Geoelectrical characterization of the internal structure and biodegradation of an old Municipal Solid Waste

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This study presents results from geoelectrical methods performed on an old French Municipal Solid Waste (MSW) landfill located in South of France. This site has been exploited from 1980 to 2001 during which 15 cells of around 15 m thick have been sequentially filled with 50% of municipal waste and 50% of industrial waste. The site was covered by a rather non homogeneous a 2 m clayey material. The most recent cells present a geomembrane at its base or at its borders.

The objective of this study was to test the feasibility of different geoelectrical methods to first characterize the internal structure of the landfill and secondly identify geoelectrical signatures associated with the degree of biodegradation. The Self-Potential (SP) method and the Spectral Induced Polarization (SIP) methods (gradient configuration) have been used over the oldest part of the landfill as cartographic methods. The Electrical Resistivity Tomography (ERT) and the Time-Domain Induced Polarization (TDIP) methods were performed as 2D profiles across cells of different age and different bottom barriers. Physico-chemical measurements (pH, EH, fluid conductivity, temperature) were performed on 16 piezometers and combined with geochemical analyses (major ions and biodegradation indicators).

Geochemical results have revealed a large contrast between the oldest cells in the Northern part of the landfill, which are characterized by stabilized leachate with waste in maturation phase, and the most recent ones in the South characterized by intermediate leachate in methanogen phase.

Geoelectrical results have shown that the SP signal is mainly influenced by the biodegradation of the waste with negative values located on the more mature cells. This method has also enabled a rather good delimitation of cells boundaries. The SIP method has identified a more conductive zone characterized by a great phase (> 50 mrad) in the Northern part of the landfill depleted of vegetation and characterized by a different geochemical behavior compared to the rest of the cell. The ERT profile has delimitated the lateral boundary of the cells and their thickness but with an overestimation, mainly due to the very great conductivity of the waste (<2 Ohm.m). Zones of perched aquifer have been identified as well as the presence of geomembrane in the bottom of the most recent cells. The most recent cells containing leachate in methanogen phase with high temperature, very low dissolved O_2 and strong negative redox potential are characterized by the lowest electrical resistivity values. The TDIP profile has clearly delimitated the boundary of the landfill with normalized chargeability greater than 3 mS/m. This method has also put in evidence the heterogeneity within each cell that presents important normalized chargeability contrasts but without clear distinctions regarding the biodegradation.

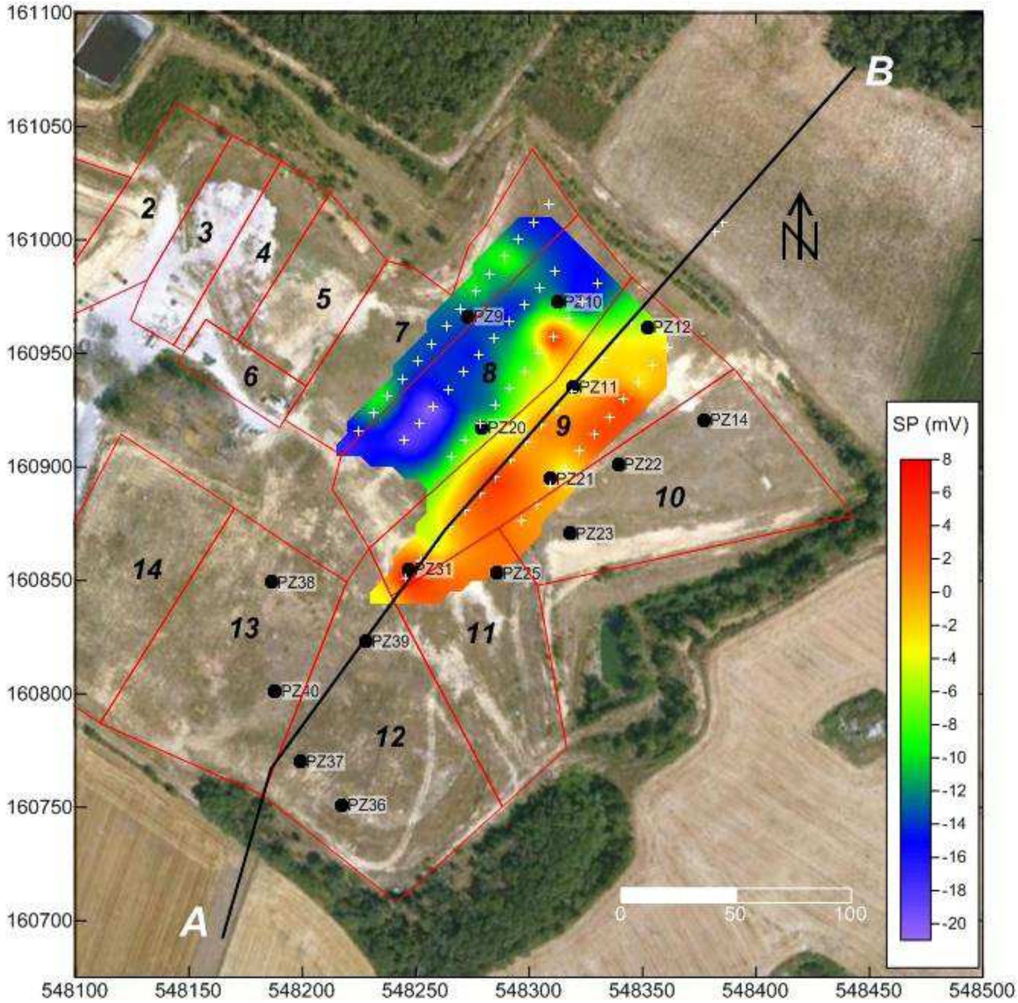

Figure 1. Self potential map obtained over the Northen part of the landfill. Data point are located as white crosses. Black numbered circles correspond to analysed piezometers. Cells are delimitated by red lines and numbered with white figures. The black line oriented South-North is the ERT profile naled AB.

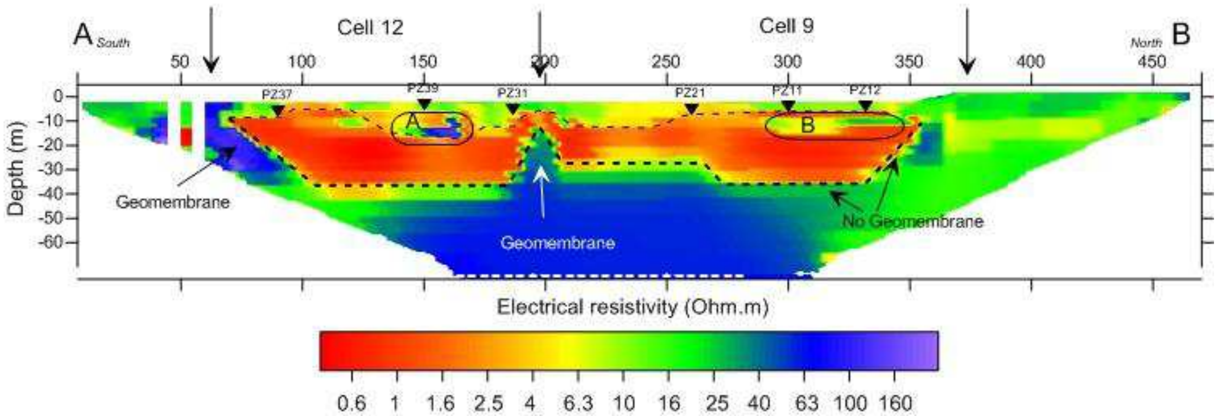

Figure 2. Electrical Resistivity Tomography obtained with a Wenner-Schlumberger array and an electrode spacing of 5 m. Cell 9 is the oldest and cell 12 is the most recent. Encircled zones A and B are possible perched aquifers inside the landfill. Leachate levels measured on piezometers are also reported as reversed black triangles.