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Geoelectric assessment of soil properties modification due to underground water contamination

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Geophysical investigations, including resistivity and conductivity measurements, have been carried out in an agricultural area with variations of crop growth, located in the vicinity of the Petrobrazi oil refinery, Romania. The scientific project was devoted to the geoelectric assessment of soil and underground water contamination with oil derived products, based on the physical properties modification due to high resistivity contaminants.
The shallow geological structure consists of soil (1 m), loess (0.5 m), sandy gravels (20 m) and clay, the oil contaminants being displaced horizontally by the aquifer dynamics with ca 100 m/year at a mean depth of 5 m, at the limit between the vadose and saturated zones. Due to sudden increase of underground contaminantion during technical accidents within the refinery, when the contaminant height above the aquifer reached 4.5 m, and oscilations of water table level associated with seasonal high precipitation regime, the geological formations within the vadose zone were upward polluted. More of that, due to capillarity processes developed on more then 70 years of industrial activity, this upward contamination affected also the soil layer.
Results of 3D multielectrode resistivity measurements using the AGI SuperSting showed significant variations of this physical parameter between the surface and 1 m depth. The southern sector, affected by high contamination at the aquifer depth displays high resistivity values, the highest geoelectric anomalies being interpreted as small areas where oil derived products accumulated as a consequence of vertical migration. The soil of the southern sector is characterised by low resistivity values, suggesting that upward contamination processes were much weaker.
In the area surveyed with the multielectrode system, conductivity measurements were carried out using a high resolution conductivity meter. Variations of soil quality between the northern sector and the southern one have been observed also on the conductivity data obtained with the GEONICS EM-34RT instrument.
By having information on the soil resistivity and conductivity obtained using different geophysical techniques we were able to clearly separate a number of horizontal soil layers and distinguish between different factors that may be the cause of variability in soil properties (moisture content, mineral composition and pollutants).
Within the non-contaminated area, the resistivity values do not show large variations (difference less than 50 Ohm*m), and the highest resistivity value does not exceed 150 Ohm*m. This range of variation may be mainly associated with differences in the mineral composition of the soil. The higher resistivity domain located at the northern part of the area, up to 400 Ohm*m, is interpreted to be due to the cummulative effect of the mineralogical changes and the presence of the high resistivity contaminant.