TOWARDS THE DETERMINATION OF VOLUMETRIC WATER CONTENT IN WASTE BODY FROM ELECTRICAL RESISTIVITY: LABORATORY TESTS PART II

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INTRODUCTION

One of the key points of bioreactor landfill is to control the hydraulic repartition of leachate in waste mass to ensure an optimal degradation. Specific conditions linked to Municipal Solid Waste (MSW) landfill exist such as: important waste cells volume, waste heterogeneity, landfilling constraints, leachate and biogas distribution and justify exploring non intrusive method with a resolution larger than waste heterogeneity. Geophysics methods appeared as an interesting tool and especially the electric tomography of resistivity to highlight the moisture variations in waste mass.

ELECTRICAL RESISTIVITY ON LANDFILLS

Since 2001, electrical resistivity device are implemented on a landfill operated by SITA France (France). Results obtained from different surveys showed the validity of use of this method to follow leachate propagation from an horizontal perforated pipe imbedded in waste body. Since the beginning of the experimental studies, the key point is to link electrical resistivity variations to volumetric water content of waste in order to manage leachate recirculation system.

FIRST LABORATORY TESTS – 2005/2006

To achieve this goal, Cemagref manage laboratory tests in order to control waste and leachate parameters (density, porosity, temperature, electrical conductivity). Grellier (2005) realized tests with Cemagref in 2005 and demonstrated the possibility to fit Archie law linking volumetric water content and electrical resistivity.

In 2006-2007, Cemagref and Suez Environnement group conducted laboratory tests to propose calibration law between resistivity and moisture data for different densities of waste. The works were managed on reconstituted MSW (Modecom model: French waste reference established by the French EPA) to get under control the composition and the grain size distribution. The pilot cell of $0.2m^3$ is a circular HDPE tank, electrically insulator, provided with a waterproof fixed bottom and a mobile top to increase the density with the assistance of a hydraulic press. Two different electrical resistivity devices were imagined, one with two stainless steel discs at the bottom and at the top of waste to get global resistivity ($\rho_{vertical}$) and the other one with four punctual electrodes on cell side to investigate waste heterogeneity ($\rho_{horizontal}$). Results showed overall resistivity data stronger (15-400 Ω.m) than those observed during geophysical measurements on landfills: 5-100Ω.m (Moreau et al. 2005) and a large resistive anisotropy ($\frac{\rho_V}{\rho_H} \approx 4$). It can be mainly explained by: (1) the nature of chosen solid waste: fresh and not yet biodegraded, contrary to those studied on landfills and (2) the vertical compaction applied. Moreover, the dipole vertical resistivity device with the 2 stainless steel discs for both electrical current injection and potential measurement took into account resistance between the electrodes and the medium. So the data were skewed and probably unusable for this configuration.

LAST LABORATORY TESTS – 2007/2008

The devices for resistivity measurements were modified twice, in 2007 and 2008, to propose finally local resistivity measurements of waste mass stored in the test cell (Figure 1). Some new electrodes were located on cell side at 4 levels and 4 vertical lines. The 2 discs (P1, P2) were kept for current injection to create vertical devices with new electrodes. Horizontal quadrupoles were programmed for the 4 levels of electrodes. The denomination "horizontal or vertical" quadrupole comes from the position of the electrodes and the direction of the current lines supposed. The first campaign for waste collection was carried out on an industrial site in June 2007. The objective consisted in taking 3 quantities of a waste mass with contrasted electrical resistivity (Figure 2).

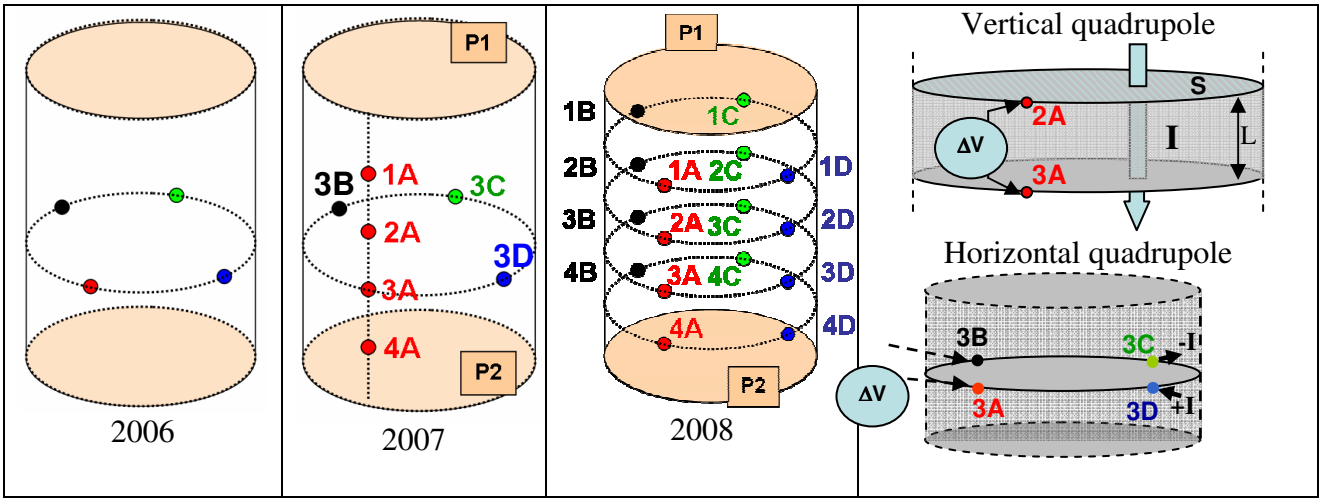

Figure 1: Evolution of resistivity configuration for the test cell

The localization of intake points of waste in the landfill was based on resistivity cartography recorded a few weeks before. Each sample of waste mass was studied in laboratory with the 2007 electrical configuration and for various stages of compression. The aim was to sweep a large range of density comparable with that observed on landfill.

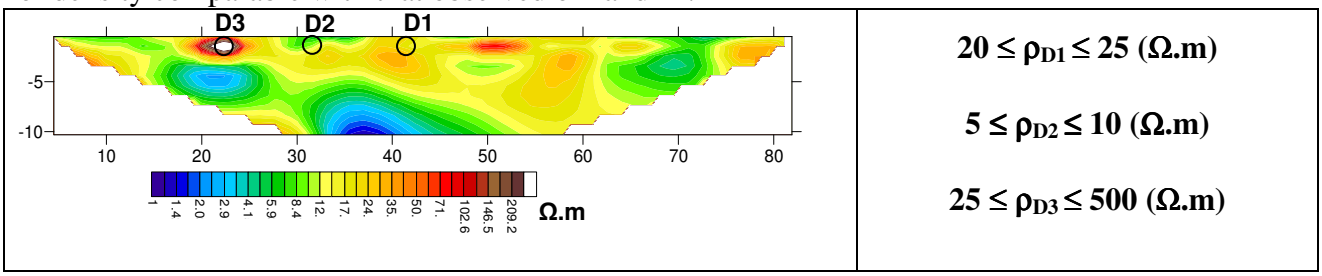

Figure 2: Cartography of waste mass collected for laboratory test

Laboratory results showed higher resistivity measurements from the both horizontal and vertical quadrupoles than data recorded on landfill (Figure 3a). Electrical resistivity anisotropy appeared like before with the Modecom waste. But the most interesting is highlighted by the local resistivities calculated from the different vertical quadrupoles: I(P1-P2) and ΔV: (1A-2A), (2A-3A), (3A-4A). For each stages of compression, important resistivity variability was observed between the 3 layers of waste mass (Figure 3b). The resistivity data variability does not allow to consider a homogenous density of waste mass in the test cell. If this assumption is verified, the volumetric water content calculated starting from the density could be also modified.

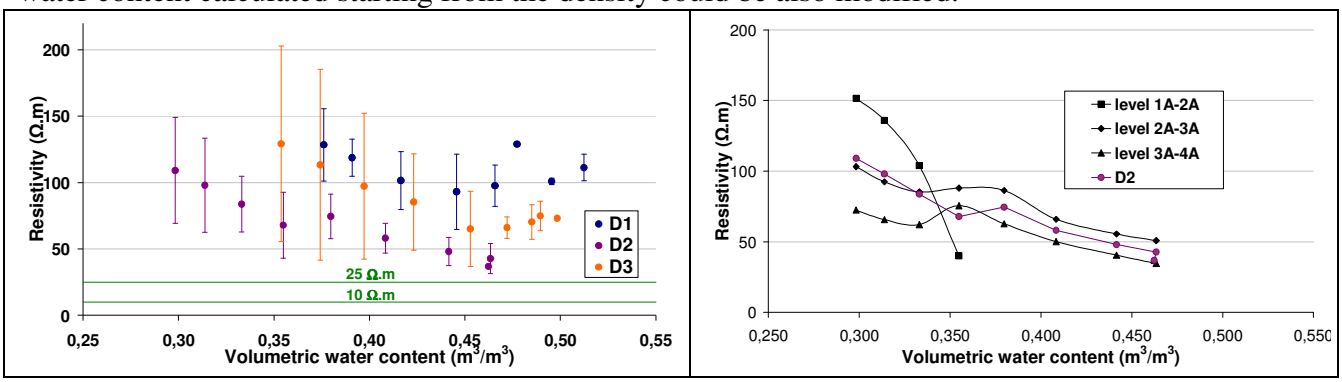

Figure 3: (a)Vertical resistivity data for the 3 samples. (b)Resistivity data according to the levels for D2

A new sampling campaign was carried out on a Landfill in 2008 to collect only one waste sample of 618kg characterized in situ for: volume, density, volumetric water content, temperature and resistivity. This original sample was separated and tested in 3 cells to estimate the reproducibility and to associate a local density and water content with the resistivity measurement calculated for each available quadrupole.