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Electrical Resistivity Tomography for monitoring the contamination from Olive Oil Mills' Wastes: Application in disposal sites of Crete, Greece

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Olive oil industry is considered to be one of the driving sectors of the agricultural economy around the Mediterranean countries. During the last 15 years Greece produced annually an average of more than 300x103 tons of olive oil, thus rendering it the third olive oil producing country worldwide after Spain and Italy. From an alternative perspective this brings the whole European Union to a leading place within the international olive oil market thus comprising an important financial activity for the producing countries. Especially the island of Crete contributes about 5% of the world's olive oil production.

Olive oil is a key element in the well-known Mediterranean diet and beneficial on the human health. However the extraction process of olive oil is associated with the production of large amounts of solid and liquid wastes with high organic load and rich in inorganic constituents. One of the main characteristics lies on the fact that these wastes are accumulated within the relatively short harvest period in winter (November to late February). Olive Oil Mill Wastes (OOMW) have dark brown color with unpleasant smell, they are characterized by low resistivity, and their high concentration of phenolic compounds renders them toxic for the environment and human health. The lack of specific legislation has led to the common practice of disposing the OOMW in man-made evaporation ponds or directly to the surface water systems such as streams, torrents or rivers. Unfortunately in reality these ponds are poorly constructed which results in the OOMW either to overflow on the ground or leak into the subsurface.

This work describes the efficiency and ability of electrical resistivity tomography to map and monitor the subsurface contamination caused by OOMW. The spatial distribution and temporal variation of these wastes are investigated through an integrated methodological flowchart composed of numerical modeling, supervised tests in experimental tanks and real data collected from three active waste disposal sites in Crete. Synthetic modeling was used to simulate and reconstruct the movement of the olive oil mills' wastes (OOMW) as a conductive target within a layered resistive medium using both surface and cross-borehole configurations. The flow of an OOMW liquid was also monitored in a saturated sandy layer through cross-hole ERT. Finally the mapping and monitoring results from three different OOMW sites in Crete validated the efficiency of ERT in real situations.

In all cases the results show that time-lapse ERT is a robust geophysical method for monitoring the spatial distribution and the temporal variation of the contaminant's movement into the subsurface. The mapping and monitoring was made feasible due to the electrical signature of the "target" which is more conductive in comparison with the environment. In general numerical, experimental and real data results show a high degree of correlation suggesting the ERT as a powerful tool to map and monitor the subsurface contamination resulted by the byproducts of the olive oil industry.