Characterization of a landfill using 2D time domain SIP

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Landfills are, or have been, the primary choice for municipal solid waste disposal in many parts of the world, as landfilling is seen as an easy and low-cost waste management option. Many landfills operational from 1950-1980 were designed without any kind of capture system underneath, leading to percolation through the waste and into the underlying geological layers and aquifer systems. Furthermore records of waste types and the deposited amount are often missing for old landfills. For large areas, it is very expensive to gain information on the landfill delineation using only drillings, and geophysics can be used for improving the knowledge in the whole area of interest. This work presents the characterization of the Risby landfill (Denmark) by a dense coverage of direct current (DC) and time-domain spectral induced polarization (SIP) profiles.

Risby landfill is an old and closed landfill that was used by the public authorities from 1959 to 1981 and privately by the Danish Forest and Nature Agency from 1981 to 1985. It is located in the vicinity of Copenhagen, on the island of Zealand, Denmark. No records explicitly report the waste types and the deposited amount, but aerial photos from 1945-1985 indicate the landfilling sequence. Furthermore, the aerial photos show that the landfill was placed on top of the old terrain without excavation.

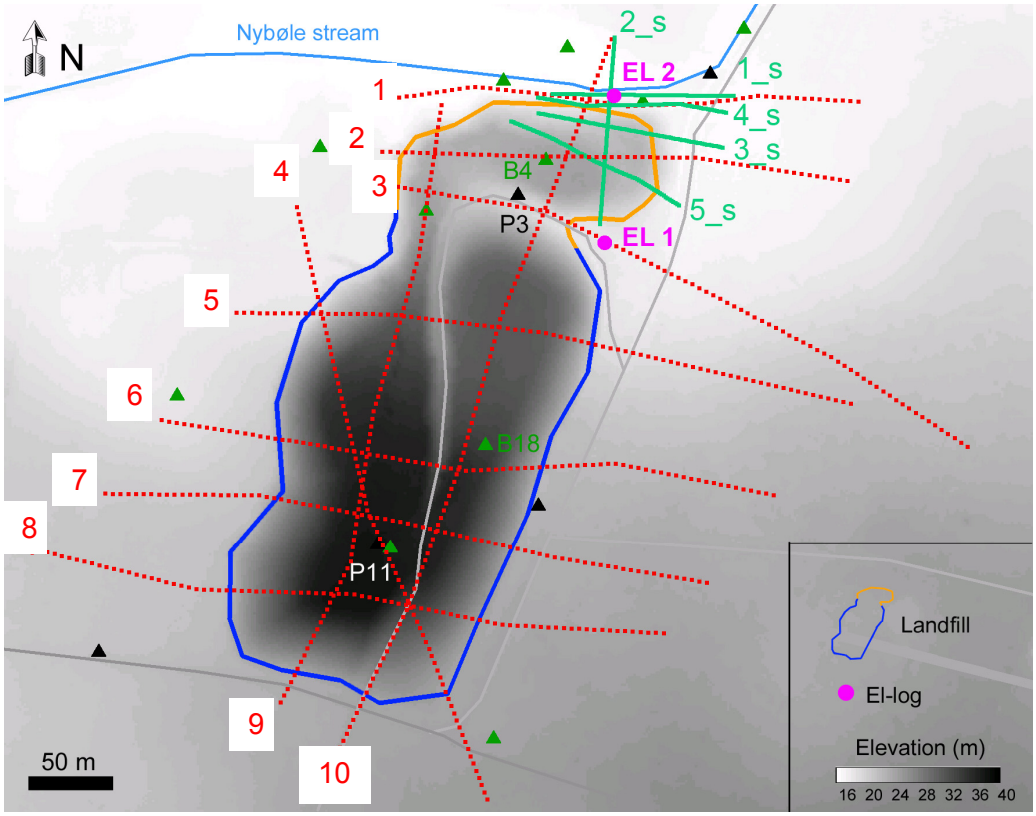

Fig. 1: Risby landfill and acquired profiles. Dotted lines: profiles with 5 m electrode spacing. Continuous lines: profiles with 1.5/1.0 m electrode spacing. Triangles: boreholes with lithology information. Circles: boreholes with in-borehole DC/IP measurements.

The survey consisted in the collection of 15 DC/IP profiles with electrode spacing of 5 m (Fig. 1, dotted lines) and 1.5 m (continuous lines, Fig. 1). Furthermore, 2 electrical loggings were carried out, with in-situ measurement of DC/IP data (Fig. 1, circles).The Syscal-Pro instrument (Iris Instruments) was used for the survey, with 4 seconds on- and off-time for current injection and 20 log-spaced time gates per quadrupole.

The DC data and the full IP decays have been inverted in 2D in terms of Cole-Cole parameters for extracting spectral information with AarhusInv, following Fiandaca et al. (2013). The inversion results have been compared with borehole information and the pre-landfill topography, obtained by kriging the DEM elevation at the landfill surroundings together with the waste/terrain interfaces in the boreholes P3, P11, B4 and B18 (Fig. 1).

The chargeability m_0 sections show anomalies with high values above the pre-landfill terrain (Fig. 2), where waste is present in the boreholes. In the north part of profile p10 and in profile p1 the chargeability anomalies appear below the pre-landfill topography and in situ DC/IP measurements (EL 2 in Fig. 2) confirm high-chargeability values below the waste, in a sand layer with polluted water. On the contrary, the resistivity sections do not show a good correlation with the waste thickness from boreholes nor with the pre-landfill topography.

These results highlight the added value of induced polarization in landfill characterization, when compared to the direct current method alone.

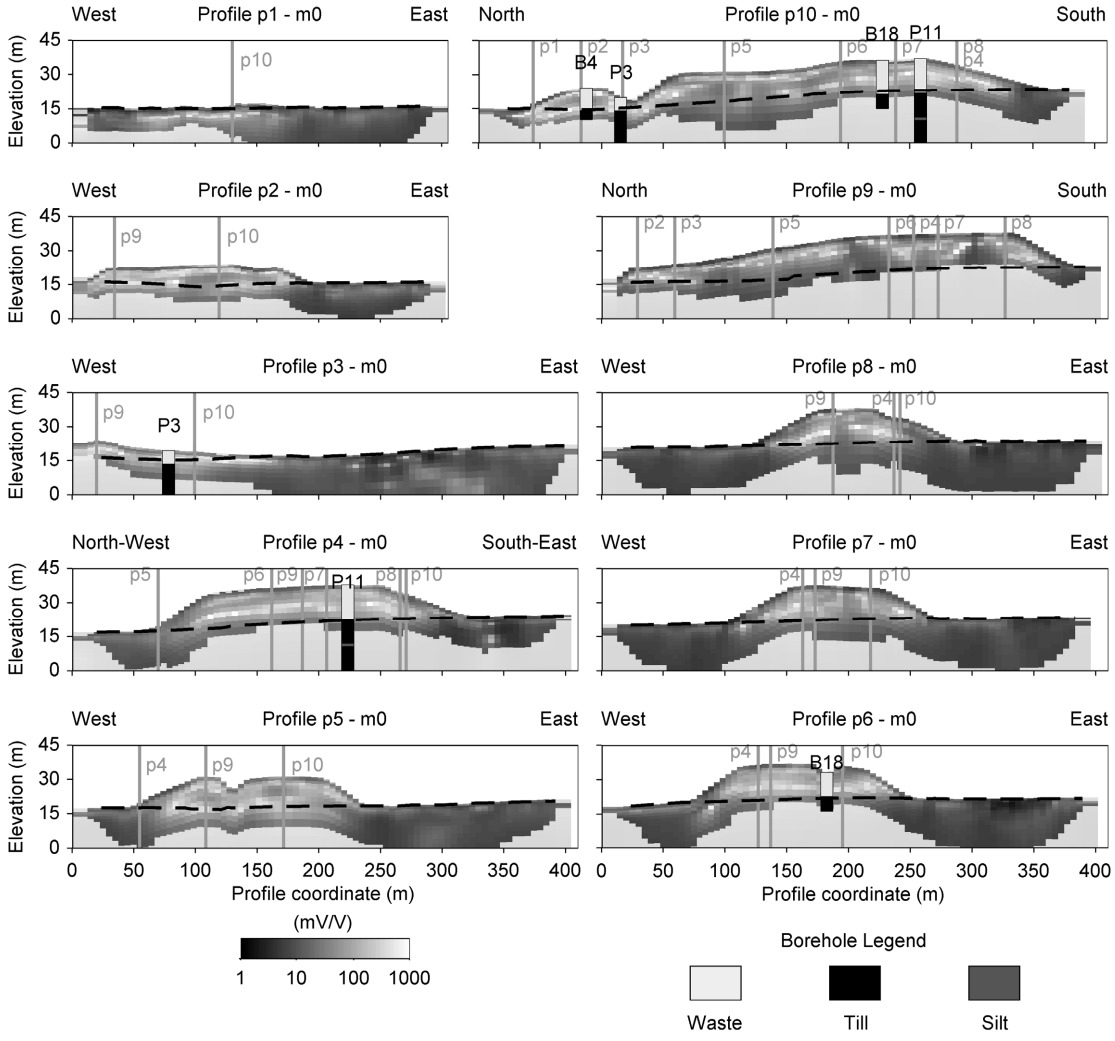

Fig. 2: Chargeability (m_0) sections for all the profiles with 5 m electrode spacing. Black dashed lines: pre-landfill topography. Grey vertical lines: crossing of profiles. Grey shading: poorly resolved area.

Reference

Fiandaca, G., Ramm, J., Binley, A., Gazoty, A., Christiansen, A.V. and Auken, E., 2013. Resolving spectral information from time domain induced polarization data through 2-D inversion. *Geophys. J. Int.*, 192, 631-646.