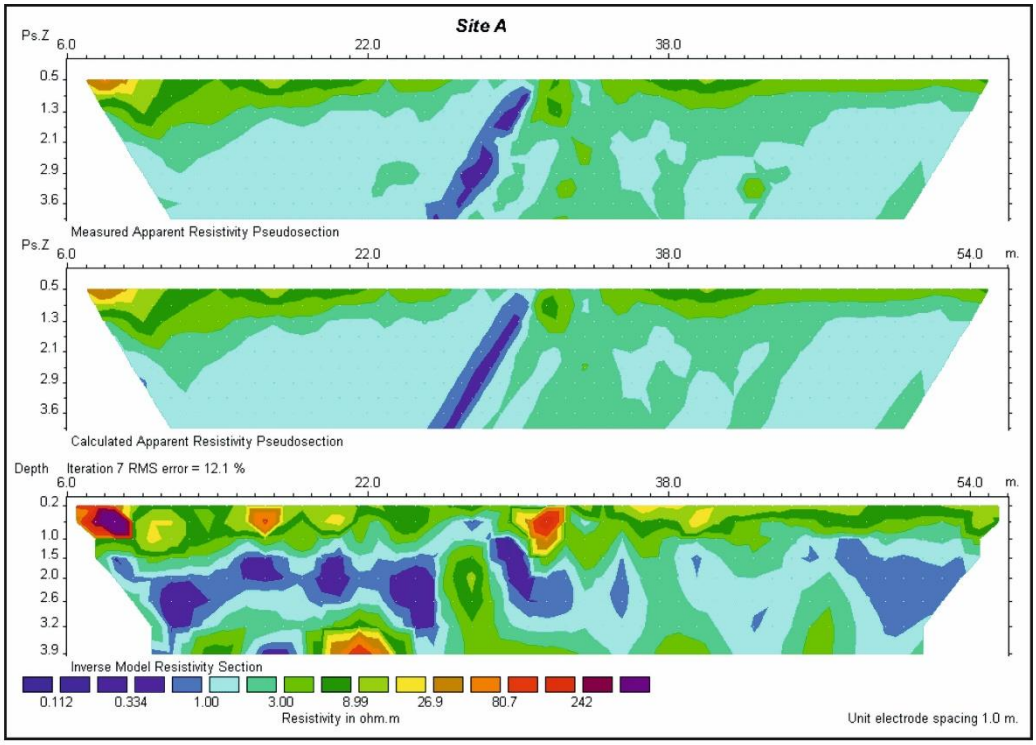

Figure 2. Inversion of geoelectrical measurements in region A.

The geophysical identification of the pollutants present in the underground water depends mainly on the contrast between the rock porosity properties, when it is saturated with water, and when it contains various humid pollutants. The rock resistivity depends also from the rock's electronic conductivity and the electrolytic (ionic) conductivity of the water contained in their pores. Thus the measurement of resistivity is decisive. The organic and inorganic substances can cause decrease of the resistivity of the materials. This decrease could be referred to the increase of the total dissolved salts (TDS) found in the rock.

The content of soil samples in chromium, at 1-meter depth, is 5 to 10 mgr/l and is lower (1%) than the surface chromium values. That content does not influence considerably to the electronic conductivity. The content of samples of water in chromium reaches the 0,2 mgr / l percentage that according to relation TDS and conductivity (Driscoll, 1986) cannot increases the conductivity of water above 0,4 mS/cm. If we take into consideration that the measured conductivity of water is 3.000 until 7.000 mS/cm (salination), we could conclude that the effect of Cr concentration to electric resistivity measurements is very small. With the same reasoning, the content in hydrocarbons of petroleum products does not affect the measurements of electric resistivity. The content in NaCl in studied region is too high (noise) that the previous concentrations does not affect decisively to measured resistivity values.

References

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